JOURNAL OF WELLNESS ORIGINAL RESEARCH

Chronotype, Shift Work, and Sleep Problems Among Emergency Medicine Clinicians

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ABSTRACT

Introduction: Extensive research has demonstrated that shift work can be detrimental to sleep. Chronotype, the preference for time of day to sleep or be active, can influence how we function at different times of day and how shift work impacts us. This study was designed to assess the chronotype of emergency physicians (EPs) and emergency advanced practice providers (EAPPs) and examine how chronotype was related to sleep problems and shifts worked over a three-month period.

Methods: A survey assessing chronotype and sleep quality was sent to 225 EPs and EAPPs in a single, large academic Department of Emergency Medicine. An archival database indicated the shifts worked during the prior three months and the percentages of day, evening, and night shifts for each practitioner were calculated.

Results: 127 people completed the survey (56.4%). Of the three chronotypes (morning, intermediate, evening), most EM clinicians were categorized as intermediate chronotype (56/127, 44.1%), followed by morning type (39/127, 30.7%) and then evening type (32/127, 25.2%). Those with an evening chronotype were more likely to report daytime dysfunction (a lack of enthusiasm and propensity to fall asleep during activities) ($p < 0.01$) and worked a greater percentage of night shifts than other chronotypes ($p < 0.05$). Interestingly, the effect of evening chronotype on daytime dysfunction was no longer significant when controlled for the relatively greater percentage of night shifts worked, suggesting that the observed dysfunction was more likely an artifact of the night shifts worked, rather than purely chronotype driven.

Conclusion: This is the first study of a large cohort of EM practitioners investigating chronotype and its influence on shift preference and sleep quality. In this pilot investigation, most of the surveyed clinicians were categorized as an intermediate chronotype. Working night shifts was associated more closely with daytime dysfunction than was chronotype, strengthening the latent literature that working night shift carries with it significant challenges to the EM clinician. Future research should evaluate the relationship between chronotype malalignment to practitioner burnout and well-being.

https://doi.org/10.55504/2578-9333.1073

Received Date: Apr 28, 2021
Revised Date: Jan 18, 2022
Accepted Date: May 5, 2021
Publication Date: May 18, 2022

Website: https://ir.library.louisville.edu/jwellness/

Recommended Citation: Hirsh, Emily L.; Britt, Thomas W.; Klinefelter, Zachary; Liptak, Justine; Meyers, Cody; Daniels, Katie; and Fowler, Lauren A. (2022) "Chronotype, Shift Work, and Sleep Problems Among Emergency Medicine Clinicians," Journal of Wellness: Vol. 3: Iss. 3, Article 10.

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INTRODUCTION

Working shifts at different times of the day is an inherent characteristic of work for emergency physicians (EPs) as well as emergency advanced practice providers (EAPPs). Numerous researchers have noted that individuals engaged in shift work are at an increased risk for fatigue and committing medical errors as a result of circadian rhythm disruption [1]. Individuals who work evening and night shifts are likely to experience disruption in the quantity and quality of their sleep, resulting in negative effects on well-being and performance [2]. Therefore, authors have recommended strategies to reduce the negative effects of circadian disruption associated with shift work, including avoiding shifts over 8 hours in duration, scheduling by rotating shifts "clockwise" (e.g., from day to evening to night shifts), and protecting the work schedules of those working the night shift so that sufficient sleep can be obtained [1, 2].

One additional area of research relevant to fatigue as a result of shift work involves the preferences individuals have regarding when to sleep and work. Chronotype refers to differences between individuals regarding when they prefer to sleep and when they prefer to be active and alert. Chronotype is influenced both by circadian rhythms, which regulate sleep and wakefulness on the basis of a 24-hour period, as well as by a homeostatic drive to sleep that builds over time, depending upon previous sleep duration and quality [3]. Validated measures have been developed to determine whether individuals can be classified as possessing a morning chronotype ("larks", who naturally tend to wake early and prefer to work in the morning), evening chronotype ("owls", who naturally tend to wake later and prefer to work into the evening), or an intermediate chronotype (those persons not showing a preference for the morning or evening) [4, 5]. Evidence indicates that employees with a

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morning chronotype report greater sleepiness in the evening and adapt less well to working a night shift [6]. One systematic review also demonstrated that possessing an evening chronotype is associated with greater fatigue, sleepiness, and anxiety among nurses [7]. However, to date only one small study has examined chronotype in EPs [8].

