

**Title:** Effects of night work on sleep, cortisol and mood of female nurses, their husbands and children

**Abbreviated title:** Night work impact on nurses and families

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**ABSTRACT**

Negative impacts of night work on employees are well documented, but little is known about immediate consequences for family members. This study examines how night work within a rotating shift pattern affects the sleep, mood and cortisol levels of female nurses, their husbands and children. Participants included twenty nurses ( $42.7 \pm 6.5$  years), their husbands and children ( $n=34$ , 8-18 years) who completed sleep diaries, rated their sleep quality, alertness and mood daily, and collected saliva samples each morning and evening for 14 days. Comparisons were made between night work and other shifts (Wilcoxon Signed Ranks test); and between periods preceding, during and following night shifts (repeated measures ANOVA with Tukey posthoc tests). Nurses' sleep after the final night shift was significantly shorter (3h 58 mins  $\pm$  46 mins) and ended significantly earlier ( $13:28 \pm 0:48$ h) than after the first night shift (sleep duration

5h 17 mins  $\pm$  1h 36 mins; wake time 14:58  $\pm$  1:41h) ( $p < 0.05$ ,  $n = 16$ ). Nurses felt significantly more sleepy with worse mood during night work compared to periods without night work. Bedtime for pre-teenage children ( $n = 15$ ) was significantly later when mothers were working night shifts. Teenage children ( $n = 19$ ) felt significantly calmer when their mothers were working night shifts. This study found significant negative impacts of night shifts on nurses. Despite some changes to children's sleep and mood, most parameters were unaffected. There was an absence of changes to husbands' sleep and mood. This suggests nurses' night work has minimal impacts on family members participating in our study.

**Key words:** circadian rhythms; families; mood; rotating shift work; sleep duration

## INTRODUCTION

It is well established that night workers' sleep and circadian timing system are affected by their working pattern. Night workers experience significantly shorter sleep duration, poorer sleep quality and increased sleepiness for day sleep following night shifts when compared with night time sleep following day shifts [1,2]. Night work is associated with negative impacts on the digestive system, increased risk of accidents, and over the longer term, increased risk of cardiovascular disease [3,4]. Most research concerning night work has studied men only. Studies exploring health impacts of night work for women indicate increased risk of hormonal and reproductive problems and breast cancer [5].

Few studies have undertaken systematic analyses concerning impacts of night work upon the families of night workers. In addition, data about night work has had to be extrapolated from studies concerning shift work or atypical working patterns; and many studies are several decades old [6,7]. Modest associations have been established between both men and women doing shift work and increased risk of relationship

breakdown and divorce [8,9]. Negative emotional outcomes have also been reported for children of men and women with atypical working hours [10,11,12,13]. Suggested explanations for negative social impacts of night work include disruption to social routines and limited shared free time [7,14]. There has been little consideration, however, of how gendered expectations about women's responsibility for household management and family members' wellbeing [15] may affect female night workers and their families' experience of night work. In addition, no previous studies have collected physiological and neurobehavioral data from the families of night workers at the same time as the night worker.

The study aims were to examine the impacts of rotating night work on sleep timing and duration, self-rated sleep quality, sleepiness and mood, and salivary cortisol levels, for female nurses, their husbands and children. We hypothesized that in addition to nurses being adversely affected by working night shifts, this pattern would also have a negative impact on their families' mood and sleep.

## **METHODS**

### ***Participants***

Female nurses and midwives working 29 hours or more per week on non-regularly rotating shift schedules in National Health Service (NHS) hospitals in southern England were recruited to the study, together with their husbands and co-resident children aged 8-18 years. Ethical approval was obtained from the appropriate NHS and University Ethics Committees. Research governance approval was obtained from eight NHS Hospital Trusts which distributed and displayed recruitment posters to their staff. Written informed consent was obtained from all participants. Each family was compensated for their inconvenience.

Twenty families participated, each including a female nurse aged 30-54 years ( $n=20$ ;  $42.7 \pm 6.5$  years, mean  $\pm$  SD), her husband (or male partner) ( $n=20$ ;  $44.6 \pm 7.2$  years) and one or more co-resident children aged 8-18 years ( $n=34$ ). Nineteen children were teenagers aged 13-18 years ( $15.5 \pm 1.5$  years) and 15 were pre-teenagers aged 8-12 years ( $9.9 \pm 1.6$  years).

