



## Original Article

## Influence of Shiftwork on Greek Nursing Personnel



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## ARTICLE INFO

## Article history:

Received 2 July 2013

Received in revised form

17 March 2014

Accepted 18 March 2014

Available online 2 April 2014

## Keywords:

Greece

nurses

rotating shift system

Standard Shiftwork Index

## ABSTRACT

**Background:** The aim of this study was to investigate the burden experienced by nursing personnel working irregular shifts in Greece and to conduct the first test of a Greek version of the Standard Shiftwork Index (SSI).

**Methods:** A cross-sectional survey was carried out. The SSI was completed by 365 nurses and nursing assistants working shifts, including nights.

**Results:** Female nursing personnel and those suffering from a chronic disease were most affected by working rotating shifts as they had elevated scores on the majority of the SSI scales, such as sleep, chronic fatigue, digestive and cardiovascular problems, general health questionnaire, cognitive and somatic anxiety, shift time satisfaction, engagement and disengagement strategies, languidity, flexibility, and neuroticism. Nurses with longer working experience and those with family responsibilities also scored higher on some of the SSI scales, such as the sleep, shift time satisfaction, social and domestic disruption, disengagement strategies, morningness, and languidity scales.

**Conclusion:** Shiftwork affects female nurses, those with chronic disease, older age, and domestic responsibilities more severely. Therefore management should take these factors into account when designing work schedules to alleviate the burden caused by shiftwork.

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## 1. Introduction

Shiftwork is an increasingly common characteristic of modern society. At present, nearly one-fifth of the total global workforce works in shifts, with around 19% of the European Union workforce engaged in night shiftwork [1]. This raw percentage disguises a more complex work pattern. In fact, in European countries, a minority of the employed workforce is engaged in regular day work: 22% of men and 11% of women. Established office hours are thus becoming more of a rarity than a norm [2]. Rotation and scheduling are the main characteristics of shiftwork. Healthcare personnel, and nurses in particular, are largely, and traditionally, locked into schedules that provide 24-hour care and include night shiftwork and are therefore a focus for special attention in published work on shiftwork.

In general, staff who work shifts tend to experience problems in four main areas caused by the desynchronization of the endogenous physiological system of circadian rhythms [3,4]. The first relates to increased fatigue and sleepiness caused by a decreased amount of sleep, which results in a cumulative sleep debt when trying to sleep during the day. The second relates to their health: staff who work shifts tend to suffer from poorer general health, both physiological and psychological, including an increase in gastrointestinal and cardiovascular problems. The third area of concern relates to their family and social life. Staff who work shifts tend to suffer from poorer family and social relationships because their working hours often overlap with times normally devoted to societal and family obligations. The fourth cluster of problems relates to the quality of the work itself and the satisfaction derived from it [1].

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## 2. Materials and methods

### 2.1. Aims

The aim of this study was to investigate the burden experienced by nursing staff working on an irregular shift system in Greece and the possible factors, such as demographic factors and work-related characteristics associated with this pattern of working. In particular, we aimed to test for the first time with a Greek population one of the most widely used instruments deployed in shiftwork research, i.e., the Standard Shiftwork Index (SSI).

### 2.2. Study design

A cross-sectional study was carried out to study the problems caused by shiftwork in nursing staff working irregular shifts and to perform an initial test of a Greek version of the SSI. The study was conducted in three public general hospitals in Athens, Greece. Most of the nursing staff at these facilities work irregular rotating shifts (morning, evening, and night shifts), but there is also a subset working exclusively morning shifts. For the cohort investigated here, morning shifts are scheduled from 7 AM to 3 PM, evening shifts from 3 PM to 11 PM, and night shifts from 11 PM to 7 AM. For the permanent morning shift group, morning shifts are scheduled from 7 AM to 3 PM.

### 2.3. Participants

The study population included all registered nurses (university and technical institute graduates) and nursing assistants working morning or night shifts for at least 3 months prior to the date of the survey and was further limited to those who had been working for at least 2 years. A total of 750 anonymous printed surveys were delivered to nurses and nursing assistants working an irregular shift system, including night shifts, and those permanently working morning shifts. A total of 365 completed questionnaires was returned, representing a response rate of 49%.

