

## RESEARCH ARTICLE

# Prevalence of sleep disruption and determinants of sleepiness in a cohort of Italian hospital physicians: The PRESOMO study

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## Abstract

Nightshift work can cause daytime somnolence and decreased alertness, and can increase risk of medical errors, occupational injuries and car accidents. We used a structured questionnaire, including the Epworth Sleepiness Scale (ESS), to assess the prevalence and the determinants of sleep disruption in 268 Italian University hospital physicians from Cagliari ( $N = 57$ ), Milan ( $N = 180$ ) and Pisa ( $N = 31$ ), who participated in the multicentre study on the prevalence of sleep disturbance among hospital physicians (PRESOMO); 198 of them (74%) were engaged in nightshift work. We explored the association between history of nightshift work and poor sleep quality and daytime somnolence with multivariate logistic regression, adjusting by personal and lifestyle covariates. Age, female gender, taking medication interfering with sleep and an elevated ESS score were significant predictors of poor sleep quality and daytime somnolence. Nightshift work was associated with a higher prevalence of unrestful sleep (84% versus 70%; odds ratio [OR] = 2.4, 95% confidence interval [CI] 1.18–5.05) and daytime dozing (57% versus 35%; OR = 1.9, 95% CI 1.03–3.64), with an upward trend by years of engagement in nightshift work for both conditions ( $p = .043$  and  $0.017$ , respectively), and by number of nightshifts/year for unrestful sleep ( $p = .024$ ). Such an association was not detected with the ESS scale. Our results suggest that nightshift work significantly affects sleep quality and daytime somnolence in hospital physicians, who might underestimate their daytime dozing problem, when asked to subjectively scale it.

## KEYWORDS

Epworth Sleepiness Scale, healthcare workers, nightshift work, sleep disorders

## 1 | INTRODUCTION

A 24/7 functioning hospital requires rotating groups of healthcare workers according to a schedule including nightshifts. As a

consequence, the healthcare personnel represent a large proportion of shift workers. In Italy, almost 8% of the total workforce is engaged in nightshift work; amongst the healthcare personnel, the rate reaches 35% (EU Publication Office, 2017).

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Working unconventional hours takes its toll on workers' health, with consequences ranging from sleep problems to mental health issues and long-term effects on physical health, including an increase in risk of cardiovascular accidents, type II diabetes and cancer (Kecklund & Axelsson, 2016).

Circadian misalignment is a direct consequence of shift work (Boivin & Boudreau, 2014): the endogenous circadian rhythm entrained by day-night alternance is mismatched with the workers sleep-work schedule. During a nightshift, values of the spectral index of cardiac sympatho-vagal modulation (LF/HF) are reduced compared to those during the morning and afternoon shifts. The resulting blunted circadian oscillation of cardiac sympatho-vagal modulation would suggest a mismatch between the endogenous circadian rhythm and the continuous changes of work and sleep schedules, and it might account for the increased cardiovascular risk as well as the daytime sleepiness and impaired alertness among shift workers (Furlan et al., 2000).

Sleep deprivation and impaired sleep quality are main effects of nightshift work, which can cause excessive sleepiness to emerge in the daytime as well as during nightshifts (Booker et al., 2018). Shift workers tend to have a shorter and fragmented sleep, especially those working on a counterclockwise shift-rotating schedule. This phenomenon has an important impact on performance at work, with a reduced level of vigilance during working hours, but also on social and family life (Shiffer et al., 2018).

The International Classification of Sleep Disorders – 3rd revision (ICSD-3) classifies “Shift Work Disorder” as a specific sleep disorder (American Academy of Sleep Medicine, 2014), characterized by insomnia and daytime sleepiness, associated with an irregular working schedule. Its prevalence among shift workers was estimated to be around 10%–38% (Di Milia et al., 2013).