Most nurses ( $n=15$ ) worked early and late day shifts of 7-8 hours and night shifts of 10-12 hours, the night shift commencing between 07.00–21.30 h and finishing between 07.00-08.00 h. The remaining 5 nurses worked 12 hour shifts with shift changes at approximate 20.00 h and 08.00 h. Fourteen of the nurses worked 37.5 hours or more per week and 6 nurses worked approximately 30 hours per week. As is common for nurses working in the UK, shifts did not follow a regular rotation pattern: nurses worked shifts as rostered, which could include between one and five of the same shifts worked consecutively, and mostly in a clockwise rotation. All of the participating nurses worked at least two night shifts consecutively during the study period. All the nurses reported very busy shifts at work, with few rest opportunities within the work shift. The nurses ranged in experience from 1 month to 31 years post-qualification and all had at least 12 months immediate prior experience of rotating shift work.

Each family participated in a two week period of daily data collection, during which the nurse worked at least two consecutive night shifts of 10-12 hours duration, and day shifts of 7-14 hours duration and days off. After waking each morning (or afternoon following night shifts), each nurse, husband and child completed a four point sleep quality scale from the Pittsburgh Sleep Quality Index [16] and the nine point Karolinska Sleepiness Scale (KSS) [17]. Wording of the scales was modified slightly for pre-teenage children. Before bed each evening (or morning following night shifts) participants completed four 9-point scales to measure their mood and alertness before

sleep [18]. Qualitative interviews were conducted with each couple before the study period, and afterwards with each family member individually [24].

### ***Salivary cortisol***

Saliva samples were collected just after waking in the morning and just before sleeping in the evening using pre-labelled tubes and stored in participants' domestic freezers. At the end of the study, samples were transported with ice packs in portable insulated containers to the laboratory and stored at -20°C until analysis. Saliva samples were thawed, centrifuged and cortisol levels were measured as an indicator of physiological response to stress [19,20] using radioimmunoassay technology (Stockgrand Ltd., University of Surrey, Guildford, UK).. The limit of detection for the saliva cortisol assay was  $0.25 \pm 0.02$  nmol/L (mean  $\pm$  SEM). The interassay CVs were 12.3% at 5.8 nmol/l, 13.9% at 30.9 nmol/l, and 9.6% at 61.6 nmol/l ( $n = 10$  at each concentration). Cortisol values above recommended levels for laboratory analyses ( $>60$  nmol/l) were excluded (0.6% of samples).

### ***Statistical analysis***

Data for nights when any family members were away from home overnight (apart from nurses' night shifts) were excluded from analysis. Sleep duration was calculated from the sleep diaries using self-reported trying to sleep time, sleep latency, night awakenings and wake time.

Sleep, mood and salivary cortisol data were analyzed in two ways to examine the impact of night shifts. Firstly, a comparison was made between periods with and without night work (Wilcoxon Signed Ranks Test). Nurses completed a mean of three

night shifts, therefore data from the twenty families reflect approximately 60 nights in the night work condition and 220 nights in the 'no night work' condition for nurses, their husbands and children.

Secondly, because qualitative interview data (data not shown) indicated changing sleep patterns for nurses before, during and after night shifts, more detailed comparisons were made between the following five work conditions: (1) night before night work commenced; (2) first night shift; (3) last or only night shift; (4) first night after night shifts ended; (5) other, not working at night. Values for any middle night shifts were excluded. Repeated measures ANOVA with Tukey post-hoc tests was conducted to test for differences between these work conditions.

## **RESULTS**

**[Insert Tables 1 and 2]**

### ***Sleep timing***

As expected, nurses' sleep timing was significantly later ( $p < 0.001$ ) by several hours during periods of night work (Table 1). Sleep and wake up time during night work, however, were not delayed equally: sleep onset was delayed much more than wake time, resulting in constrained sleep length. During night work nurses' bed time was delayed by 10h 6mins and trying to sleep time by 9h 55mins while their wake time and get up time was delayed by 7h 25mins and 7h 23mins, respectively.

Wake up time for nurses for day sleep was 14:58  $\pm$  1:41 following the first night shift and was significantly earlier ( $p < 0.001$ ) at 13:28  $\pm$  0:48 following the last or only night shift (Table 2). Get up time for nurses was 15:22  $\pm$  1:28 following the first night shift and was significantly earlier ( $p < 0.001$ ) at 13:46  $\pm$  0:55 following the last or only night shift (Table 2).