### 2.4. Instrument

The instrument used for data collection was the SSI questionnaire [5]. The SSI questionnaire is a well-established multi-scale instrument theoretically linked to published work on the known impacts of shiftwork, as well as those variables which are thought to modify an individual's response to shiftwork such as individual circumstances (age, marital status, children to look after), personality characteristics (morningness/eveningness, extraversion/neuroticism, rigidity, and vigor), coping strategies, and personal outcomes for the individual (including physical and psychological health, sleep disturbance, and social and domestic disruption). With the permission of the SSI authors, the instrument was initially translated into Greek and then a back translation was performed by two independent translators to ensure equivalency. The process of translation and cultural adaptation followed international recommendations [6]. The final translation was reviewed by the study authors. The questionnaire had acceptable to high internal consistency with Cronbach  $\alpha$  coefficients ranging from 0.70 (extraversion scale) to 0.90 (chronic fatigue scale). The scales included in SSI are as follows:

1. sleep questionnaire;
2. general job satisfaction;
3. chronic fatigue;
4. physical health questionnaire – this contains two subscales, measuring cardiovascular and gastrointestinal disorders;

5. general health questionnaire;
6. cognitive somatic anxiety questionnaire;
7. social and domestic survey – this contains two subscales, the first measures the degree to which individuals are satisfied with the amount of time their system leaves them for specific activities (shift time satisfaction) and the second scale consists of three questions relating to the amount of social, domestic, and non-domestic disruption (social domestic disruption) experienced as a result of working shifts (social and domestic life);
8. coping questionnaire containing two subscales – engagement and disengagement;
9. composite morningness questionnaire;
10. circadian type inventory, containing two subscales of languidity and flexibility;
11. Eysenck personality inventory, measuring two major dimensions of personality – extraversion and neuroticism.

A full description of the questionnaire has been presented elsewhere [5,7]. Demographic characteristics were also recorded, including personal and work characteristics.

### 2.5. Ethical considerations

The study protocol was approved by the scientific board and the ethics committee of each hospital. To protect the privacy of the respondents, the completed questionnaires were collected in sealed envelopes and contained no individual identifiers. Informed consent was obtained from all participants.

### 2.6. Statistical analysis

Quantitative variables are presented with mean, standard deviation, and/or minimum and maximum values, while the categorical variables are presented with absolute and relative frequencies. To identify the demographic and individual variables associated with the SSI dimensions, a series of multiple linear regression analyses was conducted. The independent variables explored were: sex, age, family status, professional training, the number of family members that needed to be looked after, chronic disease, type of shift worked, the presence of a second paid job, and work history. Regression coefficients ( $\beta$ ) with their standard errors were computed from the results of the regression analyses. All reported  $p$  values are two-tailed. Statistical significance was set at  $p < 0.05$  and analyses were conducted using SPSS statistical software (version 17.0).

## 3. Results

### 3.1. Demographics

Table 1 presents the sample characteristics. The total sample consisted of 49 men (13.5%) and 313 women (86.5%). The majority of nurses (75.9%) had a degree from a technical institute, although 26 nurses (7.6%) had a bachelor degree from a university. A minority (39.3%) of the sample was working exclusively morning shifts, with the balance (60.7%) working rotating shifts. Almost half of the sample (46.6%) reported that they suffered from a chronic disease.

### 3.2. Standard Shiftwork Index scales

Table 2 gives the mean values for the SSI scales and Table 3 gives the correlation coefficients between the SSI scales. There was significant inter-correlation between most of the scales. The engagement scale was significantly correlated only with the scales

**Table 1**  
Sample characteristics (n = 365)

Variables	n (%) or mean ± SD
Sex	
Men	49 (13.5)
Women	313 (86.5)
Missing values*	3
Age (y)	
<35	123 (35.5)
36–40	124 (35.8)
>40	99 (28.6)
Missing values*	19
Family status	
Single	88 (24.4)
Divorced/widowed	15 (4.2)
Married/living with a partner	258 (71.5)
Missing values*	4
Professional training	
University bachelor's degree	26 (7.6)
Technological institute degree	258 (75.9)
Nursing assistant	56 (16.5)
Missing values*	25
No. of family members looked after	
0	89 (25.7)
1–2	176 (50.9)
≥3	81 (23.4)
Missing values*	19
Chronic disease	
No	190 (53.4)
Yes	166 (46.6)
Missing values*	9
Shifts worked	
Morning	143 (39.3)
Rotating	221 (60.7)
Missing values*	0
Second paid job	
No	316 (91.6)
Yes	29 (8.4)
Missing values*	20
Work experience (y)	14.7 ± 7.4

SD, standard deviation.

\*Missing values were not replaced and added in the table.

of chronic fatigue, general health questionnaire, and the extraversion subscale of the Eysenck personality inventory.