For healthcare workers, such as hospital physicians, the adverse outcomes of nightshift work are not limited to their personal health, but they also affect healthcare quality and patients' safety. In fact, dozing at work can impair attention and various cognitive performances, resulting in an increased risk of accidents (Mullins et al., 2014) and, in the case of hospital physicians, medical errors (Howard et al., 2003). For instance, acute sleep deprivation has been associated with a late response to stimuli and impaired attention in young doctors (Sanchez et al., 2015). Also, a progressive decrease in alertness and impairment of performance have been reported during the nightshift among sleep-deprived doctors, compared to a reference group of rested doctors (Howard et al., 2003). Also, sleep deprivation has been shown to lessen work performance, particularly when quick decision-making and prompt responses are required (Parker & Parker, 2017).

Sleep deprivation, even after a single on-call night, causes altered autonomic response (Tobaldini et al., 2013). The excessive chronic sympathetic activation is a risk factor for cardiovascular disease and can also have a negative impact on cognitive performance (Hansen et al., 2004), leading to a risk of errors during the shift.

It has been suggested that the effect of a busy night on call on the doctor's performances is comparable to that caused by alcohol

intake (Arnedt et al., 2005). The risk of occupational injuries, such as needle stick injuries or other percutaneous injuries with sharp objects, is also elevated during nightshifts (Ayas et al., 2006). Driving while drowsy leads to an increased risk of car accidents amongst trainee physicians (Anderson et al., 2018). Sleep deprivation can also affect the doctor-patient relationship (Shaker et al., 2011), as doctors might feel less empathic and concerned with their patients' conditions during nightshifts (Papp et al., 2004). Long working hours and prolonged work shifts are known to affect the work performance and health status of physicians (Barger et al., 2006), although a threshold for an increasing risk has not been identified as yet.

To promote adaptation and preserve the health status of both physicians and their patients, it is of paramount importance to assess the prevalence of sleep disturbance among hospital physicians working nightshifts and which individual factors, other than the working schedule, might contribute to this.

The aim of our study was to assess the prevalence of sleep disturbances among Italian hospital physicians working nightshifts, with reference to hospital physicians who only work at daytime. A secondary outcome was to determine whether individual and lifestyle factors can influence the occurrence of daytime somnolence in physician.

## 2 | MATERIALS AND METHODS

### 2.1 | Study population

Overall, 268 physicians from Cagliari (University Hospital,  $N = 57$ ), Milan (University Hospital and San Carlo Borromeo Hospital,  $N = 180$ ) and Pisa (University Hospital,  $N = 31$ ) volunteered for participation in the multicentre PRESOMO (PREValenza di disturbi del SOInno nel personale Medico Ospedaliero, prevalence of sleep disturbance in hospital physicians) cross-sectional study. Participants were physicians from medical or surgical departments, both residents and consultants.

We considered as nightshift workers study subjects whose regular working schedule included nightshifts, according to the Italian law (Italian Law Decree N. 66 of 8 April 2003, Article 1, paragraph 2), which defines night work as that performed between 10:00 PM and 5:00 AM. This led to 198 out of the 268 participants being included. The monthly frequency of nightshifts ranged between two and four, with varying rotation schemes defined at the local hospital level.

Based on the questionnaire, 70 physicians worked only in the daytime.

### 2.2 | Questionnaire

All participants filled in a self-administered questionnaire. We used the Questionnaire for the Evaluation of Alertness in Occupational Medicine, created by the joint working group of the Italian Society of Occupational Medicine and the Italian Sleep Medicine Society

(AIMS), under whose auspices the PRESOMO study was conducted. This questionnaire was developed by the occupational health group within AIMS as a tool for the assessment of sleep and sleepiness during periodical occupational health surveillance (Roscelli & Spaggiari, 2008).

The questionnaire consists of 28 multiple-choice questions divided into two sections: the first gathers information on personal, anthropometric and lifestyle variables, and sleep habits; the second explores shift work in detail.