Pre-teenage children's bed time was significantly later ( $p < 0.01$ ) by 18 minutes when their mothers were working night shifts (Table 1). Husbands' and teenage children's bedtimes, trying to sleep times, wake times and get up times were also later during nurses' night work (Table 1), although these changes are not statistically significant.

**[Insert Figure 1]**

### ***Sleep duration***

Sleep duration of the nurses, their husbands and children during the nurses' night shift and not during night shifts is shown in Figure 1. Nurses' sleep duration was significantly shorter ( $p < 0.001$ ) by 2h 20mins during night work (mean 4:46  $\pm$  1:26) compared with other times (7:06  $\pm$  0:45) (Figure 1). Nurses' sleep duration following the last or only night of night shifts (3:58  $\pm$  0:46) was significantly shorter ( $p < 0.001$ ) compared with sleep following the first night of night shifts (5:17  $\pm$  1:36) (Table 2). Husbands' and children's sleep duration was also reduced by a few minutes when the nurses were working night shifts, but these changes were not statistically significant (Figure 1).

**[Insert Table 3]**

### ***Sleep quality and alertness/sleepiness***

During periods of night work, nurses reported worse sleep quality (nonsignificant) and more sleepiness (Karolinska Sleepiness Scale) both before ( $p < 0.01$ ) and after ( $p < 0.001$ ) their main period of day sleep when compared with night time sleep in periods of no night work (Table 3).

### ***Mood***

Nurses reported worse mood during night work compared to periods of no night work on two of the three mood scales. Nurses were more miserable ( $p < 0.01$ ) and more depressed ( $p < 0.01$ ) before their main sleep on night shifts.

Teenage children had a statistically significant ( $p < 0.05$ ) improvement on the Calm-tense scale which indicated teenagers felt less tense and more calm during their mothers' absence from home on night shifts (Table 3).

### ***Salivary cortisol***

Saliva samples for the nurses in this study ( $n=18$ ) had a mean ( $\pm$  SD) early morning (soon after rising) cortisol value of  $12.5 \pm 5.6$  nmol/L (mean sample collection time  $07:58 \pm 38$  mins) which was significantly lower ( $p < 0.001$ ) than the late evening (before retiring to bed) cortisol value of  $4.0 \pm 5.2$  nmol/L (mean sample collection time  $21:53 \pm 1$  hour 17 mins). This finding confirms the known variation in cortisol concentrations by time of day.

**[Insert Table 4]**



During periods of night work, the early morning cortisol levels for nurses was  $10.7 \pm 5.7$  nmol/L which was significantly lower ( $p < 0.05$ ) than the early morning cortisol level of  $14.2 \pm 5.0$  nmol/L for other times ( $n=18$ ). During periods of night work, however, the early morning saliva samples were collected significantly later ( $p < 0.01$ ) compared with other mornings ( $08:16 \pm 34$  mins following night shifts compared with  $07:41 \pm 34$  mins for other mornings). For late evening cortisol levels, there was a nonsignificant trend ( $p=0.102$ ) of higher cortisol levels during periods of night work ( $4.9 \pm 7.2$  nmol/L) compared with other times ( $3.0 \pm 1.5$  nmol/L). However, late evening saliva samples were collected significantly earlier ( $p < 0.05$ ) during night work ( $21:21 \pm 1$  hour 32 mins) compared with other times ( $22:22 \pm 44$  mins). When comparing cortisol levels at different stages through a series of night shifts ( $n=10$ ), there were no statistically significant differences between the early morning and late evening cortisol levels (Table 4).

## DISCUSSION

The statistically significant reduction in nurses' sleep duration, worse mood, and the increased sleepiness before and after day sleep following night shifts when compared with day shifts and night sleep were expected findings reflecting the body of previous shift work research [1,2].

Nurses' day time sleep following the last or only night shift was significantly shorter in duration with a significantly earlier wake time than after the first night shift. Although some previous studies have noted this phenomenon [1], demonstration of significantly reduced day sleep following the end of night shifts in female nurses has not been previously reported and is an important new finding concerning the impact of night shift on women's sleep. Qualitative interviews with the nurses, husbands and children all

reflected the women's concern to try to minimize the effects of their night work on their family by resuming usual household tasks and routines as soon as possible after night shifts end [24].