Multiple linear regression analysis for the sleep, job satisfaction, chronic fatigue, digestive problems, and cardiovascular problems scales (Table 4) showed that women had greater sleep disturbance and experienced more digestive and cardiovascular problems than men. Also, participants with chronic disease had poorer sleep

**Table 2**  
Descriptive statistics for Standard Shiftwork Index results

Variables	Mean	SD	Minimum	Maximum
Sleep	73.2	10.5	34	106
Job satisfaction	19.0	7.0	5	35
Chronic fatigue	26.4	7.2	10	50
Digestive problems	15.9	4.6	8	30
Cardiovascular problems	18.7	4.9	10	36
General health questionnaire	25.4	5.6	14	45
Cognitive anxiety	15.1	6.1	7	35
Somatic anxiety	13.6	4.5	7	35
Shift time satisfaction	42.3	14.4	19	95
Social domestic disruption	9.2	2.9	3	15
Engagement	57.2	9.7	16	80
Disengagement	40.7	10.4	16	69
Morningness	35.3	6.5	15	63
Languidity	33.7	6.1	13	49
Flexibility	21.5	5.0	9	37
Neuroticism	13.8	2.7	7	22
Extraversion	14.4	2.2	8	20

**Table 3**  
Correlation coefficients between Standard Shiftwork Index scales

Variables	SQ	JS	CF	GID	CVD	GHQ	CAQ	SAQ	STS	SDD	ENG	DISENG	MORN	LANG	FLEX	NEUR
JS	-0.27 <sup>‡</sup>															
CF	0.32 <sup>‡</sup>	-0.30 <sup>‡</sup>														
GID	0.39 <sup>‡</sup>	-0.33 <sup>‡</sup>	0.35 <sup>‡</sup>													
CVD	0.39 <sup>‡</sup>	-0.21 <sup>‡</sup>	0.44 <sup>‡</sup>	0.57 <sup>‡</sup>												
GHQ	0.29 <sup>‡</sup>	-0.22 <sup>‡</sup>	0.40 <sup>‡</sup>	0.32 <sup>‡</sup>	0.34 <sup>‡</sup>											
CAQ	0.26 <sup>‡</sup>	-0.26 <sup>‡</sup>	0.36 <sup>‡</sup>	0.37 <sup>‡</sup>	0.34 <sup>‡</sup>	0.55 <sup>‡</sup>										
SAQ	0.26 <sup>‡</sup>	-0.21 <sup>‡</sup>	0.39 <sup>‡</sup>	0.50 <sup>‡</sup>	0.52 <sup>‡</sup>	0.50 <sup>‡</sup>	0.68 <sup>‡</sup>									
STS	-0.25 <sup>‡</sup>	0.27 <sup>‡</sup>	-0.24 <sup>‡</sup>	-0.24 <sup>‡</sup>	-0.16 <sup>‡</sup>	-0.24 <sup>‡</sup>	-0.14 <sup>‡</sup>	-0.16 <sup>‡</sup>								
SDD	0.23 <sup>‡</sup>	-0.28 <sup>‡</sup>	0.27 <sup>‡</sup>	0.27 <sup>‡</sup>	0.21 <sup>‡</sup>	0.32 <sup>‡</sup>	0.18 <sup>‡</sup>	0.24 <sup>‡</sup>	-0.53 <sup>‡</sup>							
ENG	0.01	0.09	-0.21 <sup>‡</sup>	-0.01	-0.06	-0.16 <sup>‡</sup>	-0.08	-0.08	0.08	-0.05						
DISENG	0.32 <sup>‡</sup>	-0.17 <sup>‡</sup>	0.21 <sup>‡</sup>	0.23 <sup>‡</sup>	0.29 <sup>‡</sup>	0.36 <sup>‡</sup>	0.45 <sup>‡</sup>	0.33 <sup>‡</sup>	-0.19 <sup>‡</sup>	0.14 <sup>‡</sup>	0.01					
MORN	-0.03	0.16 <sup>‡</sup>	-0.28 <sup>‡</sup>	-0.11 <sup>‡</sup>	-0.07	-0.21 <sup>‡</sup>	-0.16 <sup>‡</sup>	-0.12 <sup>‡</sup>	0.17 <sup>‡</sup>	-0.12 <sup>‡</sup>	0.01	-0.08				
LANG	0.06	-0.21 <sup>‡</sup>	0.32 <sup>‡</sup>	0.16 <sup>‡</sup>	0.15 <sup>‡</sup>	0.20 <sup>‡</sup>	0.25 <sup>‡</sup>	0.17 <sup>‡</sup>	-0.17 <sup>‡</sup>	0.20 <sup>‡</sup>	0.07	0.07	-0.54 <sup>‡</sup>			
FLEX	-0.09	0.07	-0.17 <sup>‡</sup>	-0.04	-0.05	-0.11 <sup>‡</sup>	-0.13 <sup>‡</sup>	-0.06	0.08	-0.11 <sup>‡</sup>	-0.04	-0.14 <sup>‡</sup>	-0.12 <sup>‡</sup>	-0.15 <sup>‡</sup>		
NEUR	0.29 <sup>‡</sup>	-0.21 <sup>‡</sup>	0.34 <sup>‡</sup>	0.38 <sup>‡</sup>	0.39 <sup>‡</sup>	0.42 <sup>‡</sup>	0.55 <sup>‡</sup>	0.44 <sup>‡</sup>	-0.09	0.17 <sup>‡</sup>	0.02	0.44 <sup>‡</sup>	-0.18 <sup>‡</sup>	0.24 <sup>‡</sup>	-0.13 <sup>‡</sup>	
EXTR	-0.07	0.04	-0.28 <sup>‡</sup>	0.04	-0.05	-0.11 <sup>‡</sup>	-0.13 <sup>‡</sup>	-0.08	0.04	-0.07	0.26 <sup>‡</sup>	-0.16 <sup>‡</sup>	0.00	-0.06	0.13 <sup>‡</sup>	-0.13 <sup>‡</sup>

