SMJ Singapore Medical Journal

ONLINE FIRST PUBLICATION

Online first papers have undergone full scientific review and copyediting, but have not been typeset or proofread. To cite this article, use the DOIs number provided. Mandatory typesetting and proofreading will commence with regular print and online publication of the online first papers of the *SMJ*.

Sleep, activity and fatigue reported by postgraduate year 1 residents: a prospective cohort study comparing the effects of night-float versus traditional overnight on-call

Jia Ming Low[1], MBBS, MMed, Mae Yue Tan[1], MMBS, MMed,
Kay Choong See[2], MBBS, MRCP, Marion M Aw[1,3], MBBS, MMed

[1]Khoo Teck Puat-National University Children's Medical Institute, National University Health System, [2]University Medicine Cluster, National University Hospital, [3]Department of Paediatrics, Yong Loo Lin School of Medicine, National University of Singapore, Singapore

Correspondence: Dr Marion Aw, Associate Professor, Department of Paediatrics, NUHS Tower Block Level 12, 1E Kent Ridge Road, Singapore 119228. marion_aw@nuhs.edu.sg

---

Singapore Med J 2018, 1–12
https://doi.org/ 10.11622/smedj.2018036
Published ahead of print: 19 March 2018

Online version can be found at
http://www.smj.org.sg/online-first

ABSTRACT

Introduction: As traditional overnight on-call was shown to contribute to fatigue, Singapore moved to implement a shift system in 2014. We aimed to compare activity levels, sleep (using a wrist actigraph), fatigue and professional quality-of-life between residents working on night-float and those working on traditional overnight on-call.

Methods: All postgraduate year 1 (PGY1) residents at our institution were invited to participate. Participants were required to wear a wrist actigraph for four months, and complete two validated surveys (Epworth Sleepiness Scale [ESS] and Professional Quality of Life Scale [ProQOL]) once each at the start and at the end of study.

Results: 49 residents were recruited. Residents on night-float and on-call showed comparable median (range) number of steps (10,061 [1,195–15,923] vs. 10,649 [308–21,910]; p = 0.429), amount of sleep logged (361 [149–630] minutes vs. 380 [175–484] minutes; p = 0.369) and time taken to fall asleep (6 [0–14] minutes vs. 6 [range 0–45] minutes; p = 0.726) respectively. Residents on night-float had less efficient sleep, with 90.5% participants having over 85% sleep efficiency compared to 100% of residents on on-call (p = 0.127). More residents on night-float reported ESS > 10 (73.8% vs. 38.5%) and higher burnout scores on ProQOL (41.4% vs. 21.4%) at the start of the study. However, this was similar to the end of the study and was not statistically significant.

Conclusion: The physical activity and amount of sleep of residents on night-float and on-call rota were not significantly different. Residents on night-float reported comparatively higher fatigue and burnout.

Keywords: actigraph, burnout, sleep efficiency

INTRODUCTION

From May 2014, all house officers in Singapore have come under a national framework for training and reassessment, termed as postgraduate year 1 (PGY1) training, whereby it has been stipulated that work should not exceed 80 hours per week, including night hours.[(1)] As the traditional overnight on-call has been shown to contribute to fatigue, affecting mood and daytime sleepiness (https://www.new-innov.com/), there was a move to implement a shift system that would reduce the continuous stretch of overnight on-call work in clinical departments.

We know that fatigue and burnout have detrimental effects on residents, and there might be long-lasting implications on their physical and mental well-beings.[(2,3)] Studies have reported increased somatic complaints, depression and increased physical dangers in residents who are more fatigued.[(4)] Hence, the aim of the night-float system was to reduce fatigue in residents in order to minimise these detrimental effects.

In our institution (i.e. National University Hospital, Singapore), we have residents who work either the night-float system or the traditional overnight on-call system depending on manpower allocation and department requirements. In the night-float system, residents work for five consecutive nights in a week once every two months when compared to the traditional on-call system wherein each resident works for 4–6 nights on-call per month. Residents assigned to night-float perform on-site duty during evening/night shifts and are responsible for admitting or cross-covering patients until morning. They do not have daytime assignments.[(5)] In our institution, this is defined as working from 8 pm till 8 am the next day. As our institution had two groups of PGY1 residents doing night duty on two unique systems, this allowed us to study whether there were any difference in terms of sleep, activity and fatigue levels in our PGY1 cohort. We hypothesised that the overnight on-call rota would be associated with less sleep, and resultant increased fatigue and burnout, and the converse would be true for residents on the night-float system.