The first part includes questions to define the hypnotype, based upon how many sleep hours the subject needs to feel refreshed (more than 8, 6–8, <6), and the chronotype, defined by whether the subject prefers to sleep at conventional hours or to go to bed early and wake up early or go to bed late at night and sleep through until late morning. Further questions explore sleep satisfaction currently and in the past, and what factors (life events, working issues, other) might have impaired sleep satisfaction, and if the subject feels able to have all the sleeping hours he/she needs.

Four questions address sleepiness during the day, whether unwanted sleep episodes occur during the day, and whether any sleepiness-related accident has occurred in the recent past.

Another two questions explore snoring and respiratory pauses as perceived or reported by the partner.

The subject is also asked about any previous diagnosis of a list of sleep disorders, and about intake of any listed medication interfering with sleep, including benzodiazepines, beta-blockers, corticosteroids, antidepressants, antipsychotics, antihistamines, other hypnotics and melatonin.

The second section enquires about different aspects of shift work, including weekly hours, number of nightshifts per month, type and direction of shift rotation, occurrence of unwanted sleep episodes during working hours, and habits after a nightshift.

In order to objectively assess somnolence, we also administered the Epworth Sleepiness Scale (ESS) (Johns, 1991), a validated questionnaire composed of eight items describing regular daytime circumstances in which the subject is asked to rate her/his probability of falling asleep on a scale from 0 to 3. A final score equal to or above 11 is suggestive of excessive daytime sleepiness (EDS) (Johns & Hocking, 1997).

### 2.3 | Statistical analysis

We used parametric or non-parametric measures of central tendency as appropriate for describing the study variables. After transforming all the independent variables and the outcomes into binary variables, we first conducted univariate analyses with two-by-two contingency tables to explore the association between the independent covariates and four outcomes, namely sleep quality (poor–bad versus good–fair), sensation of rest upon wake (unrestful versus restful sleep), perceived daytime somnolence (somnolent versus vigilante) and ESS score ( $\geq 7$  versus  $\leq 6$ , with the upper quartile arbitrarily selected as the cut point for the purposes of analysis). We

used the Pearson  $\chi^2$  test to make univariate comparisons by gender (female versus male), hospital ward (surgical/emergency versus medical), body mass index (BMI, obese, overweight versus regular–underweight), chronotype (morning versus evening–intermediate), coffee ( $\leq 3$  versus  $\geq 4$ /day), alcohol (ever versus never drinkers), intake of medication interfering with sleep (yes versus no), napping (not possible because of time pressure versus yes–not needed), night-shift work (yes versus no), and on call shifts (meaning the availability to respond to emergency calls at night-time independent of being engaged in regular nightshifts; yes versus no), with the dichotomized study outcomes, and between the four outcomes versus each other. In all instances, we rejected the null hypothesis when the probability of chance associated with the appropriate test result was  $< 5\%$ .

We used unconditional logistic regression models to predict poor sleep quality, unrestful sleep, self-reported daytime somnolence and an elevated ESS score, adjusting by age (continuous), gender, body mass index (BMI), chronotype, coffee drinking, use of medication interfering with sleep, and engagement in nightshift work (yes/no). Other covariates were not considered because of very small numbers (such as workplace/car accidents, diagnosed sleep disorders, or exposure to neurotoxic chemicals), or their very poor contribution to reducing the model variance (such as hospital ward and alcohol intake), or their strong correlation with other covariates or outcomes (such as napping). Duration of nightshift work in years (categorized as below or equal to the median of 12 years and above the median) and number of nightshifts/month (categorized as below or equal to the median of 36 nightshifts/year and above the median) alternatively replaced the nightshift work dummy variable to analyse its effects in more depth. We calculated the odds ratio (OR) and its 95% confidence interval as the measure of association between the independent covariates and the respective outcome. The analysis was conducted with SPSS v20<sup>®</sup>. The ethics committee of the leading unit (AOU Pisana) approved the study protocol (CE 3522/2012), and the ethics committee of the other participating units took note of approval. All participants signed an informed consent form.