CAQ, cognitive anxiety questionnaire; CF, chronic fatigue; CVD, cardiovascular disease; DISENG, disengagement; ENG, engagement; EXTR, extraversion; GHQ, general health questionnaire; GID, gastrointestinal disorders; JS, job satisfaction; LANG, languidity; MORN, composite morningness questionnaire; NEUR, neuroticism; SAQ, somatic anxiety questionnaire; SDD, social domestic disruption; STS, shift time satisfaction.  
\*p < 0.05; †p < 0.01; ‡p < 0.001.

**Table 4**  
Multiple linear regression models: regression coefficients  $\pm$  standard error for sleep, job satisfaction, chronic fatigue, digestive problems, and cardiovascular problems scales

Variables	Sleep	Job satisfaction	Chronic fatigue	Digestive problems	Cardiovascular problems
	$\beta \pm$ SE	$\beta \pm$ SE	$\beta \pm$ SE	$\beta \pm$ SE	$\beta \pm$ SE
Sex					
Men, reference					
Women	5.95 $\pm$ 1.75 <sup>‡</sup>	-2.27 $\pm$ 1.22	2.21 $\pm$ 1.25	2.32, $\pm$ 0.75 <sup>‡</sup>	4.1 $\pm$ 0.76 <sup>‡</sup>
Age (y)					
$\leq$ 35, reference					
36–40	1.64 $\pm$ 1.89	0.49 $\pm$ 1.32	0.44 $\pm$ 1.35	0.25 $\pm$ 0.81	-0.60 $\pm$ 0.82
>40	1.23 $\pm$ 2.82	0.09 $\pm$ 1.97	0.78 $\pm$ 2.02	-0.13 $\pm$ 1.21	0.68 $\pm$ 1.22
Family status					
Single, reference					
Divorced/widowed	0.88 $\pm$ 3.87	0.90 $\pm$ 2.70	6.25 $\pm$ 2.77*	0.4 $\pm$ 1.66	0.42 $\pm$ 1.67
Married/living with a partner	4.28 $\pm$ 1.85*	1.28 $\pm$ 1.29	0.48 $\pm$ 1.32	-0.54 $\pm$ 0.79	0.04 $\pm$ 0.8
Professional training					
University bachelor's degree, reference					
Technological institute degree	0.42 $\pm$ 2.24	-3.12 $\pm$ 1.56*	-0.26 $\pm$ 1.60	-1.15 $\pm$ 0.96	-2.20 $\pm$ 0.97
Nursing assistant	1.65 $\pm$ 1.68	1.35 $\pm$ 1.17	-1.31 $\pm$ 1.20	-0.17 $\pm$ 0.72	-0.79 $\pm$ 0.73
No. of family members looked after					
0, reference					
1–2	0.44 $\pm$ 1.76	-0.64 $\pm$ 1.23	1.28 $\pm$ 1.26	1.71 $\pm$ 0.75 <sup>‡</sup>	1.12 $\pm$ 0.76
$\geq$ 3	3.18 $\pm$ 2.20	1.00 $\pm$ 1.53	1.47 $\pm$ 1.57	1.78 $\pm$ 0.94	0.62 $\pm$ 0.95
Chronic disease					
No, reference					
Yes	4.16 $\pm$ 1.22 <sup>‡</sup>	-1.62 $\pm$ 0.85	4.24 $\pm$ 0.87 <sup>‡</sup>	3.48 $\pm$ 0.52 <sup>‡</sup>	4.36 $\pm$ 0.53 <sup>‡</sup>
Shifts worked					
Morning, reference					
Rotating	2.28 $\pm$ 1.36	-0.71 $\pm$ 0.95	1.90 $\pm$ 0.97*	-0.24 $\pm$ 0.58	0.35 $\pm$ 0.59
Second paid job					
No, reference					
Yes	0.49 $\pm$ 2.35	-0.45 $\pm$ 1.64	-2.06 $\pm$ 1.68	1.34 $\pm$ 1.01	-0.12 $\pm$ 1.02
Work experience (y), mean $\pm$ SD	0.07 $\pm$ 0.16	0.09 $\pm$ 0.11	-0.08 $\pm$ 0.11	-0.05 $\pm$ 0.07	0.00 $\pm$ 0.07

\* $p < 0.05$ ; <sup>‡</sup> $p < 0.01$ ; <sup>‡</sup> $p < 0.001$ .

quality and greater fatigue, digestive, and cardiovascular problems. Nurses working rotating shifts were more likely to experience greater feelings of chronic fatigue, whereas those with responsibility for one or two family members had greater digestive problems than those who had no family member to look after. Chronic fatigue was greater in divorced or widowed participants than in single participants. Furthermore, married nurses or those living with a partner had greater levels of sleep disturbance than single participants. Lower levels of job satisfaction were found for institute-trained nurses than for more highly educated nurses.