The timing of the day sleep following the nurses' night shifts appeared to be fitted within their children's school day. Qualitative accounts [24] indicated that the nurses timed their sleep to enable delivery and collection of children to and from school and the completion of other household tasks in the morning and afternoon. This supports previous research findings: in Brazil, women factory workers with children have been reported to have shorter and more numerous day sleep episodes than women without children, and all women had shorter sleep duration than men following night shifts [22,23]; while a qualitative study in the United States showed women with children employed on night shifts valued being able to combine paid employment with being "good moms" who were available to care during the day [21]. In addition to household tasks, the participating nurses also expressed concerns about re-establishing usual night time sleep patterns as soon as possible to facilitate readiness for the next shift. For practical reasons the time of saliva collection during the night shifts was different with nurses collecting their evening saliva samples significantly earlier, and their morning saliva samples significantly later during the periods of night work. These different sampling times confound the interpretation of the significantly lower cortisol levels observed in the mornings and the trend of higher cortisol levels in the evenings during the night shifts. However, later morning sampling times should result in higher rather than lower cortisol levels, thus the findings more likely reflect an effect of the night shift. A circadian phase delay as a result of the night shift and clockwise shift rotation as well as differences in light exposure on the night shift could explain our results.

In the 24 hours after night shifts ended, only 14 out of the 20 nurses successfully collected saliva samples and recorded sample collection times. These methodological difficulties demonstrate the challenges involved in asking busy night workers to adhere to a research protocol, even though these nurses were successfully managing their night work and family responsibilities.

This is the first study to examine the impact of night work upon self-rated sleep and mood of family members, and to draw comparisons between impacts on sleep and mood of night workers and their families. Despite a large data collection from husbands and children assessing a substantial number of sleep and mood parameters in different stages of the nurses' night work, the only statistically significant changes were teenagers' calmer mood and delays in bedtime for pre-teenage children when their mothers were working night shifts compared with other times. During nurses' night work, there was a trend towards later sleep timing and shorter sleep duration for both husbands and teenage children, but this did not reach statistical significance. Our qualitative interviews support these data [24] and showed that evenings without their wives' and mothers' usual structuring and organizing influence allowed for fathers to exercise their own parenting style which usually enabled a longer and more relaxed evening.

These data about impacts of night work on family members' sleep and mood were collected as part of a study examining in detail how members of 20 families organize their lives to manage and cope with women's night work. The in-depth design and self-selecting participant recruitment mean it is unlikely that families who were coping poorly with night work would have agreed to participate. Therefore, although this study provides insights into the impacts of night work on the sleep and mood of families which appear to successfully manage night work, it cannot be considered to be representative of all female night workers and their families.

The findings of only small changes for husbands' and children's sleep and mood during nurses' night work did not confirm our hypothesis and appear to be in sharp contrast to the shift work literature, which identifies night work as socially negative [25]. Female nurses in this study, however, experienced substantial impacts of night work on their sleep and mood: firstly, because they were working night shifts, and secondly, because they tried to minimize the impacts of their night work on their husbands and children, resulting in short day sleep duration, especially following their last night shift.

In conclusion, this study has shown that night work has important effects on the sleep and mood of partnered women with children. While previous studies have reported that women may have shorter and more fragmented day sleep following night shifts compared with men [22, 23], the current study has identified that women's day sleep following the last night shift is of particularly short duration, which appears to be linked with women's concern to minimize the impacts of their night shifts on their families. These findings, moreover, suggest that where nurses appear to successfully manage their night work, this has limited effects on their husbands' and children's sleep and mood. More research is warranted studying the impacts of night work across a representative sample of female and male shift workers, their partners and children.

