# Impact of COVID-19 outbreak on nurses' mental health: A prospective cohort study

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## ARTICLE INFO

## ABSTRACT

*Objectives:* To evaluate variations in nurses' sleep quality and symptoms of depression, anxiety and stress during the COVID-19 outbreak, and to evaluate whether the presence of potential risk factors influenced these symptoms over time.

*Methods:* This prospective cohort study surveyed nurses three times – surveying personal factors, working conditions, family dynamics, and attitude towards COVID-19 – between March 31 and May 4, 2020. Nurses' mental health was assessed through Depression Anxiety Stress Scales – short version (DASS-21); their sleep quality was assessed through a 5-point Likert scale question.

*Results:* Nurses' sleep quality and symptoms of depression, anxiety and stress presented a positive variation over the COVID-19 outbreak. The only factors which are directly related to the COVID-19 outbreak and that were associated with the positive variation in nurses' symptoms of depression, anxiety and stress were the fear to infect others and the fear to be infected (higher fear of being infected or to infect someone corresponded to increased symptoms of depression, anxiety and stress).

*Conclusions:* Although the COVID-19 outbreak seems to have had an immediate impact on nurses' mental health, a psychological adaptation phenomenon was also observed. Future research should focus on assessing nurses' symptoms of depression, anxiety and stress, after the COVID-19 pandemic, in order to compare and contrast the findings with the results of our study.

## 1. Introduction

Since the end of December 2019, the world is facing the outbreak of COVID-19, novel pneumonia caused by the coronavirus disease. The disease was first reported in China, in Wuhan City, in Hubei province (Wang et al., 2020a) and it is caused by a virus which has been named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). In late 2002, the world also witnessed the outbreak of a coronavirus disease (SARS) in Canton, Mainland China. However, due to the global spread of COVID-19, this outbreak was declared a pandemic, in March 2020, by the World Health Organization (Huang et al., 2020). At that time more than 100,000 people worldwide had already been diagnosed with COVID-19 (World Health Organization, 2020). The accelerated diffusion of COVID-19 can be explained by general factors, transversal to all regions (e.g., biological characteristics of the virus, incubation period, etc.). Also, specific factors can be identified, which vary according to each region and/or city (e.g., the complex interaction between air pollution, meteorological conditions, and biological characteristics of viral infectivity). Indeed, air pollution in cities seems to be a more important predictor in the initial phase of diffusion of viral infectivity than interpersonal contacts (Coccia, 2020a). Thus, the main factors determining the diffusion of infectious diseases, such as the COVID-19, are considered to be (a) air pollution, (b) atmospheric stability/instability measured with wind speed, (c) demographic factors given by the density of population – inhabitants per km (Huang et al., 2020), and (d) respiratory disorders of people, given by mortality rate for trachea, bronchi and lung cancer (Coccia, 2020b).

Despite the respiratory-related pattern of COVID-19, its high

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prevalence in the overall population of many countries, its novelty and highly infectious nature have also contributed to the development of psychological problems. According to a longitudinal study which surveyed the Chinese general population twice – during the initial outbreak, and the epidemic's peak four weeks later – post-traumatic stress disorder (PTSD) symptoms were found to significantly decrease after four weeks. However, the mean Impact of Event Scale-Revised score of the first- and second-survey participants were above the cut-off scores, suggesting that in both moments the Chinese general population tended to present PTSD symptoms (Wang et al., 2020b). According to the same study (Wang et al., 2020b), during the initial evaluation (using the Depression, Anxiety and Stress Scale – 21 items), moderate-to-severe symptoms of stress, anxiety and depression were found, respectively, in 8.1%, 28.8% and 16.5% of the Chinese general population, and there were no significant longitudinal changes.

A secondary analysis of a national, longitudinal cohort study was also carried out in the United Kingdom (UK) to assess the changes in adult mental health in the UK population before and during the lockdown (using the 12-item General Health Questionnaire – GHQ-12). According to the findings, the population prevalence of clinically significant levels of mental distress increased from 18.9% in 2018–19 to 27.3% in April 2020 (one month into the UK lockdown). (Pierce et al., 2020).