Table 5 gives the results from the multiple linear regression analysis for the general health questionnaire, cognitive and somatic anxiety, shift time satisfaction, and social and domestic disruption scales. Female nurses had greater scores on the general health questionnaire and on the cognitive anxiety subscale and reported less satisfaction over their working hours than their male colleagues. Workers older than 40 years scored higher on the scale of social and domestic disruption. Divorced or widowed participants had significantly greater scores on the cognitive anxiety subscale, whereas those married or living with a partner reported less satisfaction with non-work time. Nursing assistants had greater scores on the cognitive anxiety subscale than their colleagues with a bachelor level education. Scores on the somatic anxiety subscale were greater for nurses with more than three family members to look after. This subset of nurses also reported less satisfaction with their non-work life than the balance of the population. Scores on the general health questionnaire and the cognitive and somatic anxiety questionnaire were also higher in participants reporting a chronic disease.

Multiple linear regression analysis for engagement/disengagement, morningness, languidity, flexibility, and the neuroticism and extraversion personality subscales (Table 6) showed that women reported higher scores on the coping questionnaire (engagement and disengagement scales), languidity, flexibility, and neuroticism

scales. Scores on disengagement and neuroticism were higher for institute-trained nurses and those with a chronic disease. Moreover, nurses also working in a second paid job showed higher scores on the flexibility scale and nurses with more years of work experience were found to have higher scores on disengagement, morningness, and the languidity scale.

#### 4. Discussion

Considering the length of the instrument in this study and the reported declining response rates in long instruments, the response rate of 49 appears to be average [5,8], if not better than average. Unsurprisingly, the demographic characteristics of the nurses who participated in the study mirror the general profile of those working in the Greek National Health System, i.e., mainly married women with a degree from a technological institute [9].

##### 4.1. Interrelationships between SSI scales

The finding that the majority of SSI scales were significantly correlated with each other is in agreement with other studies [5] and is unsurprising considering that the scales were deliberately assembled to measure the dimensions of the impact of shiftwork. The finding of a lack of a relationship between the engagement scale and other scales is not unique to this study [10] and could be explained by a lack of clarity about the meaning of engaging/coping strategies to deal with the problems of shiftwork.

##### 4.2. Regression analysis of scales for sleep, job satisfaction, chronic fatigue, digestive problems, and cardiovascular problems

Nurses working shifts, including night shifts, are subject to a cumulative sleep debt, a decreased quantity and quality of sleep, and continuous sleep deprivation [11]. In this study, regression

**Table 5**Multiple linear regression models: regression coefficients  $\pm$  standard error for general health questionnaire, cognitive anxiety, somatic anxiety, shift time satisfaction and social domestic disruption scales