METHODS

The National University of Singapore institutional review board approved the study. The study comprised two components: (a) wearing a wrist actigraph for a continuous period of four months; and (b) completing two questionnaire surveys, namely the Professional Quality of Life Scale (ProQOL) (http://www.proqol.org) and Epworth Sleepiness Scale (ESS) (http://epworthsleepinessscale.com/about-the-ess/), once each at the start and at the end of the study. The wrist actigraph (Fitbit Flex2; FitBit Inc, San Francisco, CA, USA) is a validated alternative to polysomnography for detecting sleep, and estimating sleep duration and activity level.(6) Actigraphy uses a single channel that collects data on movement, which is used to infer time spent asleep and awake.(7) It was chosen as a study tool to collect sleep and activity data for our residents, as it is less cumbersome than polysomnography, less expensive and can be worn for extended periods of time.

The ProQOL – initially created for therapists, nurses and humanitarian workers – is a widely used tool to assess positive and negative aspects of caring. It comprises the positive (Compassion Satisfaction) and negative (Compassion Fatigue or Secondary Trauma Stress) aspects of helping others who have experienced suffering. Compassion Satisfaction is defined as the pleasure derived from being able to do one's work well. Higher scores on this subscale represent greater satisfaction with one's ability to be an effective caregiver. The Compassion Fatigue or Secondary Trauma Stress subscale measures work-related secondary exposure to extremely stressful events and higher scores represent greater Compassion Fatigue. The three aspects of ProQOL were scored based on cut-off scores as per the validated scoring, and analysed as categorical data. Compassion Satisfaction scores ≥ 57 were defined as low (lower positive aspects of working as a helper), Burnout scores ≥ 57 were defined as high (inefficiency and feeling overwhelmed) and Traumatic scores ≥ 57 were defined as high.

The ESS is a self-administered questionnaire with eight questions. It provides a measure of a person's general level of daytime sleepiness, or their average sleep propensity in daily life. Scores > 10 generally depict increased fatigue. This simple questionnaire has been validated and has shown reliability as a measure of daytime sleepiness.

All PGY1 residents in the institution were invited to participate. Participants were asked if they had any known medical conditions. Exclusion criteria were doctors with psychiatric, sleep disorders or cardiac problems.

Information about the study was presented to PGY1 residents across all departments during their weekly continuing medical education sessions over four weeks prior to the launch of the study. Posters were also placed in the resident's lounge and lift lobbies around the hospital to recruit residents. Although the residents were working in different departments, the job scope for every resident was largely similar. Residents were responsible for interviewing and examining newly admitted patients, creating admission histories, writing admission orders, performing phlebotomy services, following up on laboratory results, reporting interim updates to their supervising resident and doing discharge summaries. Participants provided voluntary written informed consent. They were allowed to keep the wrist actigraph on completion of the study.

Study participants were instructed to wear the wrist actigraph on their non-dominant hand every day for four months throughout the study period. Data from the wrist actigraph was downloaded weekly or every fortnightly into an actigraphy-based scoring software programme (Detalytics Pte Ltd, Singapore), which enables calculations of sleep duration, sleep latency (time taken to fall asleep) and sleep efficiency (at least 85% of non-restless sleep). Resident call schedules were used to label sleep and activity logs that corresponded to overnight call or night-float periods. In addition, residents were routinely required to log their duty hours into the New Innovations online software (https://www.new-innov.com/pub/about.html) as part of the Accreditation Council for Graduate Medical Education system.

Data was analysed using IBM SPSS Statistics for Windows, Version 24.0 (IBM Corp, Armonk, NY). Mann-Whitney *U* test was used for continuous variables (e.g. number of steps and minutes of vigorous/moderate activity) with non-normal distribution. Chi-square test was used for categorical variables (e.g. ESS scores and ProQOL scores, which were categorically split based on the defined cut-offs).

