Sleep Health Among a Cohort of Nursing Workforce

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ABSTRACT

Sleep Health Among Nursing Workforce Members

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Background: The nursing workforce and the care they provide are essential to the health of individuals, families, communities, and populations. Approximately half of nurses report unhealthy sleep, which includes inadequate sleep duration, difficulty falling or staying asleep, short sleep duration, and inconsistent timing of sleep. Poor sleep health among the nursing workforce is associated with adverse health outcomes in the nurse, job turnover, and a decrease in safe and effective nursing care. National research priorities have underscored the need to examine sleep health among nursing workforces to inform effective mitigation strategies and best practices to optimize nursing sleep health and the provision of 24-hour safe, quality nursing care.

Purpose: The purpose of this study was to examine the association between job characteristics and sleep health (sleep duration insomnia symptoms, chronotype, self-reported snoring, and daytime dysfunction) across demographic characteristics, care settings and specialties, and sleep hygiene behaviors among a national cohort of registered nurses practicing in the United States and Canada. The specific aims were to: 1) Describe multidimensional sleep health across demographic characteristics (race, ethnicity, and immigration status) among registered nurses, 2) Describe the association between multidimensional sleep health and job characteristics (shift type, shift length, hours worked/week, and practice setting/specialty) among registered nurses, and 3) Test whether individual sleep hygiene behaviors (regularity of falling asleep with light on, brightness of ambient light during sleep, and blue light blocking application installed on electronic device) were effective at mitigating the association between job characteristics and sleep health among registered nurses.

Methods: The current study leveraged a subset of the existing national cohort data set of the Nurses' Health Study 3 (N = 1,342) to conduct three quantitative cross-sectional analyses. The first analysis (Paper one) consisted of a chi-squared test of independence to assess multidimensional sleep health across demographic characteristics of race, ethnicity, and

immigration status among nurses. Paper two involved multiple logistic regression analyses to estimate the association between multidimensional sleep health and job characteristics across nursing care settings and specialties. In paper three, logistic regression analysis was used to test for the modifying effect of sleep hygiene behaviors when examining the association between nursing job characteristics and sleep health among nurses practicing in various care settings and specialties.

Results: The first study analysis found that nearly 50% of the sample reported a healthy sleep duration on workdays, and more than 75% reported a healthy sleep duration on workfree days. The second analysis results indicated that working more than or equal to 12-hour shifts was *not* associated with decreased odds of healthy sleep compared to those working less than 12-hour shifts. The third analysis results demonstrated that individual sleep hygiene behaviors did not mitigate the decreased odds of healthy sleep associated with job characteristics.

Conclusion: The results from the three dissertation analyses provide important insights that broaden the scientific understanding of sleep health on workdays and workfree days and the complexities of the association with job characteristics among nursing workforces. Programs and policies aimed at improving sleep health among nurses should be extended beyond individual sleep health behaviors and be tailored to the distinct job design in nursing specialties. Future research is needed to expand the conceptualization of nursing work factors and how they influence sleep health among nurses and the associated patient populations.

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DEDICATION

With humility, I dedicate this dissertation to my ancestors, who broadened my shoulders, and my family and mentors, who supported my growth, determination, and passion.

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The study sponsors were not involved in the study design, analysis, data interpretation, or the writing of this dissertation.

Chapter 1: Introduction

Chapter 1. Introduction

Nurses are the largest group in the United States (U.S.) healthcare workforce.[1–3] The nursing workforce is essential to the health and well-being of individuals, families, and communities. Nursing job tasks may include administering medications and treatments, performing medical procedures, communicating with other care providers, and coordinating care and healthcare services.[2,4] These job duties, skill set, patient population, work schedule, work environment, healthcare team, and work stressors depend greatly on the care specialty and setting.[2] Nursing work is further characterized by daily physical and emotional stressors that have an adverse impact on the nurse's health and well-being, such as long work hours, variable weekly schedules, irregular shift work (i.e., working during the day and night), and short staffing.[1,5] Importantly, these job stressors are associated with an adverse impact on the sleep health of the nurse and a decrease in the delivery of safe and effective nursing care that the public depends on.[6,7]

Buysse (2014) defined *sleep health* as a multidimensional sleep-wake pattern that can meet the work and social needs of the individual and support health and well-being.[8] This definition of sleep health includes the following domains: Regularity, Satisfaction, Duration, Alertness, Timing (chronotype), Efficiency (restfulness), and Duration (RU-SATED).[8–10] It is estimated that between 58% to 68% of nurses experience poor sleep health.[7,11–13] Poor sleep health among nurses is associated with fatigue, impaired cognition, and slowed decision-making[1,5,14,15] This is a critical public health issue because this can result in medical errors, poor patient outcomes, workplace injuries, nursing shortages, and rising healthcare costs.[1,5,14,15]

Sleep health among the nursing workforce is essential to the delivery of safe and effective nursing care across healthcare settings.[7] Nurses report a high occurrence of inadequate sleep duration, difficulty falling or staying asleep, short sleep duration, and

inconsistent timing of sleep.[7,11–13] Inadequate sleep and poor quality sleep can result in fatigue, impaired cognition, and slowed decision-making, which in turn can lead to medical errors, poor patient outcomes, needlesticks, occupational injuries, and increased healthcare costs.[1,5,14,15] Furthermore, poor sleep is associated with a variety of adverse health effects for nurses themselves, including anxiety, depression, decreased quality of life, cardiovascular disease, obesity, and premature mortality.[5,14,16] Work hours may include days, nights, evenings, rotating shifts, or a combination of scheduled shifts.[2] Working during the night has been linked to many adverse health outcomes, including depression, fatigue, and sleep disturbance.[1,17] This is important because these outcomes are associated with job turnover and decreased quality of patient care.[1,6] In addition to working outside of typical waking hours, nursing shifts over 12 hours have been linked to poor sleep health, fatigue, and a subsequent decrease in the delivery of safe and effective patient care.[1,6,12,18]

There is mounting evidence identifying 12-hour or longer shifts as a risk factor for poor sleep health.[1,6,14] Subsequently, an emphasis is placed on restricting the number of hours and shift lengths to address fatigue in nurses.[1,6,14] However, work hours alone do not account for other challenges such as work schedules, the impact of prolonged exposure to inadequate sleep, or the varied effects on sleep health across nursing specialties within and outside the hospital setting.[1,6,19] The public health need for consistent nursing care is not always amenable to a reduction in shift length or timing during daytime hours.[1] Further, an estimated 83% of nurses prefer working three 12-hour shifts/36-hour work week.[20] This three-day work week may facilitate recovery from stressful work shifts, reduced childcare costs, work-life balance, and decreased time spent commuting.[1] Some studies have found that the implementation of sleep-enhancing behaviors (sleep hygiene) may be effective at mitigating the adverse impact that nursing work can have on sleep health .[1,17]

Sleep hygiene refers to sleep practices and behaviors such as consistency of sleep timing, avoidance of stimulants before sleep, and decreasing light and sound at bedtime to enhance sleep duration and quality.[16] Enacting sleep hygiene behaviors has been shown to be effective at improving the quality of sleep.[16] Prior sleep research has identified that exposure to light, especially blue light, is the most detrimental factor for shift workers like nurses.[16,17] Some strategies, such as blocking the blue waveform before bed and enhancing bright lights during work, have shown some promise in improving the disrupted sleep-wake cycle associated with shift work in the nursing population.[1,17] Further investigation is needed to determine whether enacting individual sleep hygiene behaviors is effective at mitigating the adverse effects of nursing work on sleep health.[1]

National research priorities have emphasized the critical need to examine work schedules that inform strategies to mitigate fatigue and improve sleep health in the nursing workforce.[1,7] This research priority is underscored by the need to factor in the importance of 24-hour safe quality nursing care, positive patient outcomes, and schedules that promote work-life balance.[1] The current study aligns with national research priorities and addresses several gaps in the research, and generates new knowledge that will inform future research, programs, and policies aimed at addressing the public health issue of poor sleep health among nursing workforces. The current study leveraged existing public health data to examine the association between job characteristics, nurse practice setting/specialty (e.g., hospital, oncology, school nurse, home health), sleep hygiene health behaviors, and sleep health on workdays and workfree days for currently practicing nurses across demographic characteristics and nursing specialties.[7–9]

The Nurses' Health Study 3 (NHS3) began in 2010 with the ongoing recruitment of female-identifying nurses born in 1965 or after and residing in the United States or Canada[1]. The primary purpose of the NHS3 is to continue collecting data on measures of health and

wellness among a large cohort of nurses.[1] In addition, the NH3 aims to represent a diverse background of nurses.[1] In 2012, the NHS3 expanded its recruitment strategies to include sending study flyers to invitation flyers to racial and ethnic minority dense zip codes. Inclusion criteria were extended to include Licensed Practical Nurses and Licensed Vocational Nurses. In addition, the NHS began building relationships that include the National Black Nurses Association. In 2015, the NHS3 expanded the study population by recruiting and enrolling male nurses as primary study participants and male partners of study participants.[1]

Approximately 40,000 nurses are currently enrolled, 14% of whom identify as Asian, Black/African American, Multiracial, Native American or Alaska Native, Native Hawaiian or other Pacific Islander, or Hispanic/Latine[1]. In 2015, the NHS3 began recruitment and enrollment of male-identifying nurses[1]. The NHS3 collects data via web-based questionnaires sent out to the enrolled participants every six months. These surveys ask about health and lifestyle, such as pregnancy outcomes, heart disease, smoking, and diet.[1] Participant follow-up rates for the NHS3 are approximately 76% at 6-month intervals, 82% at 12-month intervals, and between 90-94% for beyond one year[1]. In 2017, the NHS3 questionnaire included questions related to sleep health. Between 2017 and 2021, 3640 participants answered the NHS3 questionnaire, which included the five dimensions of sleep health questionnaire.

The current study conducted a cross-sectional analysis from November of 2023- March 2024. After we excluded participants with primary employment as nurse educators or administrators, non-nursing fields, or nursing students, 2483 participants remained. We then excluded those who identified working an average of zero hours in nursing over the past year, did not have a degree or license in nursing, and did not complete the sleep health questionnaire, resulting in a final sample of 1,342 registered nurses. The NHS3 study protocol is approved by the Brigham and Woman's Hospital and Harvard T.H. Channing School of Public

Health Institution Review Boards. Additional information and details about NHS3 are located in previously published work.[1]

The purpose of this study was to advance our understanding of sleep health among nursing workforces as an important indicator of the health of nurses and subsequently the ability to deliver quality nursing care. The specific aims of this dissertation were to:

1. Describe multidimensional sleep health (sleep durations, insomnia symptoms, chronotype, self-reported snoring, and daytime dysfunction) across demographic characteristics (race, ethnicity, and immigration status) among registered nurses.
2. Describe multidimensional sleep heath by job characteristics (shifts type, shift length, hours worked/week, and practice setting/specialty) among registered nurses.
3. Test whether individual sleep hygiene behaviors (regularity of falling asleep with light on, brightness of ambient light during sleep, and blue light blocking application installed on electronic device) are effective at mitigating the association between job characteristics and sleep health among registered nurses.

To meet these study aims, three quantitative cross-sectional analyses were conducted leveraging the existing national cohort data set from the Nurses' Health Study 3. Aim 1 (Chapter 2) Demographic Differences in Sleep Health Among Nurses, Aim 2 (Chapter 3) Work Schedules and Multidimensional Sleep Health Across Nursing Specialties, and Aim 3 (Chapter 4) Nursing Work Schedules, Specialties, Sleep Hygiene, and the Impact on Sleep Health. The implications of the dissertation findings for future research, programs, and policies are discussed in Chapter 5.