Variables	GHQ	Cognitive anxiety	Somatic anxiety	Shift time satisfaction	Social domestic disruption
	$\beta \pm SE$	$\beta \pm SE$	$\beta \pm SE$	$\beta \pm SE$	$\beta \pm SE$
Sex					
Men, reference					
Women	2.62 $\pm$ 1.01 <sup>†</sup>	2.40 $\pm$ 1.06*	1.07 $\pm$ 0.79	-6.70 $\pm$ 2.31 <sup>†</sup>	0.79 $\pm$ 0.49
Age (y)					
$\leq 35$ , reference					
36–40	0.01 $\pm$ 1.09	0.95 $\pm$ 1.15	0.28 $\pm$ 0.85	-3.82 $\pm$ 2.50	-0.25 $\pm$ 0.54
>40	2.14 $\pm$ 1.63	0.36 $\pm$ 1.72	-0.10 $\pm$ 1.27	-5.31 $\pm$ 3.73	1.45 $\pm$ 0.80 <sup>†</sup>
Family status					
Single, reference					
Divorced/widowed	3.50 $\pm$ 2.24	6.12 $\pm$ 2.36 <sup>†</sup>	3.10 $\pm$ 1.75	-3.71 $\pm$ 5.12	-0.36 $\pm$ 1.10
Married/living with a partner	0.41 $\pm$ 1.06	1.82 $\pm$ 1.12	0.34 $\pm$ 0.83	-5.84 $\pm$ 2.44*	0.62 $\pm$ 0.52
Professional training					
University bachelor's degree, reference					
Technological institute degree	-1.00 $\pm$ 1.29	0.08 $\pm$ 1.36	0.00 $\pm$ 1.01	-3.81 $\pm$ 2.96	0.68 $\pm$ 0.63
Nursing assistant	-0.70 $\pm$ 0.97	2.82 $\pm$ 1.02 <sup>†</sup>	0.99 $\pm$ 0.76	-3.99 $\pm$ 2.22	-0.49 $\pm$ 0.47
Family members looked after					
0, reference					
1–2	0.30 $\pm$ 1.02	-0.84 $\pm$ 1.07	1.02 $\pm$ 0.80	-6.50 $\pm$ 2.33 <sup>†</sup>	0.95 $\pm$ 0.50
$\geq 3$	1.73 $\pm$ 1.27	0.88 $\pm$ 1.34	2.28 $\pm$ 0.99*	-7.93 $\pm$ 2.91 <sup>†</sup>	0.97 $\pm$ 0.62
Chronic disease					
No, reference					
Yes	1.98 $\pm$ 0.70 <sup>†</sup>	1.70 $\pm$ 0.74*	2.00 $\pm$ 0.55 <sup>‡</sup>	-2.23 $\pm$ 1.61	0.59 $\pm$ 0.34
Shift					
Morning, reference					
Rotating	0.10 $\pm$ 0.79	0.90 $\pm$ 0.83	0.34 $\pm$ 0.61	-5.92 $\pm$ 1.8 <sup>‡</sup>	0.41 $\pm$ 0.39
Second paid job					
No, reference					
Yes	-0.24 $\pm$ 1.36	-1.21 $\pm$ 1.43	-0.18 $\pm$ 1.06	-4.48 $\pm$ 3.11	0.03 $\pm$ 0.67
Work experience (y), mean $\pm$ SD	-0.16 $\pm$ 0.09	-0.11 $\pm$ 0.10	-0.12 $\pm$ 0.07	0.79 $\pm$ 0.21 <sup>‡</sup>	-0.14 $\pm$ 0.04 <sup>†</sup>

Analysis was performed on full data set of 289 participants.

GHQ, General health questionnaire.

\* $p < 0.05$ ; <sup>†</sup> $p < 0.01$ ; <sup>‡</sup> $p < 0.001$ .**Table 6**Multiple linear regression models: regression coefficients  $\pm$  standard error for engagement, disengagement, morningness, flexibility, neuroticism, and extraversion scales

Variables	Engagement	Disengagement	Morningness	Languidity	Flexibility	Neuroticism	Extraversion
	$\beta \pm SE$	$\beta \pm SE$	$\beta \pm SE$	$\beta \pm SE$	$\beta \pm SE$	$\beta \pm SE$	$\beta \pm SE$
Sex							
Men, reference							
Women	5.00 $\pm$ 1.68 <sup>†</sup>	5.16 $\pm$ 1.77 <sup>†</sup>	-0.19 $\pm$ 1.11	3.90 $\pm$ 1.01 <sup>†</sup>	-2.01 $\pm$ 0.89*	1.50 $\pm$ 0.47 <sup>†</sup>	-0.02 $\pm$ 0.38
Age (y)							
$\leq 35$ , reference							
36–40	0.58 $\pm$ 1.82	-0.30 $\pm$ 1.92	-1.73 $\pm$ 1.21	1.42 $\pm$ 1.10	-1.57 $\pm$ 0.97	-0.04 $\pm$ 0.50	-0.14 $\pm$ 0.42
>40	-3.94 $\pm$ 2.71	-1.24 $\pm$ 2.86	-2.87 $\pm$ 1.8	2.18 $\pm$ 1.64	-1.95 $\pm$ 1.44	-0.300 $\pm$ 0.75	0.59 $\pm$ 0.62
Family status							
Single, reference							
Divorced/widowed	-5.23 $\pm$ 3.72	1.79 $\pm$ 3.92	2.63 $\pm$ 2.47	0.70 $\pm$ 2.25	-2.10 $\pm$ 1.98	1.54 $\pm$ 1.03	-0.78 $\pm$ 0.85
Married/living with a partner	-2.18 $\pm$ 1.77	-2.53 $\pm$ 1.87	1.76 $\pm$ 1.18	0.33 $\pm$ 1.07	-1.12 $\pm$ 0.94	-0.05 $\pm$ 0.49	-0.36 $\pm$ 0.40
Professional training							
University bachelor's degree, reference							
Technological institute degree	0.52 $\pm$ 2.15	-5.86 $\pm$ 2.26*	2.37 $\pm$ 1.43	-0.93 $\pm$ 1.30	0.25 $\pm$ 1.14	-1.47 $\pm$ 0.6*	-0.62 $\pm$ 0.49
Nursing assistant	0.36 $\pm$ 1.61	0.06 $\pm$ 1.70	-0.74 $\pm$ 1.07	-0.83 $\pm$ 0.97	0.86 $\pm$ 0.86	0.20 $\pm$ 0.45	0.12 $\pm$ 0.37
Family members looked after							
0, reference							
1–2	1.55 $\pm$ 1.70	1.58 $\pm$ 1.78	-1.00 $\pm$ 1.12	-0.37 $\pm$ 1.02	-0.21 $\pm$ 0.90	-0.39 $\pm$ 0.47	0.58 $\pm$ 0.40
$\geq 3$	2.80 $\pm$ 2.11	4.73 $\pm$ 2.22*	-1.18 $\pm$ 1.40	-0.73 $\pm$ 1.28	1.05 $\pm$ 1.12	0.18 $\pm$ 0.59	0.75 $\pm$ 0.48
Chronic disease							
No, reference							
Yes	0.11 $\pm$ 1.17	2.52 $\pm$ 1.23*	-0.44 $\pm$ 0.78	0.33 $\pm$ 0.71	0.69 $\pm$ 0.62	0.93 $\pm$ 0.32 <sup>†</sup>	-0.13 $\pm$ 0.27
Shift							
Morning, reference							
Rotating	0.83 $\pm$ 1.31	3.16 $\pm$ 2.28	-0.78 $\pm$ 0.87	1.69 $\pm$ 0.79*	-0.37 $\pm$ 0.70	0.10 $\pm$ 0.36	-0.11 $\pm$ 0.30
Second paid job							
No, reference							
Yes	-0.63 $\pm$ 2.26	-1.48 $\pm$ 2.38	-2.97 $\pm$ 1.50 <sup>†</sup>	1.64 $\pm$ 1.36	2.83 $\pm$ 1.20*	-0.12 $\pm$ 0.63	0.07 $\pm$ 0.52
Working experience (y), mean (SD)	0.20 $\pm$ 0.15	0.38 $\pm$ 0.17*	0.37 $\pm$ 0.10 <sup>†</sup>	-0.27 $\pm$ 0.09 <sup>†</sup>	0.01 $\pm$ 0.08	0.03 $\pm$ 0.04	-0.06 $\pm$ 0.03