RESULTS

Of the 87 PGY1 residents, 49 (56.3%) consented to study participation. These residents recruited either originated from or were rotating through the departments of inpatient general medicine, paediatrics, orthopaedics, obstetrics and gynaecology, and general surgery. The actual study was a four-month period from 1 January 2015 to 30 April 2015. As the intake year for PGY1 residents is between May and September each year, all PGY1 residents in the study would have worked for at least four months prior to the study's start date.

The median age of residents was 25 (range 25–27) years and 42.8% of participants were men. 5 (10.2%) residents listed themselves as having medical problems (including allergic rhinitis, asthma, eczema, glaucoma or Graves' disease) (Table I).

Table I. Characteristics of study population (n = 49).

Variable	**No. (%)**
Age (yr)*	25 (25–27)
Gender	
Male	21 (42.8)
Female	28 (57.2)
Medical problems†	5 (10.2)
Ethnicity	

Chinese	48 (98.0)
Malay	1 (2.0)
Medical background	
Local graduate	44 (89.8)
Overseas medical school	5 (10.2)
Individually logged data‡	
Activity	904
Sleep	321
Night-float	62
On-call	103

Data presented as median (range). †Allergic rhinitis, asthma, eczema, glaucoma or Graves' disease. ‡Data presented as absolute number.

Throughout the study period, the PGY1 residents had 904 individually logged data for activity and 321 individually logged data for sleep. There were 62 individually logged data for residents on night-float and 103 individually logged data for on-call residents.

Of the 49 PGY1 residents who participated, only 11 (22.4%) residents completed all four months of the study using the wrist actigraph; 24 (49.0%) residents logged at least one month of data using the wrist actigraph and 14 (28.6%) residents recorded less than one month's worth of data. Overall, 43 (87.8%) residents completed the two surveys at the start of study while 28 (57.1%) residents and 27 (55.1%) residents completed the ESS questionnaire and ProQOL survey, respectively, at the end of study. Residents with less than one month's worth of data were omitted from the analysis.

The recorded logs were analysed based on whether they corresponded to activity/sleep during on-call or night-float. Both groups of residents averaged similar number of steps and activity duration per day. The median daily steps for residents doing night-float (10,061 [range 1,195–15,923]) was similar to that of residents rostered in the on-call rota (10,649 [range 308–21,910]) ($p = 0.429$). The median duration of vigorous activity per day was 22.5 (range 0–67) minutes and 24 (range 0–110) minutes for residents on night-float and on-call rota, respectively ($p = 0.582$). The median duration of moderate activity per day was

110.5 (range 2–183) minutes and 108.0 (range 0–197) minutes for residents doing night-float and on-call rota, respectively (p = 0.506) (Table II).

Table II. Quantitative comparison of activity levels and sleep, measured by wrist actigraph, among residents on night-float and on-call.

Variable	**Median (range)**		**p-value**
Activity level			
	Night-float (n = 62*)	**On-call rota (n = 103*)**	
Daily steps	10,061 (1,195–15,923)	10,649 (308–21,910)	0.429
Duration of vigorous activity per day (min)	22.5 (0–67)	24 (0–110)	0.582
Duration of moderate activity per day (min)	110.5 (2–183)	108.0 (0–197)	0.506
Sleep			
	Night-float (n = 21*)	**On-call rota (n = 37*)**	
Amount of sleep (min)	361 (149–630)	380 (175–484)	0.369
Time taken to fall asleep (min)	6 (0–14)	6 (0–45)	0.726
Participants who fell asleep in < 5 min†	9 (42.9)	14 (37.8)	0.783
Sleep efficiency > 85%†	19 (90.5)	37 (100.0)	0.127

**n denotes no. of logs.* †*Data presented as no. (%).*

With regard to sleep, residents on night-float appeared to have less efficient sleep when compared to those on on-call rota despite spending similar amounts of time asleep. The proportion of residents on night-float with a sleep efficiency of over 85% was 90.5%, as compared to 100.0% residents on overnight on-calls, although the difference was not statistically significant (p = 0.127). The median amount of sleep for residents on night-float (361 [range 149–630] minutes) was comparable to that among residents on on-call rota (380 [range 175–484] minutes) (p = 0.369). Both groups of residents took a median time of 6 minutes to fall asleep (night-float: 6 [range 0–14] minutes; on-call: 6 [range 0–45] minutes) (p = 0.726). Many residents took less than five minutes to fall asleep (night-float: 42.9%; on-call: 37.8%).