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## REFERENCES

- 1 Akerstedt T. Shift work and disturbed sleep/wakefulness. *Occup Med - Oxford*. 2003;53:89-94.
- 2 Ohayon M, Lemoine, P, Arnaud-Briant V, Dreyfus M. (2002) Prevalence and consequences of sleep disorders in a shift worker population. *J Psychosom Res*. 2002;53:577-583.
- 3 Rajaratnam SNW, Arendt J. Health in a 24-hr Society. *Lancet*. 2001;358:999-1005.
- 4 Puttonen S, Harma M, Hublin C. Shift work and cardiovascular disease - pathways from circadian stress to morbidity. *Scand J Work Environ Health*. 2010;36:96-108.
- 5 Megdal SP, Kroenke CH, Laden F, Pukkala E, Schernhammer ES. Night work and breast cancer risk: a systematic review and meta-analysis. *Eur J Cancer*. 2005;41:2023-32.
- 6 Banks O. Continuous Shift Work: The attitudes of wives. *Occup Psych*. 1956;30:69-84.
- 7 Mott PE, Mann FC, McLoughlin Q, Warwick DP. *Shift Work: The Social, Psychological and Physical Consequences* Michigan: University of Michigan Press, 1965.
- 8 White L, Keith B. The Effect of Shift Work on the Quality and Stability of marital relations. *J Marriage Fam*. 1990;52:435-462.

- 9 Presser, H. Nonstandard Work Schedules and Marital Instability. *J Marriage Fam.* 1990;62:93-110.
- 10 Barton J, Aldridge J, Smith, P. The emotional impact of shift work on the children of shift workers. *Scand J Work Environ Health.* 1998;24(S3):146-150.
- 11 Han, W-J. Shift work and child behavioral outcomes. *Work Employ Soc.* 2008;22: 67-87.
- 12 Han, W-J, Miller DP. Parental work schedules and adolescent depression. *Health Soc Rev.* 2009;18:36-49.
- 13 Strazdins L, Clements, MS, Korda RJ, Broom, DH. and D'Souza, RM. Unsociable Work? Nonstandard Work Schedules, Family Relationships, and Children's Well-Being. *J Marriage Fam* 2006;68:394-410.
- 14 Volger A, Ernst G, Nachreiner F, Hänecke K. Common free time of family members under different shift systems. *Appl Ergon.* 1988;19:213-218.
- 15 Hochschild AR, Machung A. *The Second Shift.* New York: Penguin, 2003 (2<sup>nd</sup> edition).

- 16 Buysse DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiat Res.* 1989;28:193-213.
- 17 Akerstedt T. Psychological and psychophysiological effects of shift work. *Scand J Work Environ Health.* 1990;16(S1):67-83.
- 18 Sletten TL, Middleton B, Lederle KA, Skene DJ. Age-Related Changes in Acute and Phase-Advancing Responses to Monochromatic Light. *J Biol Rhythm.* 2009;24:73-84.
- 19 Eller NH, Netterstrom B, Hansen, AM. Psychosocial factors at home and at work and levels of salivary cortisol. *Biol Psychol.* 2006;73:280-287.
- 20 Schulz P, Kirschbaum C, Prueßner J, Hellhammer D. Increased free cortisol secretion after awakening in chronically stressed individuals due to work overload. *Stress Medicine.* 1998;14:91-97.
- 21 Garey AI. Constructing Motherhood on the Night Shift: "Working Mothers" as "Stay-at-Home-Moms". *Qualitative Sociology.* 1995;18(4):415-437.
- 22 Rotenberg L, Moreno C, Portela LF, Benedito-Silva AA, Menna-Barreto L. The Amount of Diurnal Sleep, and Complaints of Fatigue and Poor

Sleep, in Night-Working Women: The Effects of Having Children. *Biol Rhythm Res.* 2000;31: 515-522.

- 23 Rotenberg L, Portela LF, Marcondes WB, Moreno C, de Paula Nascimento C. Gender and night work: sleep, daily life, and the experience of night shift workers. *Cadernos de Saúde Pública.* 2001;17:639-649.
- 24 Thompson, E. (2009) Understanding how night work influences the everyday family lives of nurses, their husbands and children. EL's Unpublished PhD Thesis under previous surname. University of Surrey
- 25 Costa G. Shift work and occupational medicine: an overview. *Occup Med-Oxford.* 2003;53:83-88.