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Chapter 2: Demographic Differences in Sleep Health Among Nurses

Aim 1 Abstract

Background: Inadequate sleep and poor quality sleep in nurses can result in fatigue, impaired cognition, and slowed decision-making, which in turn can lead to medical errors, poor patient outcomes, increased healthcare costs, and adverse health effects for nurses themselves. Over half of nurses report poor sleep health. Minoritized groups in the general population, experiencing discrimination, are disproportionally burdened by the associated stress and poor sleep quality compared to whites. Sleep health disparities among socially marginalized identities are not fully understood in the nursing workforce. There is limited understanding surrounding the intersection of sleep health and sleep hygiene behaviors associated with nursing work and sleep health disparities across demographic characteristics among nurses. The current study addresses this gap through the exploration of multidimensional constructs of sleep health on workdays and workfree days and sleep hygiene behavior differences by demographic characteristics among nurses.

Purpose: The purpose of this study was to describe multidimensional sleep health (sleep durations, insomnia symptoms, chronotype, self-reported snoring, and daytime dysfunction) across demographic characteristics (race, ethnicity, and immigration status) among nurses.

Methods: A cross-sectional secondary analysis of the NHS3 cohort survey data (N = 1,342). Participants were included if they reported practicing as a nurse when they completed the NHS3 study survey. A Chi-squared test of independence was used to assess multidimensional sleep health on workdays and workfree days across demographic characteristics of race, ethnicity, and immigration status among nurses.

Results: Nearly 50% of the sample reported a healthy sleep duration on workdays compared to more than 75% reporting healthy sleep duration on workfree days. Eighty-two percent of participants reported lack of sleep having little to no impact on their daily functioning. There

were no statistically significant differences in total sleep health scores on workdays and workfree days comparing white and non-white participants. No statistically significant differences in total sleep health scores on workdays and workfree days comparing U.S.-born and non-U.S.-born participants were identified. Of the total sleep health scores, 51% of non-white participants and 60% of white participants were categorized as having healthy sleep on workfree days (p=.06). Sleep duration on workdays did not vary by diagnosis of anxiety or depression. Hispanic/Latine participants were less likely to self-identify as morning chronotype compared to non-Hispanic/Latine participants (p=.04). The sleep hygiene behavior of sleeping with the light off was reported by 69% of non-white and 78% of white participants (p=.03).

Conclusion: Multidimensional sleep health among nurses is essential to mental and physical health, patient safety, and public health. The nursing workforce may be experiencing disproportionally poor sleep duration and overall poor sleep health on workdays. Self-reported measures of daytime functioning may be inadequate at detecting daytime fatigue. Nurses of racial and ethnic minorities may be experiencing the additional burden of poor sleep on workfree days warranting more research examining sleep as a health disparity for marginalized racial, ethnic, and social identities among nurses.

Introduction

Nurses represent the largest sector of healthcare professionals and provide services essential for the public's health.[1,2] Accordingly, the health of nurses is a critical factor in the delivery of safe and quality healthcare.[3] Poor sleep health -- including short sleep duration, variability in timing, efficiency, alertness, and satisfaction -- intersects with the wellbeing of nurses, and affects an estimated 58% of hospital-employed nurses.[3,4] Two recent national studies and a meta-analysis showed that 43% to 68% of nurses reported poor sleep quality or inadequate sleep, including difficulty falling asleep or maintaining sleep, non-restorative sleep, or inadequate sleep duration.[3–6] Reasons for inadequate sleep include inconsistent sleep hygiene habits, insufficient knowledge about healthy sleep behaviors and the impact of poor sleep, comorbid mental and chronic health conditions (arthritis, cardiovascular disease, diabetes, depression, anxiety), shift work, and/or family-work stress.[7,8] Inadequate sleep and poor quality sleep can result in fatigue, impaired cognition, and slowed decision-making, which in turn can lead to medical errors, poor patient outcomes, needlesticks, occupational injuries, and increased healthcare costs.[9–12] Furthermore, poor sleep is associated with a variety of adverse health effects for nurses themselves, including anxiety, depression, decreased quality of life, cardiovascular disease, obesity, and premature mortality.[9,10,13]

Sleep health is a multidimensional pattern of sleep-wakefulness and includes sleep duration, satisfaction, alertness, efficiency, and timing (chronotype). [14–16] Individual sleep health patterns are adaptive to one's work, social, and environmental contexts.[16] Nurses have a high prevalence of short sleep duration, variability in sleep timing, and poor quality, yet the most common measures of sleep duration do not account for differences in workdays and non-work days.[18] Chronotype or sleep-wake cycle is another facet of sleep health and a surrogate measure for circadian rhythm.[15] Chronotype is particularly relevant to nurses who do shift work outside typical waking hours.[10,15,19] The circadian cycle as a contributor to sleep health is

strongly influenced by light, with blue-light having the strongest impact.[17] Sleep hygiene behaviors such as blue light blocking strategies on electronics and low ambient light during sleep have shown promise at improving the disrupted sleep-wake cycle associated with nursing shift work. [17]

Sociodemographic factors must also be considered to understand how sleep health may differ among individuals from minoritized racial, ethnic, and social groups.[12,20–22] Notably, minoritized groups in the general population, especially those experiencing discrimination, are disproportionally burdened by poor sleep quality and short sleep duration when compared to whites. [12,20,21] Discrimination is associated with stress, adverse impacts on mental health, and poor sleep.[20,22] Members of minoritized racial, ethnic, and social groups may be experiencing additional social stressors at work and outside of work that further contribute to poor sleep health and sleep behaviors.[12,22] The U.S. nursing workforce is increasingly racially and ethnically diverse, with non-U.S.-born nurses making up a growing proportion of nurses working in the hospital setting. Sleep health disparities, defined as differences in one or more dimensions of sleep health on a consistent basis that adversely affect individuals with socially-marginalized identities, are not fully understood in the increasingly racially and ethnically diverse nursing workforce [1,3,12,16]. There is limited understanding surrounding the intersection of sleep health and sleep hygiene behaviors associated with nursing work and sleep health disparities across demographic characteristics among nurses[11,12,23]. The current study addresses this gap through the exploration of multidimensional constructs of sleep health on workdays and workfree days and sleep hygiene behavior differences by demographic characteristics among currently practicing nursing workforce.

Methods

Participants and Study Design

The Nurses' Health Study 3 (NHS3) began in 2010 with the ongoing recruitment and enrollment of nurses born in 1965 or later, residing in the United States or Canada.[24] Approximately 40,000 nurses are currently enrolled, 14% of whom identify as Asian, Black/African American, Multiracial, Native American or Alaska Native, Native Hawaiian or Other Pacific Islander, or Hispanic/Latine.[24] In 2015, the NHS3 began recruitment and enrollment of male-identifying nurses.[24] The NHS3 collects data via web-based questionnaires sent out to enrolled participants every six months. More information about NHS3 is reported elsewhere.[24] Beginning in 2017, the NHS3 questionnaire included questions related to sleep health. Between 2017 and 2021, 3640 participants answered the NHS3 questionnaire, which included the six dimensions of sleep health questionnaire. After excluding participants not currently working as a registered nurse providing patient care and those who did not complete the sleep health questionnaire, the final sample for the present study was 1,342 registered nurses. The NHS3 study protocol is approved by the Brigham and Woman's Hospital and Harvard T.H. Channing School of Public Health Institution Review Boards.

The current study was granted exempt status by the University of Washington Institutional Review Board.

Measures

The Five Dimensions of Sleep Health

Sleep health was measured by five dimensions (described below) designed to be scored individually and as a composite, with higher scores indicating better sleep health. Individual dimensions were scored as a 0 (unhealthy) or 1 (healthy). Individual dimension scores are summed and equally weighted with a maximum composite sleep score of 5 and a minimum score of 0, with higher scores indicating healthier sleep. *Healthy* and *unhealthy* sleep parameters are based on scientific knowledge of sleep health and methods developed and validated by the NHS (detailed below).

Sleep duration was the average number of hours of sleep over a 24-hour period on workdays and work-free days. Short sleep duration was defined as fewer than 7 hours, adequate sleep as 7 hours to 9 hours, and prolonged sleep as more than 9 hours[14] based on the joint consensus of the American Academy of Sleep Medicine and the Sleep Research Society Participants identified as having adequate sleep were given a duration score of 1; all others were scored 0.

Insomnia symptoms were assessed using a validated *insomnia rating scale*[25] based on frequency of occurrence of the following over the last 4 weeks: 1 (trouble falling asleep), 2 (waking up at night), 3 (waking up earlier than planned), and 4 (trouble falling back asleep following early waking). Frequency ranged from 1 to 5 or more times per week. Less than 3 days a week was scored as 1 indicating low insomnia symptoms.[25] The scores of each of the four questions were then summed with a maximum score of 4. Total scores of 3 or 4 are scored a 1, consistent with low insomnia symptoms (i.e., healthier sleep); total scores less than 3 were scored 0.

Chronotype was assessed by participants identifying themselves as one of the following: ‘definitely morning type’, ‘more of a morning type', 'more of an evening type’, ‘definitely evening type’, or ‘neither’. This measure has been validated as a surrogate measure for circadian rhythm.[15] ‘Definitely a morning type’ and ‘more of a morning type’ were scored 1 indicating a healthier sleep-wake cycle; all others were scored 0.

Self-reported snoring was measured by asking participants to report the average frequency of snoring ranging from ‘every night’ to ‘almost never’. This measure is a validated predictive measure for detecting sleep apnea.[26,27] Responses of ‘almost never’ and ‘occasional’ were scored as a 1; responses ranging from ‘a few nights a week’ to ‘every night’ were scored as a 0.

Daytime dysfunction is a validated subjective measure used to assess the impact of insomnia. The daytime dysfunction question asks participants to rate the impact of not being well rested over the past four weeks on the following: fatigue, mood, ability to work, concentration, and memory.[28] Responses are selected from the following five options: ‘not at all’, ‘a little’, ‘a moderate amount’, ‘quite a bit’, and ‘very much’. Responses of ‘not at all’ and ‘a little’ were scored a 1, while responses ‘a moderate amount’, and ‘very much’ were scored a 0.

The five dimensions of sleep health were then summed for a maximum score of 5. The composite scoring developed by the NHS3 is used to reduce measurement errors and account for interrelatedness of the 5 dimensions of sleep health.[29] Based on the precedent NHS studies that used these sleep measures that were validated within the nursing population, ‘healthy sleep’ is defined as total sleep scores of 4 or 5, and ‘intermediate or poor sleep’ is defined as scores less than or equal to 3.[29]

Sleep Hygiene

In 2017, the NHS3 included five questions to assess: (a) regularity of falling asleep with light on, (b) brightness of bedroom ambient light while sleeping, (c) installation of application on electronic device that controls the color of the display to minimize bright light exposure during the night, (d) average number of occurrences of waking during sleep per night, (e) times per night they turn on a light or electronic device during night waking, and (f) electronic use before sleep. Answers were scored 0 or 1, with 1 indicating better sleep hygiene. Falling asleep with the light on and waking up at night 3 or more nights per week[17], and any light any or electronic device use during night waking were scored 0; all others scored 1.[17] Bright ambient light during sleep was scored 0, and instillation of application that minimizes light on electronics were scored 1.[17] Sleep hygiene is independent from the 5 dimensions of sleep health measures and does not contribute to the overall sleep score.

Demographic Characteristics

Age in years at time of survey, race (American Indian or Alaskan Native, white, Black or African American, Asian, Native Hawaiian or other Pacific Islander, Middle Eastern or North African, or multiple races), ethnicity (white non-Hispanic, Latine/Hispanic), and gender (female, male, and neither male nor female) were key demographic variables examined.

Other Variables of Interest

Anxiety, depression, and sleep apnea were captured by asking participants to mark yes if any of these were clinician-diagnosed.

Analysis

Descriptive statistics using percentages were calculated for race, ethnicity, gender, age, immigration status, anxiety, depression, and sleep apnea. To increase statistical power, the variable *race* was collapsed to *white* and *non-white* (Asian American, Black or African American,

Multiple Races, Native American Indian or Alaskan Native, Native Hawaiian or other Pacific Islander) for tests of independence. Non-responses and non-conditional N/As were excluded.