At the beginning of study, 73.8% of residents doing night-float reported ESS score > 10, as compared to 38.5% of residents doing on-calls (p = 0.079). This was similar to findings at the end of study, where 53.8% of residents doing night-float reported ESS score > 10 versus 15.4% of those doing on-calls (p = 0.103). A larger percentage of residents doing night-float also subjectively reported a higher burnout score on the ProQOL (night-float: 41.4%; on-call: 21.4%) at the start of study, although the difference was not statistically significant (p = 0.308) (Table III).

Table III. Comparison of ESS and ProQOL scores of residents on night-float and on-call.

Variable	**No. (%) of residents**		**p-value**
	Night-float	**On-call rota**	
Start of study			
ESS score > 10	19/26 (73.8)	5/13 (38.5)	0.079
ProQOL score			
Higher Burnout score	12/29 (41.4)	3/14 (21.4)	0.308
Lower Compassion Satisfaction score	9/29 (31.0)	2/14 (14.3)	0.291
Higher Traumatic score	6/29 (20.7)	3/14 (21.4)	0.99
End of study			
ESS score > 10	7/13 (53.8)	2/13 (15.4)	0.103
ProQOL score			
Higher Burnout score	5/16 (31.1)	1/10 (10.0)	0.211
Lower Compassion Satisfaction score	6/17 (35.3)	4/10 (40.0)	0.99
Higher Traumatic score	4/16 (25.0)	1/11 (9.1)	0.618

ESS: Epworth Sleepiness Scale; ProQOL: Professional Quality of Life Survey

DISCUSSION

Our study demonstrated that physical activity and amount of sleep for residents on night-float or on-call rota were not significantly different. These results are surprising in that the implementation of the night-float system did not appear to reduce the physical activity or increase the amount of sleep in spite of these two being important contributing factors to the development of fatigue. Furthermore, while not statistically significant, residents on night-float reported higher fatigue and burnout.

To the best of our knowledge, this is the first study that uses quantitative means to measure the amount of sleep and activity levels, together with the degree of fatigue and burnout, among PGY1 residents in Singapore. Our hospital has residents rotating through both the night-float system and traditional on-call rota. This allowed us to compare the sleep and activity levels of the same group of residents who were rostered to do night duties either through float or on-call over the four-month study period.

Our study showed similar amounts of activity and sleep patterns in these residents regardless of whether they were doing shift-work or overnight on-calls. This suggests that shortening the interval of work hours by promoting shift work has not increased sleep in residents. Results of the ESS survey also do not suggest that residents on the shift system were less fatigued than those doing overnight on-calls. A recent study by Richardson et al also reflected similar findings, where trainees with protected time failed to use the time to sleep and slept the same amount as when they were doing on-calls.[(8)] This suggests that implementing a shift system to combat fatigue levels alone is not sufficient to counteract the effects of sleep deprivation on physician performance.

In terms of sleep, residents in our hospital averaged approximately six hours of sleep every night. While some experts claim that at least six hours of sleep is required for optimal day-to-day functioning,[(9)] it is worth noting that the average amount of sleep obtained by residents is the bare minimum achieved. Recent reviews have also reported that the average underlying sleep tendency among young adults is about 8.5 hours per night.[(10,11)] Both groups also had residents who fell asleep in less than five minutes, which corresponds to severe sleepiness. This finding implies that residents might have chronic sleep deprivation. This is in accordance with our survey data, where up to half of residents reported increased fatigue and high burnout rates. This is a worrying trend, as it has been shown in multiple studies that chronically sleep-deprived residents have decreased vigilance and work productivity, and deleterious health side effects.[12,13]

Our study suggested that working shorter hours on night-float did not change the amount of physical activity of our residents (measured in terms of activity levels and amount of vigorous activity) or the amount of sleep the residents had. Both groups of residents demonstrated similar activity levels and vigorous activity throughout the day. As we did not specifically ask residents to log their activities outside of work or specify exactly how many hours they were at work, we were unable to determine if physical activity (steps taken) was predominantly during night-float (i.e. at work) or in the daytime (when they were off work and supposed to be resting).