However, the COVID-19 outbreak and the psychological related problems not only affected the general population. Also, the frontline health care workers, such as nurses, faced significant challenges to their mental health. For instance, in Italy, doctors and nurses have worked more than 100 h per week. Many doctors and nurses were contaminated, but the real prevalence of COVID-19 in these professionals is difficult to determine because the disease does not often manifest in people younger than 35 years of age (Sterpetti, 2020). Evidence shows that in similar outbreaks, nurses have already presented the highest levels of occupational stress and resulting distress when compared to other groups (Maunder et al., 2006; Nickell et al., 2004).

Several studies have assessed the mental health outcomes among health care workers treating patients exposed to COVID-19. For instance, a systematic review and meta-analysis, that aimed to synthesise and analyse the evidence on the prevalence of anxiety, depression and insomnia among health care workers during the COVID-19 outbreak, was conducted in April 2020. The findings pinpointed to an anxiety-pooled prevalence of 23.2%, a depression prevalence rate of 22.8%, and an insomnia prevalence estimated at 38.9%. Moreover, female health care workers and nurses were the ones who exhibited higher rates of affective symptoms (Pappa et al., 2020). Another review carried out in April 2020 suggested that health care workers presented a considerable degree of stress, anxiety, depression and insomnia due to the COVID-19 outbreak. Furthermore, according to the same review, there is increasing evidence suggesting that COVID-19 can even be an independent risk factor for stress in health care workers (Spoorthy et al., 2020). In Wuhan, the epicentre of the pandemic, a study evaluated the mental health of 994 medical and nursing staff in January/February 2020, using the 9-item Patient Health Questionnaire, and the results showed that 36.9% presented subthreshold mental health disturbances, 34.4% mild disturbances, 22.4% moderate disturbances, and 6.2% severe disturbance (Kang et al., 2020).

When comparing medical health workers (i.e., medical doctors and nurses) ($n = 927$) and non-medical health workers ($n = 1255$), the first group presented a higher prevalence of insomnia (38.4 vs. 30.5%), anxiety (13.0 vs. 8.5%), depression (12.2 vs. 9.5%), somatisation (1.6 vs. 0.4%), and obsessive-compulsive symptoms (5.3 vs. 2.2%) (Zhang et al., 2020a). According to another study carried out in China, with 1257 respondents (60.8% were nurses), nurses, women, and frontline health care workers reported more severe mental health symptoms (Lai et al., 2020).

A study conducted at a hospital in Wuhan, China, from February 9 to March 15, 2020, aimed to identify, through interviews ($n = 23$), the

psychological change process of nurses during the COVID-19 outbreak. The findings showed that nurses' psychological changes occurred in three stages: (1) the early stage – their psychological experience was mainly being ambivalent, as they were torn between a sense of professional mission and fear of being infected; (2) the middle stage – their main psychological characteristics identified in this stage were anxiety, depression, somatisation, compulsiveness, fear, and irritation; and (3) the later stage – during this stage nurses' psychological adaptation began to occur, as they felt that what they were doing was meaningful and valuable to the health of the people and the nation (Zhang et al., 2020b).

According to the abovementioned studies, nurses seem to be the health care workers who faced more psychological problems as a consequence of the COVID-19 outbreak. Although there is an evident initial impact on their mental health, at some point they appear to adapt to the "new normal" (Zhang et al., 2020b). However, contrary to the general population, no longitudinal studies were found in the literature which evaluated nurses' mental health in more than one moment. Nonetheless, despite some studies have identified variables which seem to be related to worst mental health status among health care workers, such as being younger, being a female, having limited access to personal protective equipment (PPE), working at a public institution, and being unsure of COVID-19 infection (Zhang et al., 2020c), also no longitudinal studies were found in the literature that evaluated the influence of those factors on nurses' mental health status over time. Thus, since cross-sectional studies collect data only once and over a short period, it is relevant to carry out a longitudinal study which allows analysing the change of nurses' mental health status over the COVID-19 outbreak, as well as the change of the impact of each factor associated with mental health outcomes over time.