Due to the homogeneity of gender in the study sample, participants who did not self-identify as female were excluded in sleep health and sleep hygiene analysis (Table 2, Table 3). A Chi-squared test of independence was performed to examine the relationship between race, ethnicity, and immigration status and individual dimension and composite sleep health scores.

Results

Sample Characteristics

Table 1 shows the demographic characteristics of the sample. The mean age of participants was 34 years; the sample was 99.6% female, 94.6% non-Hispanic/Latine white, and 87.0% were born in the United States. Participants reported medical diagnoses of anxiety, depression, and sleep apnea at 35.0%, 30.0%, and 2.4% respectively.

Five Dimensions of Sleep Health

Table 2 displays that 78% reported adequate sleep duration on workfree days and 49% on workdays. Insomnia symptoms in the study sample were reported as 82% infrequent trouble falling asleep, 66% infrequent night waking, 81% infrequent early waking, for those with early waking, and 87% infrequent trouble falling back asleep. The combined morning and more of a morning chronotype, accounted for 45% of the study sample. The majority of participants, 82%, reported little to no impact of not being well rested on their daily function.

Sleep Hygiene

Of the study sample, 89% reported TV or electronics use three or more times per week before bed and 53% reported use blue light filtering application on their TV or electronic devices (Table 2).

Table 1. *Demographic Characteristics N = 1,342*

	N	%
Race		
Asian	38	2.8
Black or African American	21	1.6
Multiple Races	41	3.1
Native American Indian or Alaska Native	5	0.4
Native Hawaiian or other Pacific Islander	2	0.1
No Response	10	0.7
White	1,225	91.0
Hispanic		
No	1,270	94.6
Yes	72	5.4
U.S. Born		
No	171	13.0
Yes	1,117	87.0
Gender		
Female	1,337	99.6
Not Identified as Female or Male	5	0.4
Anxiety		
No	867	65.0
Yes	475	35.0
Depression		
No	936	70.0
Yes	406	30.0
Sleep apnea		
No	1,310	97.6
Yes	32	2.4

Table 2. Five Dimensions of Sleep Health and Sleep Hygiene by Sample Characteristics %(N)

	Total sample	Race		Hispanic/Latine	U.S. born	Anxiety	Depression	Sleep apnea
Sleep dimension	**N = 1,327**	**Non-white, N = 106**	**White, N = 1,221**	**N = 64**	**N = 1,156**	**N = 472**	**N = 404**	**N = 32**
Sleep durations workfree days, hours/day								
Adequate	78.0	72.0	79.0	75.0	79.0	74.0	75.0	81.0
Inadequate	8.4	12.0	8.0	14.0	7.5	8.3	8.2	0.0
Prolonged	13.0	16.0	13.0	11.0	14.0	18.0	16.0	19.0
Sleep duration workdays hours/day								
Adequate	49.0	46.0	49.0	51.0	50.0	47.0	50.0	46.0
Inadequate	50.0	54.0	50.0	49.0	50.0	52.0	49.0	54.0
Prolonged	0.5	0.0	0.5	0.0	0.5	0.7	0.8	0.0
Trouble falling asleep, nights/week								
Frequent	18.0	20.0	17.0	19.0	18.0	25.0	28.0	25.0
Night waking, nights/week								
Frequent	34.0	26.0	35.0	34.0	34.0	40.0	44.0	53.0
Early waking, nights/week								
Frequent	19.0	21.0	19.0	23.0	19.0	23.0	27.0	25.0
Trouble falling back to sleep if early waking, nights/week								
Frequent	13.0	17.0	13.0	20.0	13.0	16.0	19.0	16.0
Chronotype								
Evening	20.0	22.0	19.0	25.0	20.0	21.0	24.0	38.0
More evening	30.0	33.0	30.0	34.0	30.0	34.0	31.0	22.0
Neither	4.7	3.8	4.8	7.8	4.5	4.9	5.4	6.3
Self-report snoring								
Yes	20.0	25.0	19.0	17.0	19.0	24.0	29.0	69.0
Daytime dysfunction								
Yes	18.0	20.0	18.0	17.0	18.0	26.0	26.0	31.0
Falling asleep with light on								
Yes	23.0	31.0	22.0	28.0	22.0	24.0	25.0	53.0
Ambient light during sleeping								
Moderate/high	28.0	33.0	28.0	19.0	28.0	29.0	30.0	38.0
TV/electronic device use before sleep, 3 or more times/week								
Yes	89.0	92.0	89.0	91.0	89.0	92.0	92.0	84.0
Electronic bright light filter applications								
No	47.0	42.0	48.0	41.0	47.0	46.0	46.0	56.0
Night waking while sleeping, times/night								
Frequent	24.0	17.0	24.0	20.0	24.0	27.0	29.0	41.0
Light use during night waking, times/night								
Yes	26.0	27.0	26.0	27.0	26.0	32.0	32.0	28.0

Demographic Characteristics and Sleep Health

There were no statistically significant differences in the five dimensions of sleep health or total sleep health scores or on workfree days or workdays when comparing non-white and white participants. Of the total sleep health scores, 51% of non-white participants and 60% of white participants were categorized as having healthy sleep on workfree days (p=.06), and 42% of non-white and 50% of white participants had healthy sleep scores on workdays (p=.11).

There were no statistically significant differences in the five dimensions of sleep health or total sleep health scores based on immigration status.

There was no statistically significant difference in sleep duration on workdays based on race, ethnicity, or U.S. immigration status. Of the U.S.-born participants, 54% reported adequate sleep duration on workdays compared to 48% of non-U.S. born (p=.14). Participant reports of adequate sleep duration on workdays did not significantly differ based on diagnoses of anxiety or depression. Hispanic/Latine participants were less likely to self-identify as morning chronotype compared to non-Hispanic/Latine participants (p=.04). The sleep hygiene behavior of sleeping with the light off was reported by 69% of non-white and 78% of white participants (p=.03) (Table 3).

Table 3. Five Dimensions of Sleep Health and Sleep Hygiene Scores by Sample Characteristics % of N

	Race			**Hispanic/Latine**			**U.S. born**			**Anxiety**			**Depression**		
Dimension	Non White, N = 106	White, N = 1,221	p-value	Yes, N = 64	No, N = 1,263	p-value	Yes, N = 1,156	No, N = 170	p-value	Yes, N = 472[1]	No, N = 855[1]	p-value	Yes, N = 404[1]	No, N = 923[1]	p-value
Adequate duration workfree days	72	79	***	75	78	***	79	73	***	74	80	*	75	79	***
Adequate duration workdays	51	53	***	53	53	***	54	48	***	52	53	***	54	52	***
Low insomnia symptoms	76	77	***	72	77	***	78	74	***	71	81	*	66	82	*
Morning chronotype	42	46	***	33	46	*	46	42	***	40	48	*	39	48	*
low snoring	75	81	***	83	80	***	81	78	***	76	83	*	71	85	*
Minimal daytime dysfunction	79	82	***	81	81	***	82	78	***	74	86	*	74	85	*
Total sleep health scores workfree days			**			***			***			*			*
Healthy	51	60		55	60		61	54		48	66		46	66	
Intermediate or poor	49	40		45	40		39	46		52	34		54	34	
Total sleep health scores workdays			***			***			***			*			*
Healthy	42	50		41	49		50	43		41	53		38	54	
Intermediate or poor	58	50		59	51		50	57		59	47		62	46	
Sleep hygiene															
Sleeping with light off	69	78	*	72	78	***	78	75	***	76	78	***	75	79	*
Low ambient light	67	72	***	81	72	***	72	73	***	71	73	***	70	73	***
Infrequent electronic use before bed	7.5	11	***	9.4	11	***	11	11	***	8.3	12	*	8.4	12	***
Light filter application	58	52	***	59	53	***	53	54	***	54	52	***	54	52	***
Infrequent night waking	83	76	***	80	76	***	76	76	***	73	78	*	71	78	*
Infrequent light on during night waking	73	74	***	73	74	***	74	69	***	67	77	*	68	76	*

Pearson's Chi-squared test; * $p \leq 0.05$, ** $0.05 < p \leq 0.07$, *** $p > 0.07$

Discussion

Our study findings provide insight into multidimensional sleep health on workdays and workfree days and sleep hygiene behaviors across demographic characteristics among currently practicing nurses.

Nearly 50% of the sample reported a healthy sleep duration on workdays compared to more than 75% reporting healthy sleep duration on workfree days. This might be explained by previous research that indicates that the prolonged shift work common in hospital nursing restricts sleep duration, decreases the ability to experience restful sleep, and increases daytime fatigue.[23] However, this does not explain the shortened sleep duration on workdays for nurses who work eight-hour shifts. Therefore, the cause of decreased sleep duration on workdays is likely multifactorial. Other contributing factors may include nursing work characteristics such as on the job stress and social factors such as caring for family members. Study participants also reported oversleeping at a rate nearly 26 times greater on workfree days compared to workdays, which may indicate participants attempting to recover from the shortened sleep duration on workdays.

These results demonstrated anxiety to be associated with a greater proportion of inadequate sleep duration on workfree days but not on workdays, when compared to those without anxiety. Anxiety is known to increase insomnia and decrease sleep health.[5,32] These results suggest that poor sleep health among nurses on workdays may be independent of individual medical diagnoses of anxiety. These results may be further explained by nursing job characteristics such as work stress, long hours, and job demand. Extended shifts, especially in the hospital setting where patients need 24-hour nursing care, are common for patient care nurses[30].

Markedly, the majority of the sample reported that not being well rested had little to no impact on their daytime functioning. These results are inconsistent with the sleep health literature reports that inadequate sleep among nurses is associated with daytime impairments including impaired cognition, fatigue, medical errors, and injuries at work.[9–11] It is unclear whether this is because the study participants were not aware that sleep can negatively influence decision-making, patient safety, and errors. There are safety measures or strategies to reduce cognitive fatigue (e.g., taking naps at work), the survey used for daytime function may not have been sensitive enough, and/or bias related to self-report of sleep or social desirability bias in responses to survey questions. Given the safety and health risks associated with daytime dysfunction among nurses, these findings warrant further investigation.

Less than 50% of the total sample self-identified as a morning chronotype; Hispanic/Latine participants had an even lower percentage. These results are indicative of an inconsistent circadian rhythm cycle and sleep-wake cycle.[15] Increasing scientific evidence suggests that prolonged circadian misalignment is associated with an increased risk of chronic disease and decreased safety at work.[19,31,32] These results highlight the need to explore the implementation of circadian alignment strategies and the potential to reduce the adverse impact of shift work on sleep health.[16,19,32]

These study results suggest there may be a meaningful difference in sleep health between non-white compared to white nurses on workfree days. While sleep health is increasingly recognized as an important determinant of overall health, sleep health disparities among minoritized racial, ethnic, and social identities among the nursing workforce has not been fully investigated. Our results suggest further investigation into sleep as a health disparity within the nursing population and exploration of what factors are influencing sleep health on workdays and workfree days are needed.

The study findings related to the five sleep hygiene measures call attention to the opportunity to improve sleep health and the sleep-wake cycle through reduction of electronics use before initiating sleep and installation of blue light blocking application on electronic devises.[12,21] Further, these results can inform a sleep hygiene behavioral change educational program that is co-designed with a diverse group of nurses to meet their wants and needs about sleep health and important outcomes. These programs can be implemented in nursing school education and hospital organization health promotional programs and trainings.[12,21,33,34]

Limitations

This study's limitations include the cross-sectional design, homogeneity of the sample including primarily white female nurses which decreases generalizability, and only subjective self-report measures of sleep health. Furthermore, the study was not statistically powered enough to examine demographic differences across the six distinct race categories reported by study participants. There were no objective measures of sleep health like actigraphy. Lastly, daytime dysfunction was not explicitly measured during working hours and therefore, responses may be subject to recall bias. Additional studies are needed to assess the impact of inadequate sleep on work-related fatigue measures that can be compared to self-assessment of daytime dysfunction.