Our study was not without limitations. There was a high dropout rate, with only a third of residents wearing the wrist actigraph for the entire duration of the study, and only half of the cohort completing the end of study surveys. We postulated that residents who completed the end of study survey would have been ones who were less fatigued, as they had more bandwidth, and were therefore able to comply with the study protocol. This could imply that our data under-represented the true amount of fatigue and burnout felt by PGY1 residents. Conversely, we also could not be certain if residents who were more fatigued were the ones who felt more compelled to complete the end of study surveys. We also acknowledge that the use of surveys for data collection may be open to recall bias.

We realise that it would have been interesting to compare the activity levels of residents during working hours and off-work time. However, we did not have all the appropriate data necessary to correlate the activity levels of residents with periods that they were at work or doing call duties, as a number of residents did not log their duty hours for certain time periods. Additional studies can be done to compare this directly. Furthermore, the sleep data collected was a summative of the entire amount of sleep through the day. We had no breakdown on the data collected for sleep that may have occurred as daytime naps or during rest periods.

In summary, our study suggests that adoption of a night shift system alone is insufficient for reducing fatigue and burnout levels among PGY1 residents. Further studies can be done to identify other factors outside of work that might contribute to fatigue. These may include the effect of off-duty activities on residents' sense of fatigue, burnout and overall quality-of-life.

ACKNOWLEDGEMENTS

Funding for the FitBit device was provided by the National University Health System Clinical Quality and Innovation Fund, Singapore. We thank Janelle Maria Liwanag and Wang Sha for their assistance with data collection, and Rajgor Dimple for her assistance in the editing and submission of the manuscript.

REFERENCES

1. Ministry of Health, Singapore. Working Hours for Housemen on Night Shifts. Available at: https://www.moh.gov.sg/content/moh_web/home/pressRoom/Parliamentary_QA/2015/working-hours-for-housemen-on-night-shifts-.html. Accessed January 23, 2016.
2. Lourenção L, Moscardini A, Soler Z. [Health and quality of life of medical residents]. Rev Assoc Med Bras (1992) 2010; 56:81-91. Portuguese
3. Fletcher KE, Reed DA, Arora VM. Patient safety, resident education and resident well-being following implementation of the 2003 ACGME duty hour rules. J Gen Intern Med 2011; 26:907-19.

4. Veasey S, Rosen R, Barzansky B, Rosen I, Owens J. Sleep loss and fatigue in residency training: a reappraisal. JAMA 2002; 288:1116-24.
5. Accreditation Council for Graduate Medical Education. ACGME program requirements for graduate medical education in pediatrics. Available at: https://www.acgme.org/Portals/0/PDFs/ab_ACGMEglossary.pdf. Accessed January 13, 2017.
6. Martin JL, Hakim AD. Wrist actigraphy. Chest 2011; 139:1514-27.
7. Takacs J, Pollock CL, Guenther JR, et al. Validation of the Fitbit One activity monitor device during treadmill walking. J Sci Med Sport 2014; 17:496-500.
8. Richardson LC, Lehnbom EC, Baysari MT, et al. A time and motion study of junior doctor work patterns on the weekend: a potential contributor to the weekend effect? Intern Med J 2016; 46:819-25.
9. Hirshkowitz M, Whiton K, Albert SM, et al. National Sleep Foundation's sleep time duration recommendations: methodology and results summary. Sleep Health 2015; 1:40-3.
10. Hor H, Tafti M. Physiology. How much sleep do we need? Science 2009; 325:825-6.
11. Bonnet M. Etiology of insomnia. Sleep Med 2006; 7:544.
12. Landrigan CP, Barger LK, Cade BE, Ayas NT, Czeisler CA. Interns' compliance with accreditation council for graduate medical education work-hour limits. JAMA 2006; 296:1063-70.
13. Barger LK, Ayas NT, Cade BE, et al. Impact of extended-duration shifts on medical errors, adverse events, and attentional failures. PLoS Med 2006; 3:e487.