To address the above-mentioned gap, the primary aim of this study was to evaluate variations in nurses' sleep quality and nurses' mental health status over the COVID-19 outbreak by quantifying the extent of symptoms of depression, anxiety and stress over time. The secondary aim of this study was to evaluate whether the presence of potential risk factors influenced these symptoms over time.

## 2. Materials and methods

### 2.1. Sample (participants) and data

The reporting of this prospective cohort study, which follows STROBE guidelines, was carried out from March 31 to April 6 (first survey), April 14 to April 20 (second survey), and April 28 to May 4, 2020 (third survey). All the surveys were conducted during one week. There was always a one-week interval between surveys to try ensuring maximum participation. We used a snowball sampling strategy focused on recruiting frontline nurses (working in healthcare settings) in Portugal during the COVID-19 outbreak.

### 2.2. Variables' measures

Firstly, it is important to define the concepts of depression, anxiety, and stress that were considered throughout this study. Thus, we followed Beck's (Beck, 1967) definition of depression, i.e., a syndrome that is explained by the cognitive triad of negative automatic thinking, negative self-schemas, and errors in logic (i.e., faulty information processing), with particular emphasis on symptoms such as anhedonia, hopelessness, and devaluation of life. The Barlow's (Barlow, 2002) definition of anxiety as a future-oriented mood state associated with preparation for possible, upcoming negative events, with particular emphasis on autonomic arousal symptoms was also used. Finally, the Selye's (Selye, 1936) classical definition of stress as the non-specific response of the body to any demand for change, with particular emphasis on symptoms such as tension and irritability was considered.

Depression, anxiety, and stress were measured using the Depression

Anxiety Stress Scales – short version (DASS-21) (Lovibond and Lovibond, 1995). The DASS is a self-report instrument consisting of a set of three seven-item subscales designed to measure depression, anxiety, and stress. The Depression scale assesses dysphoria, hopelessness, devaluation of life, self-deprecation, lack of interest/involvement, anhedonia, and inertia. The Anxiety scale assesses autonomic arousal, skeletal muscle effects, situational anxiety, and subjective experience of anxious affect. The Stress scale is sensitive to levels of chronic non-specific arousal. It assesses difficulty in relaxing, nervous arousal, and being easily upset/agitated, irritable/over-reactive, and impatient (Lovibond and Lovibond, 1995). The participants rate the extent to which they have experienced each symptom over the past week, on a 4-point severity/frequency scale. Overall scores for the three constructs are calculated as the sum of scores for the relevant seven items. Range of scores for each subscale is 0–21, the higher indicating more depression, anxiety, and/or stress symptoms. The Portuguese version of the DASS-21 had a Cronbach's alpha of 0.85 for the Depression scale, 0.74 for the Anxiety scale, and 0.81 for the Stress scale (Pais-Ribeiro et al., 2004).

Sleep quality was measured through the question "How would you rate your sleep quality in the last 7 days?". The question could be answered on a 5-point Likert scale with answer choices ranging from "very good" to "very poor".

### 2.3. Data analysis procedures

In Portugal, the state of emergency was announced on March 19, 2020 (Decree no, 2020) and ended on May 2, 2020. The national government then declared a state of calamity (Resolution of the Council of Ministers no, 2020). To contextualise the period of the data collection, on March 31, 2020, Portugal had 7443 infected patients and 160 deaths due to COVID-19 (Directorate-General of Health, 2020a). On May 4, 2020, the number of infected patients had reached 25,524 and the death toll was of 1063 people (Directorate-General of Health, 2020b).

Less than two weeks after the state of emergency was declared in Portugal, we started collecting data by sending e-mails to frontline nurses who were in the researchers' contact list and posting information about the study in social networks. Participating nurses were also encouraged to invite new respondents from their contacts. A questionnaire was completed through an online platform (Google Forms).

The questionnaire (Appendix I) assessed demographic variables, such as age, gender, marital status or academic degree, intending to characterise the sample and to test its representativeness of the population (nurses who work in healthcare settings in Portugal). Moreover, it assessed risk factors potentially associated with mental health symptoms among nurses, which can be divided into four major sections: (1) personal factors, such as age, gender or having a nursing speciality; (2) working conditions, like the existence of adequate PPE; (3) family dynamics, such as being displaced from home; and (4) attitude towards COVID-19, such as the fear of being infected or the fear to infect others.