In summary, these study findings provide important insights into the state of multidimensional sleep health among the nursing workforce. Importantly, our study results point to the importance of investigation into sleep health disparities within the nursing population across demographic characteristics. The findings from this study can inform interventions aimed at improving sleep health and sleep hygiene behaviors and future research that examines sleep as a health disparity in the nursing population. These results can inform future exploration and interventions aimed at optimizing sleep health among nurses.

Conclusion

Multidimensional sleep health among nurses is essential to mental and physical health, patient safety, and public health. Nurses as a profession may be experiencing disproportionally poor sleep duration and overall poor sleep health on workdays. Furthermore, nurses of racial and ethnic minorities may be experiencing the additional burden of poor sleep on workfree days warranting more research examining sleep as a health disparity for marginalized racial, ethnic, and social identities among nurses. Poor sleep health may be distinctly compounded by unhealthy sleep hygiene. Sleep hygiene behaviors and strategies implemented in nursing schools and hospitals may improve sleep health; longitudinal studies examining the implementation and outcomes are needed.

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Chapter 3: Work Schedules and Multidimensional Sleep Health Across Nursing Specialties

Aim 2 Abstract

Background: Sleep health among nurses is essential to the delivery of quality nursing care. Yet an estimated 60% to 70% of nurses experience poor sleep health. This is a critical public health issue because this can result in medical errors, poor patient outcomes, workplace injuries, nursing shortages, and rising healthcare costs. The preponderance of the research literature conventionally identifies working 12-hour or longer shifts as a risk factor for poor sleep health, hence an emphasis is placed on restricting the number of hours and shift lengths among nursing personnel to address their fatigue. However, work hours alone do not account for other challenges such as work schedules, prolonged exposure to inadequate sleep, or the varied working conditions and job demands across different nursing practice specialties and settings.

Purpose: The purpose of this study aim was to describe multidimensional sleep health by job characteristics (shift type, shift length, hours worked/week, and practice setting/specialty) among registered nurses.

Methods: This study aim used a cross-sectional secondary analysis of the NHS3 cohort survey data (N=1272). Participants were included if they reported practicing as a nurse when they completed the NHS3 study survey. Multiple logistic regression analyses were used to estimate the association between multidimensional sleep health and job characteristics across nursing care settings and specialties.

Results: Working nights and working multiple shifts were associated with lower odds of healthy sleep compared to working day shift only. Working more than or equal to 12 hours shifts was *not* significantly associated with decreased odds of healthy sleep when compared to those working less than 12-hour shifts. Working an average of 41 or more hours per week was *not significantly* associated with a decrease in the odds of healthy sleep compared to those working

an average of 40 hours or less per week. There were no statistically significant differences in the odds of healthy sleep on workdays when comparing nurse settings/specialties. Working as other inpatient nurse or other hospital nurse, school nurse, ICU and ER, and home health (OR .38) were associated with a statistically significant decreased odds of healthy sleep on workfree days in comparison to nurses who worked in the operating room and oncology nurses.

Conclusion: These findings suggest the association between shift work and poor sleep may be more complex than short length alone. Job stressors such as physical demand, effort-reward imbalance, inadequate supervisor support, job strain, shift work, long hours, job insecurity, workplace violence, irregular or unpredictable hours, and job insecurity may be critically influential in poor sleep health among the nursing workforce. There may be differences in work design in the general inpatient setting compared to other nursing specialties, which may explain this difference. Future research should consider additional, more latent factors like commute times, support staff, work stress, and cumulative working hours, that negatively influence sleep health. Additionally, findings suggest that resources directed at sleep health, nursing work, and patient care outcomes need to extend beyond the hospital setting to include other care environments such as school nursing and home health.

Introduction

Nurses are the largest group in the United States (U.S.) healthcare workforce.[1–3] Nurses are essential workforce with job tasks that include administering medications and treatments, performing medical procedures, communicating with other care providers, and coordinating care and healthcare services.[2,4] The range and type of job duties, skills, patient population, work schedule, job setting, healthcare team, and work stressors depend greatly on the care specialty and setting.[2] Nursing work is further characterized by daily physical and emotional stressors, such as long work hours, variable weekly schedules, irregular shift work (i.e., working during the day and night), patient care needs, and short staffing.[1,5] Notably, these job stressors are associated with an adverse impact on the sleep health of the nurse as well as a decrease in the delivery of safe and effective nursing care.[6,7]

Sleep health among nurses is essential to the delivery of quality nursing care.[7 8–10] An estimated 60% to 70% of nurses experience poor sleep health.[7,11–13] Nurses report a high occurrence of inadequate sleep duration, difficulty falling or staying asleep, short sleep duration, and inconsistent timing of sleep.[7,11–13] Buysse (2014) defined *sleep health* as a multidimensional sleep-wake pattern that is able to meet the work and social needs of the individual and support health and well-being.[10] This definition of sleep health includes the following domains: Regularity, Satisfaction, Duration, Alertness, Timing (chronotype), Efficiency (restfulness), and Duration (RU-SATED). Poor sleep health among nurses is associated with fatigue, impaired cognition, and slowed decision-making[1,5,16,17] This is a critical public health issue because this can result in medical errors, poor patient outcomes, workplace injuries, nursing shortages, and rising healthcare costs.[1,5,16,17] In terms of work-related factors that impact sleep, shift work and work hours (e.g., night shift) have been linked to a variety of adverse health outcomes, including depression and fatigue,[1,14] which are associated with job turnover and decreased quality of patient care.[1,6] Plus, in addition to working outside of typical wake hours, nursing shifts

over 12 hours have been linked to poor sleep health, fatigue, and subsequently poor patient care outcomes.[1,6,12,15]

The preponderance of the research literature conventionally identifies working 12-hour or longer shifts as a risk factor for poor sleep health, hence an emphasis is placed on restricting the number of hours and shift lengths among nursing personnel to address their fatigue.[1,6,16] However, work hours alone does not account for other challenges such as work schedules, prolonged exposure to inadequate sleep, or the varied working conditions and job demands across different nursing practice specialties and settings.[1,6,18] The public health need for consistent nursing care is not always amenable to a reduction in shift length or timing during daytime hours.[1] Further, over 80% of nurses prefer working three 12-hour shifts/36-hour work week,[19] which may perhaps facilitate recovery from stressful work shifts, reduced childcare costs, work-life balance, and decreased total time spent commuting.[1]

National research priorities have underscored the need to examine work schedules such as shift length and time of between shifts that inform strategies to mitigate fatigue and improve sleep health in the nursing workforce.[1,7] This research priority is emphasized by the need to factor in the importance of 24-hour safe quality nursing care, positive patient outcomes, and schedules that promote work-life balance.[1] Given that work hours and schedules differ by nursing practice specialties and settings, it is critical to examine their influence eon sleep health among nurses.[1,20] This study addresses the current research gap by examining the association between job characteristics (shift type and length, average weekly working hours), nurse practice setting/specialty (e.g., hospital, oncology, school nurse, home health), and sleep health on workdays and workfree days for currently practicing registered nurses. Findings from the present study can inform strategies on work organization factors that improved sleep health and patient outcomes across nurse specialties.

Methods

Participants and Study Design

In 2010, the Nurses' Health Study 3 (NHS3) began ongoing recruitment and enrollment of nurses born in 1965 or later, and living in the United States or Canada.[21] Approximately 40,000 nurses are currently participating in the NHS3; of these 14% altogether identify as Asian, Black/African American, Multiracial, Native American or Alaska Native, Native Hawaiian or Other Pacific Islander, or Hispanic/Latine.[21] In 2015, the NHS3 began recruitment and enrollment of male-identifying nurses[21]. The NHS3 collects data every six months via web-based questionnaires sent out to enrolled study participants. Additional information and details about NHS3 are reported elsewhere.[21]

The NHS3 includes a questionnaire asking participants to self-report characteristics of their work including shift duration, average hours worked per week, and nurse practice setting/specialty. In 2017, the NHS3 questionnaire included items related to sleep health. Between 2017 and 2021, 3,640 participants completed the NHS3 questionnaire, which included the five dimensions of sleep health questionnaire.

After excluding participants not currently working as a registered nurse providing patient care, those who did not answer questions about job characteristics, or complete the sleep health questionnaire, the analytical sample for the present study was 1,342 registered nurses. The NHS3 study protocol is approved by the Brigham and Woman's Hospital and Harvard T.H. Channing School of Public Health Institution Boards. The current study has been granted exempt status by the University of Washington Institutional Review Board.

The Five Dimensions of Sleep Health

Sleep health was measured by five dimensions (described below) designed to be scored individually and as a composite, with higher scores indicating better sleep health. Individual dimensions were scored as a 0 (unhealthy) or 1 (healthy). Individual dimension scores are summed and equally weighted with a maximum composite sleep score of 5 and a minimum score of 0, with higher scores indicating healthier sleep. The five dimensions of sleep health were then summed for a maximum score of 5. The composite scoring developed by the NHS3 is used to reduce measurement errors and account for the interrelatedness of the 5 dimensions of sleep health[26]. 'Healthy sleep' is defined as total sleep scores of 4 or 5, and 'intermediate or poor sleep' is defined as scores less than or equal to 3.[26] *Healthy* and *unhealthy* sleep parameters are based on scientific knowledge of sleep health and methods developed and validated by the NHS (detailed below). Healthy sleep was the primary outcome of interest for the current study.

Sleep duration was the average number of hours of sleep over a 24-hour period on workdays and workfree days. Short sleep duration was defined as fewer than 7 hours, adequate sleep as 7 hours to 9 hours, and prolonged sleep as more than 9 hours[8] based on the Joint Consensus of the American Academy of Sleep Medicine and the Sleep Research Society. Participants identified as having adequate sleep were given a duration score of 1; all others were scored 0.

Insomnia symptoms were assessed using a validated *insomnia rating scale*[22] based on frequency of occurrence of the following four measures over the last four weeks: 1 (trouble falling asleep), 2 (waking up at night), 3 (waking up earlier than planned), and 4 (trouble falling back asleep following early waking). Frequency ranged from 1 to 5 or more times per week. For each of the four measures those reporting a frequency of less than 3 days a week were scored as 1 indicating low insomnia symptoms.[22] The scores of each of the four questions were then

summed with a maximum score of 4. Total scores of 3 or 4 are scored a 1, consistent with low insomnia symptoms (i.e., healthier sleep); total scores less than 3 were scored 0.

Chronotype was assessed by participants identifying themselves as one of the following: ‘definitely morning type,’ ‘more of a morning type,' 'more of an evening type,’ ‘definitely evening type,’ or ‘neither.’ This measure has been validated as a surrogate measure for circadian rhythm[9]. ‘Definitely a morning type’ and ‘more of a morning type’ were scored 1 indicating a healthier sleep-wake cycle; all others were scored 0.

Self-reported snoring was measured by asking participants to report the average frequency of snoring ranging from ‘every night’ to ‘almost never.’ This measure is a validated predictive measure for detecting sleep apnea.[23,24] Responses of ‘almost never’ and ‘occasional’ were scored 1; responses ranging from ‘a few nights a week’ to ‘every night’ were scored 0.

Daytime dysfunction is a validated subjective measure used to assess the impact of insomnia. The daytime dysfunction question asks participants to rate the impact of not being well rested over the past four weeks on the following: fatigue, mood, ability to work, concentration, and memory.[25] Responses are selected from the following five options: ‘not at all,’ ‘a little,’ ‘a moderate amount,’ ‘quite a bit,’ and ‘very much.’ Responses of ‘not at all’ and ‘a little’ were scored a 1, while responses ‘a moderate amount,’ and ‘very much’ were scored a 0.

Job Characteristics

The primary independent variables focus on individual job characteristics.[1,6,15,27] The self-administered questions related to job characteristics were developed by the NHS and included: (a) shift type, (b) shift length, (c) average hours worked per week, and (d) nurse practice setting/specialty (described below).

Shift type was captured by one question that asked participants to select the shifts they worked in the past year from the following categories: early morning, days, evenings, and nights. Participants who selected more than one shift type were coded and reported as *multiple* for shift type.