The present study examined the prevalence of different chronotypes for a larger cohort of both EPs (attending physicians and residents) and EAPPs, the relationship between chronotype and sleep problems, and whether percentages of shifts worked (morning, evening, night) were consistent with EM clinician chronotype. We hypothesized that evening chronotypes would report greater sleep problems than the other chronotypes, based on previous studies [9]. In emergency departments where EM clinicians have some say in which shifts they work, morning chronotypes were expected to work a higher percentage of day shifts and evening chronotypes were hypothesized to work a commensurate portion of evening shifts.

METHODS

Study Design, Setting, and Participants

This study was conducted in an academic Department of Emergency Medicine (DEM). All 225 members of the DEM (167 EPs, including both attending physicians and residents, and 58 EAPPs, including both physician assistants and nurse practitioners) were recruited for the online survey via a link sent to them by email along with a brief message explaining the purpose of the study. Participants were told their responses would remain confidential and not be shared with department leadership. The survey took approximately 15 to 20 minutes to complete. Participants were not compensated for their participation but were provided with a feedback packet indicating their chronotype, along with lifestyle and sleep recommendations based on their chronotype. This study was approved by the local Institutional Review Board (Pro00089131).

Data analysis was performed by members of the research study team at University of South Carolina School of Medicine Greenville and Clemson University. To maintain confidentiality, no clinicians or members of the DEM had access to study participant lists or to raw data.

Measures

Measures used in the current survey included questions from the Morningness-Eveningness Questionnaire (MEQ) [4], Pittsburg Sleep Quality Index (PSQI) [10], and demographic information. Finally, an item included a request for consent to collect participants' previous three months' worth of shift data (i.e., type and number of shifts) from the hospital system's shift scheduling database.

MEQ

The five items of the reduced MEQ were created by Adan and Almirall [4] and come from the original and lengthier MEQ created by Horne and Ostberg [5]. This questionnaire asks when participants would tend to go to sleep and wake up if they were entirely free to plan their day. One example item is, "At what time in the evening do you feel tired and as a result in need of sleep?". The responses to each item are given a score, which are then summed to provide a chronotype score. Scores are categorized into one of five groups ranging from "Definitely Evening Type" to "Definitely Morning Type." The Cronbach's Alpha for this scale in the present study was 0.77.

PSQI

Four of the seven subscales of sleep quality (Sleep Disturbances, Use of Sleep Medication, Daytime Dysfunction, and Sleep Quality) relevant to emergency personnel were taken from the PSQI [10]. Of note, the other three subscales (sleep latency, sleep duration, and habitual sleep efficiency) were not studied, as they require answers that vary greatly for EM clinicians who go to bed at different times throughout the month and would produce substantial within-physician variability. For Sleep Disturbances, participants were asked to rate how often they have experienced each of a list of 10 potential reasons for trouble sleeping (e.g., cough or snore too loudly, feel too hot). Participants responded on a 4-point scale ranging from Not during the past month to Three or more times a week. Use of Sleep Medication was assessed by the item: "How often have you taken medicine (either prescribed or "over the counter") to help you sleep?", assessed on the same 4-point scale. Daytime Dysfunction was assessed with two items addressing trouble staying awake during activities and having enthusiasm to get things done, also assessed on the same 4-point scale. Sleep Quality was assessed with the single item, "During the past month, how would you rate your sleep quality overall?", responded to on a 4-point scale ranging from Very good to Very bad.

Shift-Type Percentage

Number and time of day of each shift worked by EM clinicians were collected from an archived database (ShiftAdmin scheduling software) for the participants covering the three-month period prior to completing the survey. The shift information was used to calculate the percentage of types of shifts worked by each participant. Shifts were categorized into three times: day (shift ends between 3pm and 7pm), evening (shift ends between 10pm-2am), and night (shift ending between 3am and 8am).

Shifts ranged from 8-11 hours in length. Clinicians in this DEM do not all work equal numbers of each shift per month. The DEM does have a group of full-time night-shift clinicians. The remaining clinicians work fewer night shifts and more day and evening shifts. Prior to schedule generation, clinicians can make certain schedule requests, specifying partial or entire days they cannot work for personal or professional reasons. There is a limit to the amount of requests each clinician can make. Of note, clinicians are not able to request to work certain shifts. The schedule is generated using ShiftAdmin software and with substantial oversight by a full-time DEM non-clinician scheduler. Once the schedule is published, clinicians are permitted to trade shifts with others. As a result, the final shifts worked during the study period were a mix of published and traded shifts. Finally, as this is an academic DEM, some of the EPs have compensated time to perform educational, research, and administrative duties. These EPs work fewer clinical shifts overall.