## 3 | RESULTS

The mean age of study participants was 46.7 years (standard deviation [SD] 11.47); the mean BMI was 24.0 (SD 4.37), comprising 180 regular weight or underweight subjects, sixty-five overweight subjects and 23 obese subjects. The prevalent chronotype was intermediate (60%); 16% had a morning chronotype and 24% an evening chronotype. Table 1 summarizes the distribution of study subjects by the dichotomized or categorical variables used in this study. Table 1 also shows the results of the univariate analysis exploring the association between nightshift work and individual and lifestyle variables, with the outcomes suggestive of insufficient or disrupted sleep. These include poor or bad sleep quality, unrestful sleep, daytime somnolence and an elevated ESS score. The median ESS score was 3, with six subjects (2.2%) scoring  $\geq 11$ , the EDS threshold, and 43 scoring  $\geq 7$ , corresponding to the upper quartile of its distribution.

**TABLE 1** Two-by-two contingency tables between dependent outcomes and independent covariates: number of subjects with and without the outcome associated with the risk factor

Independent covariates	Sleep outcomes			
	Poor–bad sleep quality versus fair–good	Unrestful/restful sleep <sup>a</sup>	Daytime somnolent/vigilante	ESS $\geq 7/\leq 6$
<b>Gender</b>				
Male	41/58	79/20	37/62	14/85
Female	90/79 (0.061)	135/33 (0.912)	99/70 (0.001)	29/140 (0.516)
<b>Hospital ward</b>				
Medical	89/109	152/45	102/96	33/165
Surgical/emergency	42/28 (0.031)	62/8 (0.040)	34/36 (0.673)	10/60 (0.641)
<b>Chronotype</b>				
Morning/intermediate	107/117	183/40	111/113	34/190
Evening	24/20 (0.412)	31/13 (0.078)	25/19 (0.379)	9/35 (0.384)
<b>Naps</b>				
Yes/no need	29/67	65/31	39/57	17/79
Can't	101/70 ( $6.23 \times 10^{-6}$ )	148/22 ( $1.52 \times 10^{-4}$ )	97/74 (0.012)	26/145 (0.594)
<b>Medication interfering with sleep</b>				
No	78/120	146/51	86/112	26/172
Yes	53/17 ( $1.83 \times 10^{-7}$ )	68/2 ( $3.45 \times 10^{-5}$ )	50/20 ( $5.84 \times 10^{-5}$ )	17/53 (0.029)
<b>Coffee<sup>a</sup></b>				
$\leq 3$ /day	115/116	188/42	112/119	37/194
$\geq 4$ /day	16/20 (0.061)	26/10 (0.181)	23/13 (0.086)	6/30 (0.922)
<b>Alcohol<sup>a</sup></b>				
No	84/76	126/33	87/73	33/127
Yes	47/60 (0.170)	87/20 (0.680)	49/58 (0.170)	10/97 (0.014) <sup>a</sup>
<b>Night shift work</b>				
No	31/39	48/21	24/46	9/61
Yes	100/98 (0.371)	166/32 (0.010)	112/86 (0.001)	34/164 (0.398)
<b>On-call shifts</b>				
No	54/57	97/14	64/47	12/99
Yes	77/80 (0.949)	117/39 (0.012)	72/85 (0.057)	31/126 (0.050)
<b>Sleep quality</b>				
Good/fair		91/46	40/97	12/125
Poor/bad		123/7 ( $8.32 \times 10^{-9}$ )	96/35 ( $2.38 \times 10^{-9}$ )	31/100 ( $9.10 \times 10^{-4}$ )
<b>Unrestful sleep</b>				
No			13/40	9/44
Yes			122/92 ( $2.38 \times 10^{-5}$ )	34/180 (0.847)
<b>Daytime somnolence</b>				
No				11/121
Yes				32/104 (0.001)

Note: The  $p$ -value associated with the Pearson's  $\chi^2$  is reported among brackets. ESS, Epworth Sleepiness Scale.

<sup>a</sup>One response was missing.