The analysis was performed on a full data set of 289 participants.

\* $p < 0.05$ ; <sup>†</sup> $p < 0.01$ ; <sup>‡</sup> $p < 0.001$ .

analysis showed that female nurses working shifts reported greater sleep disruption than their male colleagues when taking into account other variables. Other studies have shown that women, despite experiencing a longer mean sleep duration than men, have a greater need for sleep as they suffer more sleep problems than men [12]; this is a particular problem in a female-dominated profession such as nursing. Moreover, sleep problems are greater amongst married nurses or those living with a partner. Being part of a family implies greater responsibilities and poses a significant strain on personal resources, which may affect the quality and quantity of sleep. In our study, married nurses and those with a chronic disease reported greater sleep problems.

Job satisfaction is a very important component of professional experience and is a predictor of low staff turnover [13]. According to our study, nurses with a less advanced qualification reported lower job satisfaction than their colleagues with a university level qualification. Limited opportunities for clinical decision-making and contribution to policy-making, a lack of clinical autonomy and established nursing procedure protocols, as well as ineffective nursing management and the irregular rotating shift system followed have been emphasized as major sources of dissatisfaction for Greek nurses [9]. In Greek hospitals, nurses with a university level bachelor degree and more work experience are given greater opportunities to contribute to policy-making and nursing management, factors linked to job control, which may explain their higher job satisfaction levels.

The more often workers are engaged in shiftwork, the more severe their chronic fatigue [14], a finding supported in our study. In particular, staff who work shifts are vulnerable to work-related fatigue, which occurs as a result of insufficient restorative sleep due to the cumulative effects of chronic and acute sleep deprivation and a mismatch between the sleep–wake schedule of a particular job role and the output of the endogenous circadian pacemaker [15,16]. It may also be linked to a mismatch with the demands of their personal life. In this study, divorced nurses had higher scores on the chronic fatigue scale than their married colleagues or those living with a partner. This finding agrees with that of Winwood et al [17]. The demands associated with having a family are a substantial factor in the management of work strain by nurses in relation to absorbing their work-related fatigue and delivering family responsibilities.

Several studies have shown that sleep impairment occurs among professionals working rotating shifts and shiftwork has been implicated as a risk factor in a number of chronic diseases [12]. Our cross-sectional findings support the epidemiological evidence presented in other studies on the relationship between shiftwork and the risk of chronic disease, including cardiovascular problems (including cardiovascular disease) [4,18–20], digestive and gastrointestinal problems [19–23], metabolic syndrome and diabetes [12], and poor psychological health [18,24–26]. The continuous sleep disturbance or cumulative sleep deficit resulting in chronic fatigue, as well as associated lifestyle factors, are two of the factors responsible. Shiftwork has been hypothesized as contributing to the development of cardiovascular disease and other metabolic disorders through a number of pathways, including the disruption of circadian rhythms, lifestyle changes, job strain and stress, as well as social stress [12].