<b>Table 1: Subjective sleep timing (mean ± SD) during nurses' night work and not night work</b>					
		<b>Bedtime (h:min)</b>	<b>Trying to sleep time (h:min)</b>	<b>Wake time (h:min)</b>	<b>Get up (h:min)</b>
<b>Nurses (n=20)</b>	Not night work	<b>23:06 ± 0:40</b>	<b>23:28 ± 0:40</b>	<b>07:04 ± 0:32</b>	<b>07:27 ± 0:35</b>
	Night work	<b>09:14 ± 0:56***</b>	<b>09:23 ± 1:02***</b>	<b>14:29 ± 1:01***</b>	<b>14:50 ± 1:02***</b>
<b>Husbands (n=19)</b>	Not night work	23:19 ± 0:44	23:35 ± 0:45	06:52 ± 0:56	07:10 ± 0:55
	Night work	23:39 ± 0:51	23:59 ± 0:53	07:03 ± 0:50	07:26 ± 0:53
<b>Teenage children (n=19)</b>	Not night work	22:40 ± 1:11	22:57 ± 1:10	07:46 ± 0:46	07:59 ± 0:46
	Night work	23:07 ± 1:28	23:26 ± 1:25	07:52 ± 1:05	08:05 ± 1:06
<b>Pre- teenage children (n=15)</b>	Not night work	<b>21:10 ± 0:43</b>	21:28 ± 0:40	07:14 ± 0:34	07:29 ± 0:20
	Night work	<b>21:28 ± 0:50**</b>	21:38 ± 0:50	07:10 ± 1:14	07:28 ± 1:16
** p<0.01; *** p<0.001 compared to "not night work"					

<b>Table 2: Nurses' subjective sleep parameters (mean <math>\pm</math> SD) for five stages of night work</b>					
<b>n = 16</b>	<b>Night before night shifts</b>	<b>First night shift</b>	<b>Last or only night shift</b>	<b>Night after night shift ends</b>	<b>Other non-night shifts</b>
Bed time (h:min)	23:00 $\pm$ 0:53	09:06 $\pm$ 0:35 <i>a,b,d</i>	09:06 $\pm$ 0:38 <i>a,b,d</i>	23:00 $\pm$ 1:30	23:00 $\pm$ 0:44
Trying to sleep time (h:min)	23:00 $\pm$ 0:58	09:12 $\pm$ 0:43 <i>a,b,d</i>	09:18 $\pm$ 0:40 <i>a,b,d</i>	00:00 $\pm$ 1:24	23:00 $\pm$ 0:43
Wake time (h:min)	07:41 $\pm$ 1:04	14:58 $\pm$ 1:41 <i>a,b,c,d</i>	13:28 $\pm$ 0:48 <i>a,b,d</i>	06:52 $\pm$ 1:08	06:57 $\pm$ 0:32
Get up time (h:min)	08:12 $\pm$ 1:14	15:22 $\pm$ 1:28 <i>a,b,c,d</i>	13:46 $\pm$ 0:55 <i>a,b,d</i>	07:28 $\pm$ 1:13	07:17 $\pm$ 0:31
Sleep duration (h:min)	7h 55 mins $\pm$ 1h 7 mins	5h17 mins $\pm$ 1h 36 mins <i>a,b,c,d</i>	3h 58 mins $\pm$ 46 mins <i>a,b,d</i>	6h 28 mins $\pm$ 1h 17 mins	6h 59 mins $\pm$ 47 mins
<p>a p&lt;0.05 compared with "Other non-nights shifts"</p> <p>b p&lt;0.05 compared with "Night before night shifts"</p> <p>c p&lt;0.05 compared with "Last or only night shift"</p> <p>d p&lt;0.05 compared with "Night after night shift ends"</p>					