RESULTS

Demographic Data

Survey links were sent to all 225 EPs, emergency medicine residents, and EAPPs within the DEM, and 127 people completed the survey (56.4% response rate). This included 74 attending EPs (58.3%), 20 emergency medicine residents (15.7%), and 33 EAPPs (26.0%). The gender distribution of the cohort was 54.8% Male and 42.6% Female, with 2.6% preferring not to answer. The ethnic distribution of the cohort was 87.8% White, 0.9% African American, 1.7% Asian, 0.9% Indian, and 3.5% Latino, with 5.2% preferring not to answer. The average age of participants was 38.4 years old (SD = 10.1). Most of the participants were married (74.8%) and had at least one child in the home (56.0%). The demographics of the cohort were similar to the demographics of the overall DEM (**see Table 1**).

Based upon shift data provided by ShiftAdmin, the average breakdown of shifts across participants during the three-month study period was 14.06 Day Shifts, 14.13 Evening Shifts, and 6.82 Night Shifts. The shift lengths were 8.85 hours on average, with a SD of 0.892 hours. Nine respondents worked greater than 93% of their shifts as night shifts, while 39 respondents worked no night shifts whatsoever during this study period.

Table 1: Demographics for the Current Cohort and the Overall Department of Emergency Medicine (DEM)

	Cohort	DEM
Total N	127	225
Physician	74 (58.3%)	137 (60.1%)
EAPP	33 (26.0%)	58 (25.8%)
Resident	20 (15.7%)	30 (13.3%)
Gender		
Male	70 (54.8%)	138 (61.3%)
Female	54 (42.6%)	87 (38.7)
No answer	3 (2.6%)	NA
Avg Age (SD)	38.4 (10.1)	39.5 (10.6)
Ethnicity *	115	
White	101 (87.8%)	195 (86.7%)
African American	1 (0.9%)	3 (1.3%)
Asian	2 (1.7%)	7 (3.1%)
Indian	1 (0.9%)	NA
Latino	4 (3.5%)	1 (0.4%)
Multiple responses	NA	18 (8.0%)
Prefer not to answer	6 (5.2%)	1 (0.4%)
% Married *	86 (74.8%)	NA
% w/ Children *	64 (55.7%)	NA

Note. This table includes demographic information for both the study cohort and the full Department of Emergency Medicine from which the cohort was obtained.

*12 participants in the cohort did not answer questions about their ethnicity, nor whether they were married or had children. N=115 for these demographics.

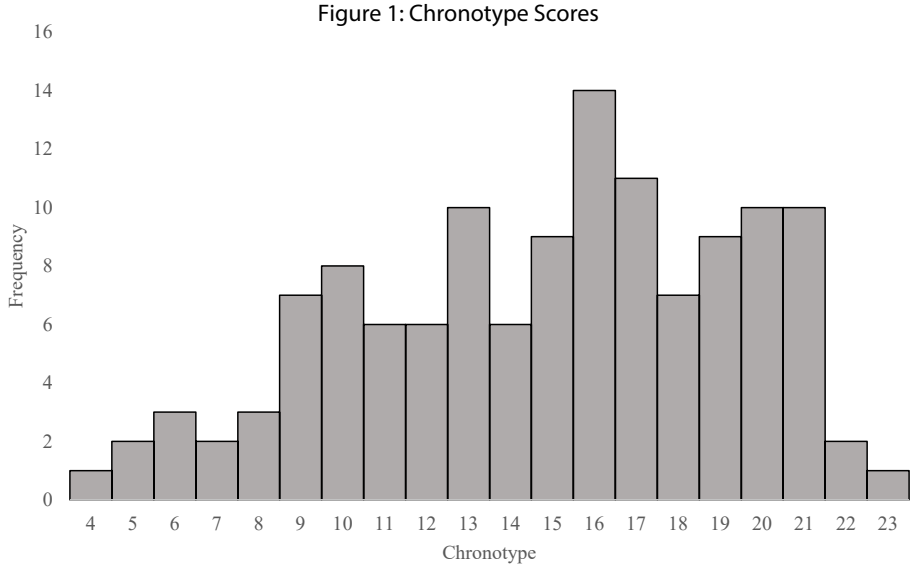
Chronotype Percentages and Demographic Differences

The continuous score on the Chronotype measure was recoded into categories of Morning, Intermediate, and Evening Chronotypes based on the guidelines of Adan and Almirall [4]. Across the emergency medicine personnel, 39/127 (30.7%) were classified as morning, 56/127 (44.1%) were classified as intermediate, and 32/127 (25.2%) were classified as evening (**see Figure 1**). The percentages of different Chronotypes did not vary as a function of Gender, $\chi 2\ (2) = 2.95$, $p = 0.23$, nor Job Title, $\chi 2\ (4) = 2.95$, $p = 0.64$. The Chronotypes also did not differ by age, $F(2, 103) = .874$, $p = 0.42$.