Shift length asked participants to report the average hours worked per month in the last year of each schedule. Shift length in hours was calculated based on shift start time-shift end time in 30-minute increments. Responses were dichotomized to greater than or equal to 12 hours and less than 12 hours per shift.

Average hours worked per week was asked for over the last year: 0, 1-20, 21-40, 41-60, and >60 hours. Participants who reported '0' were excluded from the analytic sample. Response categories were collapsed into full-time or less (1-40 hours/week) or more than full-time (≥41 hours/week).

Nurse practice setting/specialty asked participants to select which specialties or setting(s) they work in as a nurse from the following categories: emergency room (ER), home health, intensive care unit (ICU), non-hospital, oncology, operating room, other-hospital, other-inpatient, outpatient, and school nurse. Participants who selected more than one of the above were coded as *multiple* for nurse practice setting/specialty. Based on a conceptual understanding of nurse practice environments; nurse practice setting/specialty was collapsed into seven specialties/areas of practice: outpatient and non-hospital, other inpatient and other hospitals, school nurse, multiple nurse roles, ICU and ER, oncology and operating room, and home health.

Covariates

Demographic characteristics are self-reported as age in years at the time of the survey, race (American Indian or Alaskan Native, white, Black or African American, Asian,

Native Hawaiian or other Pacific Islander, Middle Eastern or North African, or multiple races), ethnicity (white non-Hispanic, Latine/Hispanic), and gender (female, male, and neither male nor female).

Working a job outside of nursing asked participants to report average hours worked outside of nursing over the past year. Those who reported working ≥ 1 hours outside of nursing were coded as 1.

Call shifts were captured by asking participants to select if they have worked call shifts over the past year, dichotomized as yes or no.

Sleep Hygiene was assessed using responses to the following five questions developed by the NHS3 in 2017: (a) regularity of falling asleep with light on, (b) brightness of bedroom ambient light while sleeping, (c) installation of application on electronic device that controls the color of the display to minimize bright light exposure during the night, (d) average number of occurrences of waking during sleep per night, (e) times per night they turn on a light or electronic device during night waking, and (f) electronic use before sleep. Answers were scored 0 or 1, with 1 indicating better sleep hygiene. Falling asleep with the light on and waking up at night 3 or more nights per week[15,21], and any light any or electronic device use during night waking were scored 0; all others scored 1.[28] Bright ambient light during sleep was scored 0, and instillation of application that minimizes light on electronics were scored 1.[28]

Diagnosis included anxiety, depression, and sleep apnea. These variables were captured by asking participants to mark yes if any of these were clinician-diagnosed.

Analysis

Percentages were calculated for demographic variables (race, ethnicity, gender, immigration status), health-related diagnosis (anxiety, depression, sleep apnea), and job

characteristics (shift type, work outside of nursing, worked call shifts, and nurse practice setting/specialty). Measures of central tendency were calculated for age, shift length, and average hours worked in nursing per week. For the logistic regression analysis, the variable *race* was collapsed to *white* and *non-white* (Asian American, Black or African American, Multiple Races, Native American Indian or Alaskan Native, Native Hawaiian or Other Pacific Islander). Non-responses and non-conditional N/As were excluded. Due to the homogeneity of gender in the study sample, participants who did not self-identify as female were excluded from the analysis.

Non-responses were examined for differences in independent (job characteristics) and dependent (sleep health on workdays and workfree days) variables by demographic characteristics. No patterns were observed with regard to missing data. Data from participants with missing responses for any of the independent or dependent variables of interest were also excluded from the analytical sample.

Multiple logistical regression analyses were conducted to estimate odd ratios (OR) of a healthy sleep score on workdays as well as on workfree days relative to job characteristics. Separate models were examined for workdays and workfree days and primary outcomes were defined as ‘healthy sleep’ for workdays and workfree days relative to the statistical models.

A cross-tabular assessment was performed of the independent variables and dependent variables. Participants who reported working early morning shifts were excluded only from this logistic regression due to small cell size (<10). A sensitivity analysis for statistical models with and without early morning shifts did not have markedly different regression coefficients or standard errors.

The final multivariate models for workdays and workfree days included the following job characteristics: (a) shift type: days, evenings, nights, multiple; (b) shift length: >12 hours, $\leq$ 12

hours; (c) average hours worked per week: ≥41 hours per week, ≤ 40 hours per week; and (d) nurse practice setting/specialty: oncology, operating room, outpatient, non-hospital, other inpatient, other hospital, school nurse, ICU and ER, multiple nurse roles, and home health. Both models included the following covariates identified in previous research to have a relationship with sleep health: race, ethnicity, immigration status, age, anxiety, depression, sleep apnea, sleep hygiene behaviors, working call shifts, and working a second job outside of nursing.[1,6,15,29,30]

Results

Sample Characteristics

Table 1 displays sample characteristics. Mean age was 31 years (SD=8.6), 100% identified as female, 92% white, 95% as non-Hispanic/Latine white, and 87% were born in the United States. Anxiety and depression were the most common reported medical diagnosis, 35% and 31% respectively. Of the sample, 53% worked day shift, mean shift length was 12 hours, 70% worked on average 21-40 hours per week, and approximately 64% worked in the hospital setting. Less than half of study participants reported healthy sleep on workdays while over half reported healthy sleep on workfree days.

Table 1. Characteristics N = 1,272

		N	%
Gender			
Female		1,272	100.0
Race			
Asian		38	3.0
Black or African American		21	1.7
Multiple Races		40	3.1
Native American Indian or Alaska Native		5	0.4
Native Hawaiian or Other Pacific Islander		2	0.2
White		1,166	92.0
Race			
Non-white		106	8.3
White		1,166	92.0
Hispanic		60	4.7
U.S. Born		1,109	87.0
Age: mean years (min, max)		31 (27, 39)	
Anxiety		451	35.0
Depression		388	31.0
Sleep Apnea		31	2.4
Shift type			
Day		668	53.0
Evening		51	4.0
Night		246	19.0
Multiple		307	24.0
Shift length: mean hours/shift (min, max)		12.00 (9.00, 12.50)	
On call shift		119	100.0
Average working time as nurse in past year (hours/week)			
1-20		62	4.9
21-40		896	70.0
41-60		295	23.0
61+		19	1.5
Worked at least part-time as non-nurse in past year			
Yes		218	17.0
No		1,054	83.0
Nurse practice setting/specialty			
ER nurse		96	7.5
Home health nurse		27	2.1
ICU nurse		196	15.0
Multiple nurse roles		96	7.5
Non-hospital nurse		71	5.6
Oncology nurse		78	6.1
Operating room nurse		43	3.4
Other hospital nurse		133	10.0
Other inpatient nurse		354	28.0
Outpatient nurse		152	12.0
School nurse		26	2.0
Healthy sleep on workdays		617	49.0
Healthy sleep on workfree days		753	59.0

Sleep Health on Workdays

Table 2 reports the odds ratio of healthy sleep by job characteristics. In the adjusted model for sleep health on workdays, working nights, and multiple shifts [OR .27, .40, 95% confidence interval (95%CI) .18-.39, .29-.54 respectively] was associated with lower odds of healthy sleep compared to working day shift only. Working more than or equal to 12 hours shifts was *not* significantly associated with decreased odds of healthy sleep when compared to those working less than 12-hour shifts (OR .83, 95% CI .61-.1.13). Working an average of 41 or more hours per week was *not* significantly associated with a decrease in the odds of healthy sleep compared to those working an average of 40 hours or less per week (OR .76, 95% CI .57-1.02). There were not statistically significant differences in the odds of healthy sleep on workdays when comparing nurse settings/specialties.

Table 2. Odds of healthy sleep on workdays with work characteristics among 1,272 registered nurses [OR= odds ratio; 95% CI= 95% confidence interval]

Work characteristics	OR [a]	95% CI	P-value [b]
Shift type			
Days (reference)			
Evening	0.70	0.37-1.32	***
Night	0.27	0.18-0.39	*
Multiple	0.40	0.29-0.54	*
Shift length in hours			
<12 (reference)			
>= 12	0.83	0.61-1.13	***
Average working time as nurse in past year (hours/week)			
1-40 (reference)			
41-61+	0.76	0.57-1.02	**
Nurse practice setting/specialty			
Oncology, operating room (reference)			
Outpatient, non-hospital	1.01	0.61-1.66	***
Other inpatient, other hospital	0.63	0.40-1.01	*
School nurse	0.62	0.25-1.53	***
ICU/ER	0.77	0.46-1.29	***
Multiple nurse roles	0.70	0.38-1.28	***
Home health	0.65	0.26-1.62	***

[a] This model tests the association of individual work characteristics separately and healthy sleep health scores workdays controlling for race, ethnicity, immigration status, age, anxiety, depression, sleep apnea, sleep hygiene behaviors, working call shifts, and working a second job outside of nursing. [b] Wald test * $p \leq 0.05$, ** $0.05 < p \leq 0.07$, *** $p > 0.07$

Sleep Health on Workfree Days

Table 3 shows the odds of healthy sleep on workfree days with work characteristics. In the adjusted model for sleep health on workfree days, nights, and multiple shifts were associated with lower odds of healthy sleep compared to working day shift only; OR .67, .42, .65, respectively. Working $\geq$ 12 hours shifts was *not* significantly associated with decreased odds of healthy sleep when compared to those working less than 12-hour shifts (OR .79, 95% CI .58-1.09). Working as other inpatient nurse or other hospital nurse (OR .51), school nurse (OR .29), ICU and ER (OR .51), and home health (OR .38) were associated with a statistically

significant decreased odds of healthy sleep on workfree days in comparison to nurses who worked in the operating room and oncology nurses.

Table 3. Odds of healthy sleep on workfree days with work characteristics among 1,272 registered nurses [OR= odds ratio; 95% CI= 95% confidence interval]

	OR [a]	95% CI	P value [b]
Shift type			
Days (reference)			
Evening	0.67	0.35-1.28	***
Night	0.42	0.29-0.61	*
Multiple	0.65	0.47-0.90	*
Shift length in hours			
<12 (reference)			
>= 12	0.79	0.58-1.09	***
Average working time as nurse in past year (hours/week)			
1-40 (reference)			
41-61+	0.77	0.58-1.04	***
Nurse practice setting/specialty			
Oncology, operating room (reference)			
Outpatient, non-hospital	0.78	0.45-1.35	***
Other inpatient, other hospital	0.51	0.31-0.85	*
School nurse	0.29	0.11-0.73	*
ICU/ER	0.51	0.30-0.89	*
Multiple nurse roles	0.54	0.28-1.02	**
Home health	0.38	0.15-0.96	*

[a] This model tests the association of individual work characteristics separately and healthy sleep health scores on workfree days controlling for race, ethnicity, immigration status, age, anxiety, depression, sleep apnea, sleep hygiene behaviors, working call shifts, and working a second job outside of nursing. [b] Wald test * $p \leq 0.05$, ** $0.05 < p \leq 0.07$, *** $p > 0.07$

Discussion

Consistent with national estimates, our findings indicate that 59% of the study population reported unhealthy sleep on workdays and 49% reported unhealthy sleep on workfree days.[7,11–13] This is markedly higher than the prior reports of a 33% occurrence of inadequate sleep among all United States workforce members.[31] This is an important finding given that poor sleep, shift work, and job stress are associated with decreased health and well-being of the

nursing workforce and poor patient outcomes.[18,19,27] Exposure to work stress disrupts the sleep-wake cycle, resulting in poor sleep health.[32] These findings suggest that job stressors -- physical demand, effort-reward imbalance, inadequate supervisor support, job strain, shift work, long hours, job insecurity, workplace violence, irregular or unpredictable hours, and job insecurity.[5,6,17,33] This may be critically influential in poor sleep health among the nursing workforce.