More recently, there has been a wider interest in the roles of the disruption of circadian rhythms, long-term sleep disruption and deprivation, immune depression, and the desynchronization of clock genes caused by shiftwork in the development of cancer [12], but this was outside the scope of our study. The issue warrants further study, particularly with populations of nurses.

#### 4.3. Regression analysis of scales for general health questionnaire, cognitive anxiety, somatic anxiety, shift time satisfaction, and social domestic disruption

According to Armstrong and Khawaja [27], there is an observable gender difference in the self-reporting of cognitive and somatic symptoms of anxiety and our findings confirm their earlier work. Multiple roles (e.g., employee, mother, caregiver) pose a particular challenge for female shift workers, inevitably creating conflict and strain and resulting in negative psychological (and perhaps physical) health consequences. Female staff working shifts who alter their family or social life to adapt to shiftwork commitments tend to report greater cognitive and somatic anxiety [10].

A large body of evidence suggests that working shifts is linked to a range of behavioral and lifestyle factors. In particular, a lack of appropriate food on the shift or excessive consumption of coffee and tobacco during shifts has been shown to be related to chronic diseases and nervous disorders [10,12,28]. The disturbances of working shifts equate to a chronic stressor and can trigger acute effects on mood, anxiety, and neuroticism, as our findings demonstrate, which may account for some of these behavioral changes.

#### 4.4. Regression analysis of scales for engagement, disengagement, morningness, flexibility, neuroticism, and extraversion

The finding that female nurses working shifts had greater scores on the engagement and disengagement scales could be explained by a greater sensitivity to external environmental cues (including stress) and there is evidence that there are sex differences in noting and reacting to internal physiological stimuli [29]. Also, Greek cultural norms may dictate that women are more expressive and energetic towards environmental circumstances, as the traditional female role in Greece has been constructed around greater domestic and family responsibility, regardless of work status.

This study suggests that nurses with longer working experience have the maturity and experience to develop practical nursing and life skills, including time management, to overcome some of the problems related to working shifts. Alternatively, nurses who spend an extended period in nursing self-select to some degree, with ‘survivors’ continuing, whereas those unable to cope with the impact of shiftwork leave the industry. The adaption of experienced nurses has its limits, however. In this study, age worked in the opposite direction, with nurses over 40 years old experiencing greater difficulty in managing domestic disruption. It is pertinent to note that older people have a tendency to morning activities and thus score higher on the morningness scale; morningness, in turn, is associated with a poorer adaption to shiftwork [30].

#### 4.5. Study limitations

The self-reporting nature of the study limits the interpretation of our findings, with memory and response biases affecting data [5]. The design of the current study does not allow findings to be triangulated systematically with objective data, such as morbidity and absenteeism, and the cross-sectional design does not allow a clear interpretation of causation, both of which represent avenues for further study. A less significant limitation is the response rate, which is probably a function of the length of this particular bank of scales, which collectively take between 45 and 60 minutes to complete [5]. Finally, there are some parameters that may have not been taken into consideration in the present study, notably individual preference in the shiftwork schedule. Preference and control, or at least a sense of control, have emerged as key variables in

several prospective studies and both are associated with good health [2].

This study has documented the working conditions of Greek nursing personnel in relation to a rotating shift system. The main conclusion of this study is the recognition of the need for further clarification of the consequences of the rotating shift system in the clinical environment and the adoption of a shift system with fewer implications for physical and psychological health, as well as family and social life. Considering the demanding nature of the nursing profession, with the associated psychological load and disrupted and reduced sleep, the findings suggest that shiftwork may have a particularly acute impact on the nursing profession, particularly when considering the consequences in terms of patient outcomes. Although shiftwork is certain to remain a permanent feature of the profession, there is an increasing trend towards developing interventions designed to minimize the impact of shiftwork without eliminating it altogether. For example, Smith et al [31] continue to actively work on the therapeutic use of bursts of blue light to trigger temporary movement in circadian rhythms. It is important that nurses are informed of and educated about the implications of shiftwork to allow them to organize work hours and use appropriate coping strategies to avoid poor sleep and high levels of fatigue, which are probably a key factor in health consequences [32], or to explore the use of the new suite of interventions. Finally, this study illuminates a number of mechanisms that underlie the associations found between working shifts and gender, chronic disease, age, and burden of domestic responsibilities; these would benefit from further investigation.

### Conflicts of interest

All contributing authors declare no conflicts of interest.

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