Therefore, for the purposes of the analysis, we used the upper quartile as the cut point of a dichotomous ESS score. Fifty percent of the study subjects reported requiring more than 8 h of sleep to feel refreshed upon wake (long sleeper hypnotype). Fifty percent also

reported poor or bad sleep quality, with 62% of them declaring that their sleep is now worse than in the past and pointing to their job as the cause. Only 3% reported frequent unwanted sleep episodes during the daytime, and five subjects reported the occurrence of car

accidents or injuries in the workplace due to somnolence (not shown in the Table).

Subjects working on nightshifts more frequently reported unrestful sleep (84% versus 76%;  $p = .010$ ) and daytime somnolence (57% versus 34%;  $p = .001$ ), but their ESS score was unaffected (17% versus 13%;  $p = .398$ ). Table 2 shows the comparison of individual and lifestyle variables by work-shift schedule. Nightshift physicians did not differ from the colleagues working only daytime by age ( $p = .661$ ) and prevalence of female gender ( $p = .411$ ); BMI was a little higher among nightshift physicians compared to daytime physicians ( $p = .048$ ) and, although the distribution of BMI categories did not vary ( $p = .631$ ), they were more likely to be obese (obese versus normal weight:  $p = .047$ ). Nightshift physicians were more likely to have an intermediate chronotype ( $p = 5.71 \times 10^{-5}$ ) and to take medication interfering with sleep ( $p = .001$ ), to have four or more cups of coffee/day ( $p = .003$ ), although the pattern of coffee intake did not vary significantly ( $p = .098$ ), and to drink alcoholic beverages ( $p = .007$ ), compared to those working daytime shifts only. Working on-call shifts was also related to unrestful sleep, but not to the other sleep

outcomes. Female doctors more frequently reported daytime somnolence, although their ESS scores were similar to those of their male counterparts. Working in surgical wards or emergency departments was associated with a poorer sleep quality and unrestful sleep, but not with self-reported or ESS-measured daytime sleepiness. Taking medication interfering with sleep was strongly associated with all the adverse sleep outcomes, but coffee and alcohol intake did not affect any.

Napping was associated with poorer sleep quality, unrestful sleep and self-reported daytime somnolence, but not with an elevated ESS score.

Results of the logistic regression models predicting poor sleep quality, unrestful sleep, perceived daytime somnolence and an elevated ESS score are shown in Table 3. Female gender was a strong risk factor for perceived daytime somnolence (OR = 3.4, 95% CI 1.76–6.37), but it was not associated with an elevated ESS score. Obesity was a risk factor for an elevated ESS score (OR = 5.5, 95% CI 1.94–15.4), and it was accordingly associated with an increase in risk for the other adverse sleep outcomes. Those with a morning chronotype were more likely to enjoy a restful sleep (OR = 0.5, 95% CI 0.20–1.03), and those who drank four or more cups of coffee a day were more likely to suffer from daytime somnolence (OR = 2.2, 95% CI 0.95–5.01), possibly the reason why they drank coffee more frequently during the day. Taking medication capable of interfering with sleep was a strong predictor for all the four sleep outcomes, and particularly for unrestful sleep (OR = 5.7, 95% CI 1.26–26.1), poor sleep quality (OR = 3.3, 95% CI 1.59–6.78) and daytime somnolence (OR = 3.1, 95% CI 1.48–6.34). An elevated ESS score was a significant predictor of poor sleep quality (OR = 2.5, 95% CI 1.11–5.56) and self-reported daytime somnolence (OR = 2.8, 95% CI 1.23–6.43), but it did not affect the probability of unrestful sleep. Nightshift work was associated with unrestful sleep (OR = 2.4, 95% CI 1.18–5.05) and self-reported daytime somnolence (OR = 1.9, 95% CI 1.03–3.64), with a positive upward trend by years of nightshift work for both conditions ( $p = .043$  and  $p = .017$ , respectively), and by number of nightshifts/year for unrestful sleep ( $p = .024$ ).