Contrary to prior studies, healthy sleep on workdays and workfree days did not significantly differ for nurses working $\geq$ 12-hour shifts in comparison to working < 12-hour shifts. Our findings may be explained by commute times, availability of support staff, work stress, recovery time, cumulative working hours, and regularity of work, which were not measured in this study. Prior studies have shown associations between poor sleep and fatigue in nurses working 12-hour or longer shifts.[1,6] This finding indicates that the association is more complex than shift length alone. Importantly, working as an inpatient nurse or other hospital nurse was the only work setting associated with decreased odds of healthy sleep on workdays. There may be differences in work design in the general inpatient setting such as patient care responsibilities, scope of nursing practice, and job tasks compared to other nursing specialties, which may explain this difference. Future research should consider additional, more latent factors like commute times, support staff, work stress, and cumulative working hours, that negatively influence sleep health.

On workfree days, nurses who work in the hospital setting, critical care specialties, school nurses, and home health nurses reported decreased odds of healthy sleep. Some of these specialties did not involve extended shifts outside daytime hours, which is typically associated with poor sleep health among nurses.[1] This suggests that shift work alone does not explain our results. For example, characteristics of work such as stress, unpredictability, intensity, role strain, and irregularity of shift work may have a residual or cumulative effect that

adversely impacts sleep health on workfree days. Although school nurses typically work less than 12-hour shifts during the day, on average, school nurses commute to three different schools and are often the sole medical personnel in the building, which has been known to contribute to work stress.[34] Similar work design features can be found in home health; these can impede fatigue countermeasures such as division of labor and allocation of resources.[1] Long commute times to, from, and during work may also contribute to poor sleep health.[6] Traffic delays decrease time off for emotional recovery between shifts and decrease sleep duration.[6] Short staffing is another characteristic of work associated with irregular schedules, decreased breaks at work, and increased workload which are all associated with poor sleep health.[1,6] Further, short staffing is a barrier to implementing shift work countermeasures such as napping at work.[6] The current evidence suggests that the high work intensity in the critical care setting may also adversely impact sleep health.[5]

The current study provides important insight into the state of sleep health on workdays and workfree days across nursing specialties, practice settings, and work schedules. Findings indicate that future research on sleep health among nursing workforces should expand the focus on shift length, shift timing, and hospital setting to include a more diverse sample of nurses. They further point to the potential insights of exploring deeper, more specific measures of work organization factors. Additionally, findings suggest that resources directed at sleep health, nursing work, and patient care outcomes need to extend beyond the hospital setting to include other care environments such as school nursing and home health. Nursing practice settings and specialties are as distinct as the patient populations served; therefore, future research should consider the impact that poor sleep among nurses has on vulnerable patient populations. For example, public school children are dependent on the care of school nurses, while cancer patients require specialty care from oncology nurses.

Limitations

Although this study has notable strengths, there are limitations that warrant discussion. First, the cross-sectional design cannot address causality and the long-term impact of job characteristics on sleep health. Second, the secondary analysis of an existing dataset is limited by the inability to control how concepts were operationalized and measured. For example, job characteristics were limited in their ability to capture all the facets of work design that may influence sleep health among nurses. Additionally, all study data was collected via self-report study measures, which introduces recall bias. Future research should include objective measures of job characteristics and sleep, like staffing, patient acuity scores, and actigraphy. Lastly, our study sample was limited in that the majority of the sample were white female identifying nurses, which is not representative of the nursing workforce.

Conclusion

This study provides insight into the complexities of the association between job characteristics on workdays and workfree days among nurses. Given the important health services these nursing specialties provide, research is needed to determine what characteristics of these work settings may be associated with poor sleep health. Poor sleep health mitigation strategies tailored to the distinct job design in nursing specialties are needed. Findings from the current study inform future research aimed at improving the work setting as a mechanism of improving sleep health among nurses and subsequently patient outcomes.

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Chapter 4: Nursing Work Schedules, Specialties, Sleep Hygiene, and the Impact on Sleep Health

Abstract

Background: Sleep is an important determinant of overall health and is required to support well-being. Inadequate sleep duration, poor quality sleep, and irregular timing of sleep are also associated with fatigue and daytime impairments that in turn, result in loss of work productivity, more medical errors, workplace injuries, poor decision-making, and patient safety. The negative consequences of poor sleep health are particularly relevant for nurses who spend a considerable amount of time at the bedside and in the community (school setting, community clinics). Nursing involves highly specialized skills that require attention and vigilance to inform good decision-making and safe quality care. National research priorities have underscored the importance of sleep health and the need to better understand nursing job characteristics impact on sleep health and strategies to improve sleep among the nursing workforce.

Purpose: The purpose of this study aim was to test whether individual sleep hygiene behaviors (regularity of falling asleep with light on, brightness of ambient light during sleep, and blue light blocking application installed on electronic device) had a moderation effect on job characteristics between the association of job characteristics and sleep health among registered nurses.

Methods: This study aim used a cross-sectional secondary analysis of the NHS3 cohort survey data. Participants were included if they reported practicing as a nurse when they completed the NHS3 study survey (N=1272). Logistic regression analysis to test for the modifying effect of sleep hygiene behaviors when examining the association between nursing job characteristics and sleep health among nurses practicing in various care settings and specialties.

Results: Sleep hygiene behavior counts were associated with increased odds of healthy sleep on workdays and workfree while controlling for shift type, shift length, average hours worked per

week, and nurse type constant. There was no statistical evidence of interaction between sleep hygiene behaviors and job characteristics. Working 12-hour or longer shifts was *not* associated with decreased odds of healthy sleep compared to those working less than 12-hour shifts on workdays or workfree days. Additionally, working more than 40 hours per week was not associated with a decreased odds of healthy sleep on workdays or workfree days. Working in schools and in ICU and ER were associated with 50% or higher odds of having unhealthy sleep in comparison to those working in the operating room and oncology setting/specialty on workfree days.

Conclusion: Findings suggest that individual sleep hygiene behaviors alone are not effective at mitigating the effects of work working different schedules or shifts or working night shift. Programs and policies aimed at improving sleep health among nurses should not rely on individual-level behavior change alone. Nursing workplaces' administrators, executive officers, managers, supervisors, and schedulers need to increase their understanding of what work factors can be modified to improve nurses' health and well-being. These results support that exposure to characteristics of work such as short staffing, commuting during work, and time off between shifts may impact sleep health on workfree days. The results of this study suggest that the association is more complex than shift length alone, and supports the argument that a change in focus away from reducing nurses' shift length to improving sleep health. Expanding the approach in looking at factors outside of shift length aligns with nurses reporting 12-hour shifts optimizing their work-life balance, ability to recover from or cope with work stress, attending to their own medical care needs, and building resiliency. Future research is needed that explores the interactions and associations between work schedules, time off, work-life balance, job characteristics, and sleep health among nurses.

Introduction

Sleep is an important determinant of overall health and is required to support well-being.[1] Yet, an estimated 70 million adults in the U.S. suffer from poor sleep health including inadequate sleep duration, poor quality sleep, irregularity in sleep timing, and daytime sleepiness.[2] Inadequate sleep duration, poor quality, and irregular sleep timing are associated with hypertension, diabetes, obesity, and poorer cognitive, emotional, and social functioning.[1,3–7] In addition to the health consequences, inadequate sleep duration, poor quality sleep, and irregular timing of sleep are also associated with fatigue and daytime impairments (e.g., sleepiness, reduced attention, vigilance, poor decision-making), that in turn, result in loss work productivity, more medical errors, workplace injuries, poor decision-making, and patient safety.[5,7,8] The negative consequences of poor sleep health are particularly relevant for nurses who spend a considerable amount of time at the bedside and in the community (school setting, community clinics). An estimated 58% to 68% of the nursing workforce has poor sleep health which is concerning given nurses are the largest healthcare workforce who provide essential healthcare for individuals, families, and communities.[9,13,14] Nursing involves highly specialized skills such as administering medications and treatments, performing medical procedures, and coordinating care and healthcare services that are demanding and require attention and vigilance to inform good decision-making and safe quality care.[13,14] Moreover, shift work, long work hours, and short staffing are common in nursing and contribute to poor wellbeing, decreased delivery in safe and effective nursing care, and poor sleep health.[5,8,9,16,17] Several studies report the effects of inadequate sleep duration and poor quality sleep with increased fatigue, impaired cognition, and poordecision-making.[5,7–9] Inadequate sleep duration, poor quality sleep, irregular sleep timing, and daytime sleepiness is a public health concern given prior studies linking poor sleep health with increased medical errors, poor patient outcomes, workplace injuries, job turnover, nursing shortages, and rising healthcare costs.[7,9,16,18] National research priorities have underscored the importance of sleep health and the need to better

understand nursing job characteristics impact on sleep health as a strategy to improve sleep among the nursing workforce.[8,9,18]

Sleep hygiene includes activities and routines prior to sleep that contribute to inadequate sleep, poor quality sleep, and irregularity in sleep timing. In considering nursing, shift work and shift length (8 hrs., 10 hrs., or 12 hrs.) is common and likely contributes to poor sleep habits, that, in turn negatively impacts sleep duration, quality, and timing of sleep. Prior studies in nurses have shown working longer than 12-hours per shift is associated with decreased sleep health.[5,7,9] However, the precise mechanism of association between extended shift length and poor sleep health is not fully understood.[9] Further, the focus on shift length in the hospital setting does not take into account nurses practicing in other settings such as schools. Prior studies show that exposure to light, especially blue light, as the most detrimental factor for shift workers.[10,20] Some strategies, such as blocking the blue waveform before bed and bright lights during work, have shown some promise in improving the disrupted sleep-wake cycle associated with shift work in nurses.[9,20] However, further investigation is needed to determine whether enacting individual sleep hygiene behaviors is effective at mitigating the adverse effects of work factors associated with poor sleep health.[9]

The current study addresses two national research priorities by exploring the association between job characteristics (shift work, shift length, average hours per week), health behaviors, and sleep health as an indicator of health and well-being among nursing workforces[8,9,18]

Methods

Participants and Study Design

Beginning in 2010, the Nurses' Health Study 3 (NHS3) started the ongoing recruitment and enrollment of nurses living in the United States or Canada and born in 1965 or later.[19] Approximately 40,000 nurses are currently enrolled in the NHS3 study. The NHS3 collects data

every six months via web-based questionnaires sent out to enrolled study participants. The NHS3 includes a questionnaire that asks participants to self-report various information, including job characteristics, health behaviors, and health indicators. In 2017, the NHS3 questionnaire included questions related to sleep health and has continued to include them in subsequent years. Additional information and details about NHS3 are reported elsewhere.[19]

The NHS3 study protocol is approved by the Brigham and Woman's Hospital and Harvard T.H. Channing School of Public Health Institutional Review Boards. The current study was granted exempt status by the University of Washington Institutional Review Board.

Measures

The Five Dimensions of Sleep Health

Sleep health was measured by five dimensions (described below) designed to be scored individually and as a composite, with higher scores indicating better sleep health. Individual dimensions were scored as a 0 (unhealthy) or 1 (healthy). Individual dimension scores were summed and equally weighted with a maximum composite sleep score of 5 and a minimum score of 0, with higher scores indicating healthier sleep. *Healthy* and *unhealthy* sleep parameters are based on scientific knowledge of sleep health and methods developed and validated by the NHS (detailed below). Healthy sleep health was the primary outcome of interest.

Sleep duration was the average number of hours of sleep over a 24-hour period on workdays and workfree days. Short sleep duration was defined as fewer than 7 hours, adequate sleep as 7 hours to 9 hours, and prolonged sleep as more than 9 hours[11] based on the joint consensus of the American Academy of Sleep Medicine and the Sleep Research Society. Participants identified as having adequate sleep duration were given a score of 1; all others were scored 0.

Insomnia symptoms were assessed using a validated *insomnia rating scale*[12] based on frequency of occurrence of the following over the last 4 weeks: 1 (trouble falling asleep), 2 (waking up at night), 3 (waking up earlier than planned), and 4 (trouble falling back asleep following early waking). Frequency ranged from 1 to 5 or more times per week. The scores of each of the four questions were then summed with a maximum score of 4. Total scores of 3 or 4 were scored a 1, consistent with low insomnia symptoms (i.e., healthier sleep); total scores less than 3 were scored 0 suggesting frequent insomnia symptoms.