Chronotype Differences in the Sleep Problem Variables

One-way Analyses of Variance (ANOVA) were conducted to assess differences on the sleep problem variables as a function of Chronotype. The effect of Chronotype was significant for Daytime Dysfunction, $F\ (2, 112) = 6.61$, $p < 0.01$, but not for the other three sleep problem variables (p's > 0.50). Follow-up Least Significant Difference (LSD) comparisons revealed that emergency medicine personnel with an evening chronotype reported greater Daytime Dysfunction (M = 2.36) than those with a morning (M = 1.19) or intermediate (M = 1.52) chronotype (p's < 0.05).

Figure 1: Chronotype Scores



Note. Figure 1 shows the distribution of chronotype scores among the study cohort. Possible scores ranged from 4 to 25. Scores ranging from 4 to 11 represent an evening chronotype, 12 to 17 represent an intermediate chronotype, and 18 to 25 represent a morning chronotype. This cohort had 0 participants with scores of 24 or 25.

Chronotype Differences in Shift Percentages

To investigate the effects of Chronotype on the percentages of morning, evening, and night shifts worked by emergency medicine personnel, three between-subjects ANOVAs were conducted with Chronotype as the independent variable and the shift percentage as the dependent variable. Participants were only included in these analyses if they worked 20 or more shifts in the past three months (N = 97). The results revealed a significant effect of Chronotype on percentage of day shifts, $F(2, 83) = 4.37$, $p = 0.02$, $\eta 2 = 0.10$, and night shifts worked, $F(2, 84) = 4.92$, $p = 0.01$, $\eta 2 = 0.11$, but not evening shifts worked, $F(2, 83) = 1.65$, $p = 0.20$. The means and standard deviations for the three shift percentages are provided in **Table 2**.

Table 2: Percentage of day, evening, and night shifts worked in the prior three months as a function of Chronotype

	Day Shift %		***Evening Shift %***		***Night Shift %***	
Chronotype	Mean	SD	Mean	SD	Mean	SD
Morning	38.28 [ab]	21.08	46.98 [c]	25.39	11.12 [d]	17.94
Intermediate	47.70 [a]	21.16	38.39 [c]	19.74	13.65 [d]	22.48
Evening	31.43 [b]	22.00	36.55 [c]	22.72	31.86 [e]	36.17

Note. Means within a column that do not share the same superscript are significantly different at $p < 0.05$.

As seen in Table 2, evening chronotypes worked a lesser percentage of day shifts than intermediate chronotypes. They also worked a greater percentage of night shifts than other types. Contrary to our hypotheses, however, overall they tended to work roughly the same percentages of all three types of shifts. Also contrary to our hypotheses, morning chronotypes did not work a greater percentage of day shifts compared to other types but worked most of their shifts as evening shifts. And most day shifts were worked by clinicians of intermediate chronotype. For the night shift percentage, evening chronotypes worked a greater percentage of night shifts than morning or intermediate chronotypes.

Given that evening chronotype personnel worked a greater percentage of night shifts and reported a higher level of daytime dysfunction than morning or intermediate chronotypes, an Analysis of Covariance (ANCOVA) was conducted to examine whether the effect of Chronotype on daytime dysfunction would remain significant when controlling for percentage of night shifts worked. The results revealed that the effect of Chronotype on daytime dysfunction was no longer significant when controlling for the night shift percentage, $F(2, 74) = 2.23$, $p = 0.12$.

DISCUSSION

This study assessed the chronotypes of EPs and EAPPs and examined how chronotype was related to sleep problems and shifts worked over a three-month period. Our analysis found that most of the EM personnel were of intermediate chronotype followed by morning type, and finally evening type. This is similar to findings in a study by Castro [8]. We also found a significant effect of chronotype on daytime dysfunction (falling asleep during daytime activities, lack of enthusiasm for activities). Participants with an evening chronotype had the most issues with daytime dysfunction. This finding is consistent with prior research suggesting that an evening chronotype is associated with greater fatigue and sleepiness [7]. Chronotype has been shown to impact a wide variety of variables, including executive function [11], vigilance [12], and physical ability [13], all of which could affect physician performance and patient outcomes in the ED. Chronotype's effects on performance have been studied in a wide variety of occupations, including military, transportation, and nursing, but the research on physicians, specifically EPs, is lacking. To our knowledge, only one small study has examined chronotype in EPs. Castro et al [8] examined 26 EPs on different shifts, assessing chronotype, sleepiness, and performance on a gambling task. The authors found that performance on the gambling task was better when EPs reported low sleepiness. The greatest percentage of respondents were classified as the intermediate chronotype, followed by the morning chronotype. The authors did not find relationships between chronotype and performance on the gambling task. However, the small cohort size in this study resulted in low power to detect relationships that may have been present.