**TABLE 2** Prevalence of individual and lifestyle variables in nightshift and daytime physicians

Variable	Nightshift	Daytime	<i>p</i> -value
Age: mean (SD)	46.9 (11.09)	46.2 (12.48)	.661
BMI: mean (SD)	24.3 (4.63)	23.1 (3.55)	.048
BMI categorical: <i>n</i> (%)			
Normal	130 (65)	50 (71)	.631
Overweight	47 (24)	18 (26)	
Obese	21 (11)	2 (3)	
Gender: <i>n</i> (%)			
Male	76 (38)	23 (33)	.411
Female	122 (62)	47 (67)	
Chronotype: <i>n</i> (%)			
Intermediate	129 (65)	23 (33)	$5.71 \times 10^{-5}$
Morning type	25 (13)	19 (27)	
Evening type	34 (17)	28 (40)	
Missing	10 (5)	-	
Medication interfering with sleep: <i>n</i> (%)			
No	136 (69)	62 (89)	.001
Yes	62 (31)	8 (11)	
Coffee: <i>n</i> (%)			
Never	12 (6)	4 (6)	.098
≤3/day	152 (77)	64 (91)	
≥4/day	34 (17)	2 (3)	
Alcohol: <i>n</i> (%)			
No	111 (56)	52 (74)	.007
Yes	87 (44)	18 (26)	

*Note:* The *p*-value for the continuous variables (age and body mass index [BMI]) is associated with the t-test for independent samples; that for the categorical variables is associated with the Pearson's  $\chi^2$  test. SD, standard deviation.

## 4 | DISCUSSION

To our knowledge, this is the first study on sleep disruption among Italian hospital physicians. In this study, we focused on sleep disruption and daytime sleepiness in general; we did not consider sleepiness occurring specifically at work.

Overall, only 2.2% of the study participants had an ESS score suggestive of excessive daytime sleepiness, although the majority reported unrestful sleep (80%), poor or bad sleep quality (49%), and perceived daytime somnolence (51%). Nightshift work, number of nightshifts/month and years of engaging in nightshift work were significant predictors of self-reported unrestful sleep and daytime somnolence, but did not affect sleep quality or result in an elevated ESS score. Indeed, only six study subjects had an ESS score ≥11, the value suggestive of excessive daytime sleepiness. Five of

**TABLE 3** Results from logistic regression modelling. Odds ratio and 95% confidence interval of dependent outcomes in relation to the independent covariates