Chronotype was assessed by participants identifying themselves as one of the following: ‘definitely morning type’, ‘more of a morning type', 'more of an evening type’, ‘definitely evening type’, or ‘neither’. This measure has been validated as a surrogate measure for circadian rhythm[13]. ‘Definitely a morning type’ and ‘more of a morning type’ were scored 1 indicating a healthier sleep-wake cycle; all others were scored.

Self-reported snoring was measured by asking participants to report the average frequency of snoring ranging from ‘every night’ to ‘almost never’. This measure is a validated predictive measure for detecting sleep apnea.[14,15] Responses of ‘almost never’ and ‘occasional’ were scored 1; responses ranging from ‘a few nights a week’ to ‘every night’ were scored 0.

Daytime dysfunction is a validated subjective measure used to assess the impact of insomnia. The daytime dysfunction question asks participants to rate the impact of not being well rested over the past four weeks on the following: fatigue, mood, ability to work, concentration, and memory.[16] Responses are selected from the following five options: ‘not at all’, ‘a little’, ‘a moderate amount’, ‘quite a bit’, and ‘very much’. Responses of ‘not at all’ and ‘a little’ were scored a 1, while responses ‘a moderate amount’, ‘quite a bit’, and ‘very much’ were scored a 0 suggestive of more daytime dysfunction.

Total Sleep Health Scores were determined by summing the five dimensions of sleep health for a maximum score of 5. The composite scoring developed by the NHS3 is used to reduce measurement errors and account for interrelatedness of the 5 dimensions of sleep health.[17] Based on the precedent that NHS studies used these sleep measures, which were validated within the nursing population, 'healthy sleep' was defined as total sleep scores of 4 or 5, and 'intermediate or poor sleep' was defined as scores $\leq$3.[17]

Sleep Hygiene

The primary independent variable focused on ***Sleep Hygiene*** behaviors assessed by: (a) regularity of falling asleep with light on, (b) brightness of bedroom ambient light while sleeping, (c) installation of application on electronic device that controls the color of the display to minimize bright light exposure during the night, and (d) electronic use prior to sleep. Answers were scored 0 or 1, with 1 indicating healthier sleep hygiene behaviors. Falling asleep with the light on 3 or more nights per week[10,18] were scored 1; all others were scored 0.[19] Bright ambient light during sleep was scored 0, and instillation of application that minimizes light on electronics was scored 1.[19] Sleep hygiene behaviors were treated as a count ranging from 0-4; scoring a 1 on all sleep hygiene behaviors resulted in a count of 4, suggesting healthy sleep hygiene; scoring a 1 on three sleep hygiene behaviors resulted in a count of 3; and a 0 on one behavior results in a count of 3, and so forth.

Job Characteristics

The self-administered questions related to **Job Characteristics** were categorized as follows: (a) shift type, (b) shift length, (c) average hours worked per week, and (d) nurse type (described below). These categories were selected based on their relevance to sleep health.[2,6,18,20]

Shift type was captured by one question that asked participants to select the shifts they worked in the *past year* from the following categories: 1) early morning, 2) days, 3) evening, and 4) nights. Participants that selected more than one shift type were coded and reported as *multiple* for shift type. Related to small cell size and unclear parameters, those that answered 'early morning' were excluded from the analysis.

Shift length asked participants to report the average hours worked per month in the last year of each schedule. Shift length in hours was calculated based on shift start time-shift end time in 30-minute increments. Responses were dichotomized as 1) ≥12 hours; and 2) < 12 hours per shift.

Average hours worked per week referred to the average hours participants worked per week *over the last year* using the following categories: 0, 1-20, 21-40, 41-60, and > 60 hours per week. Participants who reported '0' were excluded from the analytical sample. Response categories were collapsed into full-time or less (1-40 hours/week) or more than full-time (≥41 hours/week).

Nurse specialty/setting refers to the specialties(s) or setting(s) nurses worked in: 1) emergency room (ER), 2) home health, 3) intensive care unit (ICU), 4) non-hospital, 5) oncology, 6) operating room, other-hospital, other-inpatient, outpatient, and school nurse. Participants who selected more than one of the above were coded as *multiple* for nurse specialty/setting. Based on a conceptual understanding of nurse practice environments, nurse setting/specialty were collapsed into seven specialties/areas of practice: outpatient and non-hospital, intensive care unit (ICU) and emergency room (ER), oncology and operating room, other inpatient and other hospital, school nurse, multiple nurse roles, and home health.

Covariates

Demographic characteristics were self-reported as age in years at time of survey, race (American Indian or Alaskan Native; white; Black or African American; Asian, Native Hawaiian or other Pacific Islander; Middle Eastern or North African; or multiple races), ethnicity options included white non-Hispanic and Latine/Hispanic; and gender options were female, male, and neither male nor female.

Diagnoses included anxiety, depression, and sleep apnea. These variables were captured by asking participants to mark "yes" if any of these were clinician-diagnosed.

Analysis

Participants with missing responses for any of the independent, dependent, or covariate variables of interest were excluded from the analytical sample. Participants excluded based on missing were examined for systematic non-responses and differences in demographic characteristics, and patterns differences were not found. Percentages and counts were calculated for demographic variables (race, ethnicity, immigration status), health-related diagnosis (anxiety, depression, sleep apnea), job characteristics (shift type and nurse setting/specialty), sleep health, and sleep hygiene. Means and ranges were calculated for age, shift length, and average hours worked in nursing per week.

For the logistic regression analysis, the variable *race* was collapsed to *white* and *non-white* (Asian American, Black or African American, Multiple Races, Native American Indian or Alaskan Native, Native Hawaiian or other Pacific Islander). Non-responses and non-conditional N/As were excluded.

Logistic regression analysis was used to estimate the association between sleep hygiene behaviors on workdays and workfree days and the significance of the demographic and

health-related diagnosis covariates. Sleep hygiene behaviors were assessed for a moderation effect on job characteristics between the association of job characteristics and sleep health

Multivariate logistical regression analysis was conducted to estimate odd ratios (OR) of a healthy sleep score on workdays and workfree days relative to sleep hygiene behaviors and job characteristics among current practicing registered nurses. Separate models were used for workdays and workfree days to assess the primary outcome defined as 'healthy sleep' for workdays and workfree days.

The final multivariate models for workdays and workfree days included sleep hygiene behaviors, and job characteristics: (a) shift type: days, evenings, nights, multiple; (b) shift length: >12 hours, ≤ 12 hours; (c) average hours worked per week: ≥41 hours per week, ≤ 40 hours per week; and (d) nurse setting/specialty: (1) oncology & operating room, (2) outpatient & non-hospital, (3) other inpatient & other hospital, (4) school nurse, (5) ICU and ER, (6) home health, and (7) multiple roles. No interaction terms were included in the statistical models because there was no evidence of interaction between sleep hygiene behaviors and job characteristics.

The workday model included the following covariates (e.g., gender, race, ethnicity, depression, anxiety) based on scientific and statistical significance.[2,6,18,21,22] The workfree days model included the following statistically and scientifically relevant covariates: race, age, and medical diagnosis of depression. [2,6,18,21,22]

Results

Sample Characteristics

Table 1. shows the sample demographics, sleep, and sleep hygiene behaviors. The mean age of participants was 31 years, 100% were female-identifying, 92% white, nearly 95% non-Hispanic/Latine, and 87% were born in the United States. Participants reported medical diagnoses of anxiety, depression, and sleep apnea at 35%, 31%, and 2.4% respectively. Of the

sample, 53% worked day shift, mean shift length was 12 hours, 70% worked on average 21-to-40 hours per week, and approximately 64% worked in a hospital setting. Forty-nine percent of study participants reported healthy sleep on workdays, while 59% reported healthy sleep on workfree days. More than 50% of participants reported: falling asleep with the light off, sleeping with low ambient light, and having a light-blocking application on an electronic device. Only 11% did not use electronics prior to the initiation of sleep.

Sleep Health on Workdays

In the adjusted multivariate model for sleep health on workdays (Table 2) sleep hygiene behaviors were associated with a 1.3 increase in odds of healthy sleep on workdays while holding shift type, shift length, average hours worked per week, and nurse specialty/setting constant [95% confidence interval (CI) 1.1-1.5].

In the adjusted multivariate model for sleep health on workdays, various job characteristics were associated with decreased odds of healthy sleep while adjusting for sleep hygiene behaviors. Working nights and multiple shifts were both associated with a decreased odds of healthy sleep in comparison to those working day shift [Odds ratio (OR) .30, .40, 95% CI .20-.40, .30-.50, respectively]. Working 12-hour or longer shifts was *not* associated with a decreased odds of healthy sleep in comparison to those working less than 12-hour shifts (OR .9, 95% CI .7-.1.2). Working an average of more than 40 hours per week was not significantly associated with a decreased odds of healthy sleep in comparison to those working 40 hours per week or less (OR .7, 95% CI.6-1.0). None of the settings/specialties were associated with a significant decreased odds of healthy sleep in comparison to working in an outpatient setting.

Sleep Health on Workfree Days

In the adjusted multivariate model for sleep health on workdays (Table 2) sleep hygiene behaviors were associated with an increase in odds of healthy sleep on workdays while holding

shift type, shift length, average hours worked per week, and nurse specialty/setting constant [OR (odds ratio) 1.3, 95% confidence interval (CI) 1.1-1.5].

In the adjusted multivariate model for sleep health on workfree days, some shifts and care settings/specialties were associated with a decreased odds of healthy sleep on workfree days, when holding sleep hygiene behaviors constant. Working nights, and multiple shifts were all associated with a decreased odds of healthy sleep compared to those working day shift, (OR.4, .5, 95% CI, .3-.5, .5-.8 respectively). Working 12-hour or longer shifts was *not* associated with a decreased odds of healthy sleep compared to those working less than 12-hour shifts (OR .8, 95% CI .6-1.1). Working as other inpatient or other hospital, ICU/ER, school nurse, and home health were all associated with a significant decrease in the odds of healthy sleep in comparison to working in an outpatient setting on workfree days. School nurses, ICU and ER, and were associated with 50% or higher odds of having unhealthy sleep in comparison to those working in the operating room and oncology setting/specialty.

Table I. Characteristics N = 1,272

	N	%
Gender		
Female	1,272	100.0
Race		
Asian	38	3.0
Black or African American	21	1.7
Multiple Races	40	3.1
Native American Indian or Alaska Native	5	0.4
Native Hawaiian or Other Pacific Islander	2	0.2
White	1,166	92.0
Race		
Non-white	106	8.3
White	1,166	92.0
Hispanic	60	4.7
U.S. Born	1,109	87.0
Age: mean years (min, max)	31 (27, 39)	
Anxiety	451	35.0
Depression	388	31.0
Sleep Apnea	31	2.4
Shift type		
Day	668	53.0
Evening	51	4.0
Night	246	19.0
Multiple	307	24.0
Shift length: mean hours/shift (min, max)	12.00 (9.00, 12.50)	
Average working time as a nurse in past year (hours/week)		
1-20	62	4.9
21-40	896	70.0
41-60	295	23.0
61+	19	1.5
Nurse setting/specialty		
ER nurse	96	7.5
Home health nurse	27	2.1
ICU nurse	196	15.0
Multiple nurse roles	96	7.5
Non-hospital nurse	71	5.6
Oncology nurse	78	6.1
Operating room nurse	43	3.4
Other hospital nurse	133	10.0
Other inpatient nurse	354	28.0
Outpatient nurse	152	12.0
School nurse	26	2.0
Dimensions of sleep health		
Healthy sleep duration workfree days	992	78.0
Healthy sleep duration workdays	670	52.7
Low insomnia symptoms	980	77.0
Morning or mostly morning chronotype	561	44.1
Infrequent self-reported snoring	1,022	80.3
Low daytime dysfunction	1,037	81.5

Healthy sleep on workdays	617	49.0
Healthy sleep on workfree days	753	59.0
Sleep hygiene		
Sleeping with light off	986	78.0
Low ambient light	916	72.0
Blue light blocking app	678	53.0
No electronic use before bed	137	11.0
Sleep hygiene behaviors counts[a]		
0	46	3.6
1	241	19.0
2	511	40.0
3	442	35.0
4	32	2.5

[a] Sleep hygiene behaviors assessed by regularity of (a)falling asleep with light on, (b) bedroom ambient light while sleeping, (c) installation of application on electronic device that controls the color of the display to minimize bright light exposure during the night, and (d) electronic use prior to sleep. Answers were scored 0 or 1, with 1 indicating healthier sleep hygiene behaviors. Falling asleep with the light on 3 or more nights per week was scored 1; all others were scored 0. Bright ambient light during sleep was scored 0, and instillation of application that minimizes light on electronics was scored 1. Sleep hygiene behaviors were treated as a count ranging from 0-4; scoring a 1 on all sleep hygiene behaviors resulted in a count of 4, suggesting healthy sleep hygiene; scoring a 1 on three sleep hygiene behaviors resulted in a count of 3; and a 0 on one behavior results in a count of 3, and so forth.