Contrary to our expectations, EPs did not work a greater percentage of shifts consistent with their chronotype. However, evening types worked a greater percentage of night shifts than the other two chronotypes. The effect of chronotype on daytime dysfunction was no longer significant when we controlled for percentage of night shifts worked. This finding suggests the greater daytime dysfunction reported by those with an evening chronotype is a function of these individuals working a greater percentage of night shifts, rather than being purely chronotype driven. Night shifts are out of alignment with all chronotypes and would be expected to be related to daytime dysfunction from sleep problems. While some strategies, such as altering duration of shifts or the use of Casino Shifts [14] have been explored to mitigate the effects of night shifts, no strategy has been shown to be effective at alleviating the problems associated with night shift (fatigue, sleepiness, and daytime dysfunction). Because evening types worked a greater percentage of night shifts than the other types, one question that arose in this work is whether working night shifts causes clinicians to develop evening chronotype. Although there is no definitive way to answer this question from this particular study, several studies demonstrate that chronotype is approximately 50% determined genetically, with 50% determined by factors such as age, gender,

and social cues [15]. From these prior studies, it seems unlikely that working nights would be the only variable to alter individuals' overall chronotype, but it could change some aspects of how they adapt.

There were nine participants in our sample who would be considered full-time night shift clinicians, working night shifts 90% or more of the time during the prior three months. Given the design of this study and small size of this sample, it is not possible to compare their responses to the chronotype and sleep variables separately from the other participants.

Notably, one-third of our study population (33.6%) worked no night shifts whatsoever during the study period. Similarly to the group of exclusively night shift workers, the study design lacked capability to determine whether these study participants had different chronotypes compared with other participants.

However, it is worth examining in future research whether emergency medicine personnel who only work night shifts have different chronotypes than other physicians—and whether those who have significant compensated time, or who work few to no night shifts, have different chronotypes from other clinicians.

LIMITATIONS

There are several limitations to our study. First, this study cohort and DEM is less diverse than others might be. Second, in this academic setting, some clinicians work full-time clinically, while others have compensated academic and administrative time. As a result, some clinicians' data were excluded due to working fewer than the minimum 20 shifts in the three-month study window. It is unclear how these factors might affect the generalizability of the study results.

As noted above, the study cohort included several persons who worked exclusively night shifts, and other practitioners who worked very few night shifts. Again, these factors may affect the generalizability of study results. Given the confidentiality parameters of the study and the study design itself, we are unable to further comment on why so many respondents worked very few to no night shifts during the study period. It is possible that the presence of full-time night shift clinicians meant that other clinicians simply were not scheduled to work night shifts during the study window. It is also possible that some of the respondents work very few night shifts in general. Either way, variability related to these factors likely contributed to smaller numbers of persons with morning and intermediate chronotypes who worked night shifts. Finally, this study was not designed to determine how full-time night shift clinicians, and those who work very few or no night shifts, might differ in chronotype from those in the general pool of emergency clinicians.

As to future research directions, we recommend replicating this study in the community setting, where physicians tend to work a more even distribution of shifts; this would reduce variability seen in this study and allow more power to determine the degree of daytime dysfunction in each chronotype in relation to working night shifts. Second, while this study found that working night shifts is correlated to daytime dysfunction, and it is true that the components of daytime dysfunction (fatigue and lack of enthusiasm) are related to items in standard burnout measures [16], this study was not designed to determine how much chronotype, night shifts, and fatigue contribute to burnout. Therefore, another area for study would be the relationship of chronotype malalignment with physician burnout. Third, we would like to study the possible benefits of scheduling by chronotype to improve daytime dysfunction, well-being, and burnout.

CONCLUSION

In this pilot study of EPs and EAPPs, most of the surveyed clinicians were categorized as intermediate chronotype. Working night shifts was associated more closely with daytime dysfunction than was chronotype. Further investigation is needed to determine the generalizability of the results from this study and how these findings relate to clinician burnout.

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