Independent covariates	Dependent outcomes											
	Sleep quality poor–bad/ fair–good			Unrestful/restful sleep			Daytime somnolent/vigilante			ESS ≥7/≤ 6		
Age (continuous, $\beta$ [SE])	0.030 (0.014)			0.024 (0.016)			–0.021 (0.014)			–0.031 (0.020)		
	Ca/Ctrl	OR	95% CI	Ca/Ctrl	OR	95% CI	Ca/Ctrl	OR	95% CI	Ca/Ctrl	OR	95% CI
<b>Gender</b>												
Male	41/58	1.0		79/29	1.0		37/62	1.0		14/85	1.0	
Female	90/79	1.7	0.91–3.19	135/33	1.6	0.73–3.44	99/70	3.4	1.76–6.37	29/140	1.0	0.46–2.28
<b>Body mass index</b>												
Underweight, regular	86/94	1.0		137/42	1.0		88/92	1.0		28/152	1.0	
Overweight	26/39	0.7	0.32–1.39	55/10	1.3	0.51–3.21	30/35	1.7	0.81–3.46	3/62	0.3	0.07–0.99
Obese	19/4	2.4	0.67–8.58	22/1	2.9	0.33–25.5	18/5	3.0	0.88–10.2	12/11	5.5	1.94–15.4
Wald test for trend (p-value)	.662			.313			.046			.030		
<b>Chronotype</b>												
Evening/intermediate	20/117	1.0		183/40	1.0		111/113	1.0		34/190	1.0	
Morning	24/107	1.4	0.67–2.64	31/13	0.5	0.20–1.03	25/19	1.2	0.57–2.44	9/35	1.5	0.63–3.73
<b>Medication interfering with sleep</b>												
No	78/120	1.0		146/51	1.0		86/112	1.0		26/172	1.0	
Yes	53/17	3.3	1.59–6.78	68/2	5.7	1.26–26.1	50/20	3.1	1.48–6.34	17/53	2.1	0.86–5.21
<b>Coffee</b>												
≤3/day	115/116	1.0		188/42	1.0		112/119	1.0		37/194	1.0	
3 or more/day	6/7	1.0	0.45–2.23	26/10	0.6	0.24–1.47	23/13	2.2	0.95–5.01	6/30	1.1	0.39–3.05
<b>ESS</b>												
≤6	100/125	1.0		180/44	1.0		104/121	1.0				
≥7	31/12	2.5	1.11–5.56	34/9	0.8	0.31–2.02	32/11	2.8	1.23–6.43			
<i>And alternatively</i>												
<b>Night shift work</b>												
No	98/39	1.0		48/21	1.0		24/46	1.0		9/61	1.0	
Yes	100/31	1.0	0.52–1.80	166/32	2.4	1.18–5.05	112/86	1.9	1.03–3.64	34/164	0.9	0.38–2.24
<b>Or</b>												
<b>Years of night shift work</b>												
Never	31/39	1.0		48/21	1.0		24/46	1.0		9/61	1.0	
≤12	37/63	0.8	0.40–1.70	78/22	2.6	1.14–5.86	51/49	1.5	0.75–3.18	12/88	0.6	0.23–1.68
≥13	63/35	1.2	0.54–2.55	88/10	2.2	0.78–6.01	61/37	2.7	1.18–5.96	22/76	1.9	0.58–6.18
Wald test for trend (p-value)	.635			.043			.017			.211		
<b>Or</b>												
<b>Night shifts/year</b>												
Never	32/43	1.0		51/23	1.0		28/47	1.0		10/65	1.0	
≤36	43/58	0.7	0.32–1.33	85/16	2.2	0.94–4.95	54/47	1.4	0.70–2.80	15/86	0.8	0.30–2.12
≥37	56/36	1.6	0.80–3.20	78/14	2.8	1.17–6.56	54/38	1.7	0.87–3.50	18/74	1.0	0.39–2.59
Wald test for trend (p-value)	.103			.024			.118			.665		

*Note:* The predicted condition (poor–bad sleep quality, not feeling refreshed upon wake, daytime somnolence and an ESS score ≥7) is defined as being a case (ca in the table subheading), the opposite as being a control (ctrl in the table heading). EJSS, Epworth Sleepiness Scale; SE, standard error.

them worked nightshifts, and four did so more than 40 times/year. Although suggestive of an effect, these numbers would not allow a reliable inference to be drawn. Therefore, we used the fourth quartile of the ESS score distribution to categorize excessive daytime sleepiness, which might explain the disagreement between the results using the binary symptoms of sleep disruption and the ESS. The ESS is a validated, semi-quantitative indicator of subjective daytime sleepiness, but it does not account for the individual ability to compensate for an underlying sleep deprivation status (Bargiotas et al., 2019). This might result in patients underestimating sleepiness, while qualitatively acknowledging it, as suggested by the significant difference in the ESS score resulting from the patients' questionnaires and that resulting from the patients' partners (Kumru et al., 2004). This might be a contributing factor for the apparent discrepancy in our findings. Physicians working nightshifts had a slightly higher BMI, and they were more likely to take medication interfering with sleep, to drink four or more cups of coffee per day, and to drink alcoholic beverages. Among the contributing individual and lifestyle factors we explored, female gender, working in surgical wards and taking medication interfering with sleep were associated with perception of unsatisfactory sleep quality and daytime somnolence; on the other hand, obesity was a strong determinant of elevated ESS scores. Although it is known that female nightshift workers more frequently report job stress, emotional problems and taking sleeping pills (Gordon et al., 1986), few studies have explored the nightshift work impact on sleep by gender. Consistently with our findings, those studies suggested that sleep deprivation and insomnia do occur more frequently among women working nightshifts (Pepin et al., 2018), especially those working a counter-clock rotating shift schedule, which may cause a more severe circadian misalignment (Shiffer et al., 2018). Our results are also consistent with other reports showing an excess of EDS among residents in surgical wards (Chen et al., 2008), and obesity occurring more frequently in nightshift workers in relation to unhealthy eating habits (Sun et al., 2018). On the other hand, the association with medication that interferes with sleep might, at least be in part, be a reverse causality effect.