Table 2. Bivariate and Multivariate Logistic Regression Models for Odds of Healthy Sleep Among 1,512 Registered Nurses [OR= odds ratio; 95% CI= 95% confidence interval]

		Bivariate Workdays		**Bivariate Workfree Days**		**Model 1 Workdays**		**Model 2 Workfree Days**
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Sleep Hygiene	1.2*	1.1-1.4	1.3***	1.2-1.5	1.3*	1.1-1.5	1.3*	1.3-1.5
Shift Type								
Days(refence)								
Evenings					0.8***	0.4-1.5	0.7***	0.4-1.3
Nights					0.3*	0.2-0.4	0.4*	0.3-0.5
Multiple					0.4*	0.3-0.5	0.6*	0.5-0.8
Shift Length								
<12 hours (reference)								
≥ 12 hours					0.9***	0.7-1.2	0.8***	0.6-1.1
Average hours worked/week								
≤ 40 (reference)								
> 40					0.7*	0.6-1.0	0.7*	0.6-1.0
Nurse setting/specialty								
Operating Room & Oncology (reference)								
Outpatient & non-hospital					0.9***	0.6-1.5	0.8***	0.4-1.3
Inpatient & Other hospital					0.6*	0.4-1.0	0.5*	0.3-0.8
School Nurse					0.6***	0.2-1.4	0.3*	0.1-0.7
ICU & ER					0.7***	0.5-1.2	0.5*	0.3-0.9
Home Health					0.6***	0.2-1.4	0.4*	0.1-0.9
Multiple Roles					0.7***	0.4-1.3	0.5**	0.3-1.0

Wald Test * $p \leq 0.05$, ** $0.05 < p \leq 0.07$, *** $p > 0.07$

Discussion

The current study describes nursing job characteristics, sleep hygiene behaviors, and their association with sleep health among a national cohort of practicing nurses. The findings from this study provide insight into the impact of sleep hygiene, health behaviors, and job characteristics on sleep health on workdays and workfree days.

Consistent with national estimates, more than 50% of the sample had unhealthy total sleep health scores on workdays and workfree days.[4,5,8,15] As expected and consistent with prior studies, falling asleep with the light off, low ambient light while sleeping, and installation of application on electronic device that controls the color of the display to minimize bright light

exposure during the night, and electronic use prior to sleep applications were positively associated with better sleep health on workdays and workfree days.[7,16,17] Individual behaviors before initiating sleep, such as limiting light exposure, have been associated with improving sleep health among nurses.[7,16,17] Contrary to our hypothesis no interactions between sleep hygiene behaviors and job characteristics on sleep health.

These findings suggest that individual sleep hygiene behaviors alone are not effective at mitigating the impact of work working different schedules or shifts or working night shifts. This differs from previous research on nurses, which indicates that sleep hygiene can mitigate the adverse effects of shift work on nurses' sleep health.[7,16,17] Accordingly, these results suggest that programs and policies aimed at improving sleep health among nurses should not rely on individual-level behavior change alone. Rather, nursing workplaces need to better understand what work factors can be modified to improve nurses' health and well-being.

As expected, nurses who worked night shifts reported decreased odds of healthy sleep compared to those who worked day shifts. These findings are consistent with research indicating that working outside daylight hours disrupts circadian rhythms and, as a result, sleep health[1,7,9] and underscore the critical need for research in the optimization of nursing work schedules that promote sleep health while balancing patient care needs. Strategies such as health organizational policies that promote, increased time off in between shifts; consistent work schedule timing; improved staffing to increase support and decrease fatigue; and employee sleep spaces that promote napping for nurses working nights have shown promise.[1,7]

Nurses who work in the hospital setting, schools, and home health all reported decreased odds of healthy sleep on workfree days. These results support that exposure to characteristics of work such as short staffing, commuting during work, and time off between shifts may impact sleep health on workfree days.[7] The school nurse specialty schedule is

characterized by working five eight-hour shifts per week during daylight hours.[20] Markedly, the results indicate that school nurses report a higher proportion of healthy sleep on workdays and a lower proportion on workfree days. These results suggest that there may not be adequate time off between nursing shifts to recover from work stressors that adversely impact sleep health.[1] Working multiple shift types were associated with decreased odds of healthy sleep on both workdays and workfree days. Studies in other populations of workers have found that unpredictable and inconsistent work is associated with poor sleep.[21] This was found to be particularly true of female-identifying workers who are primary caregivers for other family members. [21]

In contrast to previous research emphasizing the association between shift length and poor sleep health, the current study did *not* find a difference in the odds of healthy sleep on workdays or workfree days for nurses working greater than or equal to 12-hour shifts compared to those working less than 12-hour shifts. This finding indicates that the association is more complex than shift length alone, and supports the argument that a change in focus away from reducing nurses' shift length to improving sleep health. Expanding the approach in looking at factors outside of shift length aligns with reports that the majority of nurses prefer 12-hour shifts. Importantly, nurses have cited 12-hour shifts as optimizing their work-life balance, ability to recover from work stress, and attending to their own medical care needs. Future research is needed that explores the interactions and associations between work schedules, time off, work-life balance, job characteristics, and sleep health among nurses.

On workfree days nurses who work in the hospital setting, critical care specialties, schools, and home health, reported decreased odds of healthy sleep. Some of these specialties do not involve extended shifts outside daytime hours, which is typically associated with poor sleep health among nurses. This further suggests that shift work alone cannot fully account for poor sleep health among nurses. These findings support an expanded focus that includes

characteristics of work such as stress, intensity, role strain, and consistency of shift work, which may have a residual or cumulative effect that adversely impacts sleep health on workfree days.

Limitations

This current study is limited by its cross-sectional design and study measures. Cross-sectional studies cannot account for the long-term effect or variation of job characteristics and sleep hygiene behaviors on sleep health. All study measures were self-reported and may be subject to recall bias, social desirability, and study participants' ability to accurately self-assess. In addition, study measures did not address factors in nursing specialties, such as short staffing, that adversely impact sleep health. Sleep hygiene measures did not account for other behaviors known to influence sleep, such as consistency of times initiating sleep. This validates the need for future research that includes objective measures of job stressors such as staffing support, work schedules, multifaceted sleep hygiene measures, and sleep measurement using technology such as actigraphy.

Conclusion

The results from the current study provide important insight into best practices, policies, and sleep health education that optimizes sleep health among nurses and results in improved job retention and patient outcomes. Nursing workforces are disproportionately impacted negatively by poor sleep health. Poor sleep health among nurses has adverse impacts on the health of the nurses and the care they deliver. The current study expands our understanding of sleep health on workdays and workfree days among nursing workforces across care settings and specialties. The results generated from the current study provide a meaningful contribution to science in that they provide guidance on how to implement the next steps in approaching the study of sleep health in nurses. Further, these findings support the allocation of resources to develop policies and programs that include nurses across care settings and specialties as part of the program development, decision-making process, implementation, and evaluation. This

holistic approach to improving sleep health across nursing care settings and specialties has the potential to make a positive impact on public health.

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Chapter 5: Conclusion

Nurses are the largest healthcare workforce and are essential to the provision of healthcare for individuals, families, and communities across care settings and specialties. Nursing job tasks, skill set required, patient population, work schedule, work environment, healthcare team, and work stressors depend greatly on the care specialty and setting. Nursing job stressors such as long work hours, variable weekly schedules, irregular shift work, and short staffing are associated with poor sleep health among the nursing workforce. It is estimated that over half of practicing nurses are experiencing poor sleep health. Poor sleep health among nurses has been associated with increased healthcare costs, job turnover, poor patient outcomes, nursing shortages, and adverse effects on the health and well-being of the nurse. Sleep health among nurses is an important public health issue that has been underscored by national research priorities to explore the association between job characteristics, health behaviors, and sleep health as an indicator of health and well-being among nursing workforces across demographic characteristics and care settings and specialties. The results from this dissertation provide important insights into best practices, policies, and sleep health education that may improve sleep health among nurses. These have the potential to improve job retention and patient outcomes.

The current study aligned with national research priorities by leveraging a subset of the existing national cohort dataset of the Nurses' Health Study 3. The overall purpose of this dissertation was to examine the association between job characteristics and sleep health (sleep duration, insomnia symptoms, chronotype, self-reported snoring, and daytime dysfunction) across demographic characteristics, care settings and specialties, and sleep hygiene behaviors among a cohort of registered nurses practicing in the United States and Canada. All three study aims were met. Paper 1 (Chapter 2) aimed to describe multidimensional sleep health across demographic characteristics. The purpose of paper 2 (Chapter 3) was to describe the association between multidimensional sleep health and job characteristics among registered

nurses. Lastly, the purpose of paper 3 (Chapter 4) was to test whether individual sleep hygiene was effective at mitigating the association between job characteristics and sleep health among registered nurses.

The results from these three dissertation papers further the scientific understanding of the association between nursing job characteristics and sleep health on workdays and workfree days across nursing care settings and specialties. In contrast to previous research emphasizing the association between shift length and poor sleep health, the current study did *not* find a difference in the odds of healthy sleep on workdays or workfree days for nurses working greater than or equal to 12-hour shifts compared to those working less than 12-hour shifts. This is an important finding that has several implications. This finding indicates that the association is more complex than shift length alone. These results support a shift in focus away from reducing nurses' shift length to focusing on improving sleep health. Expanding the approach in looking at factors outside of shift length aligns with reports that most nurses prefer 12-hour shifts. Nurses have cited 12-hour shifts as optimizing their work-life balance, ability to recover from work stress, and attending to their own medical care needs.

On workfree days, nurses who work in the hospital setting, critical care specialties, schools, and home health reported decreased odds of healthy sleep. Some of these specialties do not involve extended shifts outside daytime hours, which is typically associated with poor sleep health among nurses. This further suggests that shift work alone cannot fully account for poor sleep health among nurses. These findings support an expanded focus that includes characteristics of work such as stress, intensity, role strain, working multiple roles, and consistency of shift work, which may have a residual or cumulative effect.

The current study found no evidence of an interaction between sleep hygiene behaviors and job characteristics impacting sleep health. These findings suggest that individual sleep

hygiene behaviors alone are not effective at mitigating the impact of working differing schedule, shift timing or variability. Accordingly, these results suggest that programs and policies aimed at improving sleep health among nurses should not rely on changes in individual behaviors alone.

The current study expands our understanding of sleep health among nursing workforces. The results generated from this dissertation provide a meaningful contribution to science by providing evidence supporting the allocation of resources, policy, and programs that apply a holistic approach to improving nurses' sleep health and, subsequently, patient outcomes both in and outside the hospital setting. The results from this dissertation can inform interventions aimed at improving sleep health and sleep hygiene behaviors and future research that examines sleep as a health disparity in the nursing workforce. These findings can also support allocating resources to develop policies and programs that include nurses across care settings and specialties as part of the program development, decision-making process, implementation, and evaluation. This holistic approach to improving sleep health across nursing care settings and specialties shows promise to make a positive impact on public health.