<b>Table 3: Self-rated sleepiness and mood (mean <math>\pm</math> SD) during nurses' night work and other times</b>						
		<b>Alert-sleepiness (following main sleep)</b>	<b>Cheerful – miserable (before main sleep)</b>	<b>Calm – tense (before main sleep)</b>	<b>Elated – depressed (before main sleep)</b>	<b>Alert – sleepiness (before main sleep)</b>
<b>Nurses (n=20)</b>	Not night work	<b>4.3 <math>\pm</math> 1.4</b>	<b>3.9 <math>\pm</math> 0.9</b>	3.9 $\pm$ 1.0	<b>4.3 <math>\pm</math> 0.6</b>	<b>4.7 <math>\pm</math> 0.9</b>
	Night work	<b>5.8 <math>\pm</math> 1.9**</b>	<b>4.6 <math>\pm</math> 1.1**</b>	4.2 $\pm$ 1.3	<b>4.7 <math>\pm</math> 0.9*</b>	<b>5.7 <math>\pm</math> 1.7*</b>
<b>Husbands (n=19)</b>	Not night work	4.2 $\pm$ 1.3	4.0 $\pm$ 1.1	4.0 $\pm$ 1.1	4.3 $\pm$ 0.8	4.9 $\pm$ 1.4
	Night work	4.6 $\pm$ 1.6	4.0 $\pm$ 1.1	4.0 $\pm$ 1.3	4.2 $\pm$ 0.9	5.0 $\pm$ 1.4
<b>Teenage children (n=19<sup>a</sup>)</b>	Not night work	4.9 $\pm$ 1.1	3.7 $\pm$ 1.0	<b>3.6 <math>\pm</math> 1.0</b>	3.7 $\pm$ 1.1	4.9 $\pm$ 1.3
	Night work	4.8 $\pm$ 1.8	3.5 $\pm$ 1.2	<b>3.1 <math>\pm</math> 1.4*</b>	3.4 $\pm$ 1.1	5.0 $\pm$ 1.7
<b>Pre-teenage children (n=15)</b>	Not night work	3.8 $\pm$ 1.4	3.4 $\pm$ 1.3	3.3 $\pm$ 1.0	3.7 $\pm$ 1.0	4.4 $\pm$ 1.6
	Night work	4.1 $\pm$ 1.7	3.5 $\pm$ 1.3	3.5 $\pm$ 1.2	3.8 $\pm$ 1.5	4.4 $\pm$ 1.9
* $p$ <0.05; ** $p$ <0.01; *** $p$ <0.001 compared to “not night work”						
<sup>a</sup> $n$ =17 for <i>Cheerful-miserable</i> ; $n$ =18 for <i>elated-depressed and alertness/sleepiness before main sleep</i>						

<b>Table 4: Salivary cortisol values (mean <math>\pm</math> SD, nmol/L) for nurses at different stages of night work and other times</b>						
	<i>n = 10</i>	<b>Day before night shift</b>	<b>Day following first night shift</b>	<b>Day following last or only night shift</b>	<b>Day after night shifts end (after night time sleep resumes)</b>	<b>Other non-night shifts</b>
<b>Cortisol</b>	<b>Early morning</b>	14.0 $\pm$ 5.7	12.2 $\pm$ 3.6	9.0 $\pm$ 7.0	8.9 $\pm$ 3.5	10.5 $\pm$ 4.5
	<b>Late evening</b>	4.1 $\pm$ 3.7	3.0 $\pm$ 1.4	1.7 $\pm$ 0.7	2.2 $\pm$ 1.2	2.3 $\pm$ 1.0

Figure 1: Sleep duration during nurses' night work and not night work

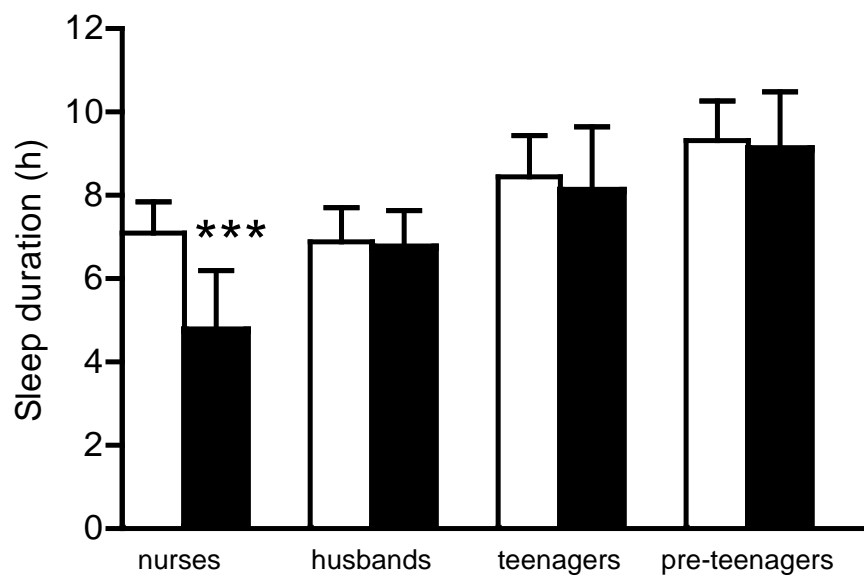


Figure legends

Figure 1: Sleep duration (h, mean  $\pm$  SD) in nurses (n = 20), their husbands (n = 19) and teenage (n = 19) and pre-teenage (n = 15) children during non-night work ( $\square$ ) and night work ( $\blacksquare$ ). \*\*\* p < 0.001 compared to the corresponding non-night work.