Our results differ substantially from those reported among American interns from five academic health centres, who reportedly work long hours and suffer from serious sleep deprivation, 84% of whom had an ESS score above the EDS threshold (Papp et al., 2004). Another study reported a 23% prevalence of EDS among Turkish academic physicians, 43% of whom were taking night calls and 24% worked nightshifts; the EDS prevalence among those taking night calls was 56%, significantly higher than among those who did not. No corresponding figures were given for the 60 subjects working nightshifts (Ozder & Eker, 2015). More than half the physicians who participated in a survey in the USA reported episodes of dozing off while writing patients' records or reviewing their examinations during nightshifts; 48% of staff rotating on a ward service and 81% of those taking night calls reported acute sleep deprivation (Rosen et al., 2004). In Europe, physicians' working hours are regulated by the European Working Time Directory (EWTD) law, which states

that the weekly workload must not exceed 48 h, and that an 11 h rest must be guaranteed within 24 h. These rules are not homogeneously applied all over Europe; for instance, their strict application in Italy started only in 2015. Nonetheless, in spite of a more reasonable shift work schedule, we still observed a higher prevalence of unrestful sleep and daytime somnolence, but not an impairment in sleep quality, among physicians working nightshifts.

Most of the studies investigating the effects of sleep deprivation in hospital physicians focused on acute sleep deprivation, with only a few investigating doctors' sleep habits and quality. A cohort study of Brazilian psychiatrists reported impaired sleep quality (Melo et al., 2016) and a study of emergency care physicians observed that those not working nightshifts slept significantly better (Castro & de Almondes, 2018).

Our study suffers from interpretative limitations due to the small study size and the low prevalence of subjects with an ESS score above the EDS threshold. Also, we relied on self-reported perceptions, and we did not have any objective measurement, such as biomarkers or polysomnography records, to validate those perceptions. We did not collect information on physical activity and somnolence during the work shift; the first might be relevant in improving sleep quality (Del Brutto et al., 2020) and the second would be a risk factor for medical errors, a possible outcome of sleep deprivation (Kaliyaperumal et al., 2017). Also in this study, we did not consider sleepiness occurring specifically at work, nor the related frequency of errors, injuries and car accidents. These limitations further impair interpretability of our findings.

Nonetheless, the PRESOMO questionnaire proved to be useful for investigating sleep habits, sleep quality and sleep disturbance and, based on our results, it is well accepted and may be profitably used as a screening tool in occupational health surveys of working populations at risk of sleep deprivation.

In conclusion, our results provide clues to the evaluation of the impact of nightshift work on sleep among hospital physicians and suggest which factors might contribute to reducing the ability to tolerate working nightshifts among this population. Further larger-size studies are warranted to better assess the risk of nightshift work disorder among hospital physicians, and the impact of nightshift work and sleep deprivation on their performance.

## CONFLICT OF INTEREST

The authors report no conflict of interest.

## AUTHOR CONTRIBUTIONS

All authors have contributed significantly to the manuscript. E. Bonanni, M. Maestri and M. Puligheddu contributed to the study design and coordination of the centres. R. Lecca, E. Battaglia, M. Maestri, M. Figorilli, P. Congiu and G. Gioi contributed to the data collection and analysis plan. F. Meloni and P. Cocco contributed to statistical analysis and data interpretation. R. Lecca contributed to manuscript drafting. P. Cocco, M. Maestri, E. Bonanni, E. Battaglia and M. Puligheddu provided expert advice and critical review of the manuscript. All authors read and approved the final version.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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