The characteristics of the sample at baseline were summarized by mean and standard deviation (sd) for quantitative variables and by frequency and percentages for qualitative variables.

Linear mixed-effects models were used to identify potential factors associated with changes on each outcome (depression, anxiety and stress) over time. In the first step, univariable (unadjusted) models were considered to explore the unadjusted association between covariates (fixed effects) and outcomes. In a second step, multivariable (adjusted) models comprising all covariates (fixed effects) identified as significant in the first step were entered. For each outcome, this model was compared with the full model (model adjusted for all covariates considered in the first step – results not presented) using goodness-of-fit measures (likelihood ratio test [LRT], Akaike Information Criterion [AIC] and Bayesian Information Criterion [BIC]), to make sure that the parsimonious models fit as well as the full model. The structure of random effects comprised random intercept (individual level) and random slope (time level).

All analyses were performed in R software, and a significance level of 0.05 was considered.

This study was carried out in accordance with the code of ethics of the World Medical Association (Declaration of Helsinki). Ethics approval was obtained from the Ethical Committee of the School of Health of the Setúbal Polytechnic Institute (56/AFP/2020) and the Ethical Committee of University Fernando Pessoa (FCS/PI – 63/20). All respondents provided informed consent.

## 3. Results

### 3.1. Sample characteristics

At baseline, the sample comprised 829 nurses, 675 (81.4%) were female and 154 (18.6%) were male. The mean age was 39.0 years (sd = 9.4 years, range 22–65 years) and more than 50% were married (n = 521, 62.8%). Around 70% were graduated, 28.3% had a master degree and only 1.2% had a PhD. A total of 442 (53.3%) were nurse specialists. At moment 2 and 3, the number of participants was 364 and 296, respectively.

### 3.2. Depression, anxiety and stress

Fig. 1 presents the profile of DASS-21 depression, anxiety and stress over time. We can observe a tendency of decrease in the three scores over time. These results were confirmed based on the models that include time as unique fixed factor (Depression: −0.24 (se = 0.08), p = 0.004; Anxiety: −0.61 (se = 0.07), p < 0.001; Stress: −0.51 (se = 0.10), p < 0.001)).

In order to identify potential predictive factors of change for each outcome, univariable models were separately performed (results not presented). Based on these results, multivariable models, one for each outcome, were tested and results are presented in Table 1.

Based on the univariable model, the potential predictive factors of change in depression score were gender, age, nursing speciality, number and quality of face masks, quality of gowns, quality of glasses/visors, fear to be infected and fear to infect others. In the multivariable model, gender, nursing speciality, fear to be infected and fear to infect others remained significant predictors of changes in the depression score. The mean score of depression remained almost stable over time, after adjustment of potential confounders.

Male participants presented a lower mean score for depression when compared with women. Nurse specialists also presented a lower mean score for depression. The higher the fear (to be infected or to infect others), the more symptoms of depression.

Based on the goodness-of-fit indicators (Table 2), the final model and the full model were not significantly different in their fits for data and, based on the principle of parsimony, it was decided to choose the model presented in Table 1.

Based on the univariable model, the potential predictive factors of change in anxiety score were gender, age, nursing speciality, number and quality of face masks, number and quality of glasses/visors, quality of gowns, being displaced from residence, fear to be infected and fear to infect. In the multivariable model, time, gender, nursing speciality, quality of face masks, fear to be infected and fear to infect remained significant predictors of changes in anxiety score.

Anxiety symptoms decreased over time. As observed with the depression score, male and nurse specialists presented a lower mean score for anxiety. Nurses that agreed the quality of face masks was adequate presented a lower mean score for anxiety than nurses who disagreed. Finally, the higher the fear (to be infected or to infect), the more symptoms of anxiety.

Similar to the previous outcome, the final model (displayed in Table 1) was as good as the full model in fitting data (Table 2), and considering the principle of parsimony, the final model was chosen.
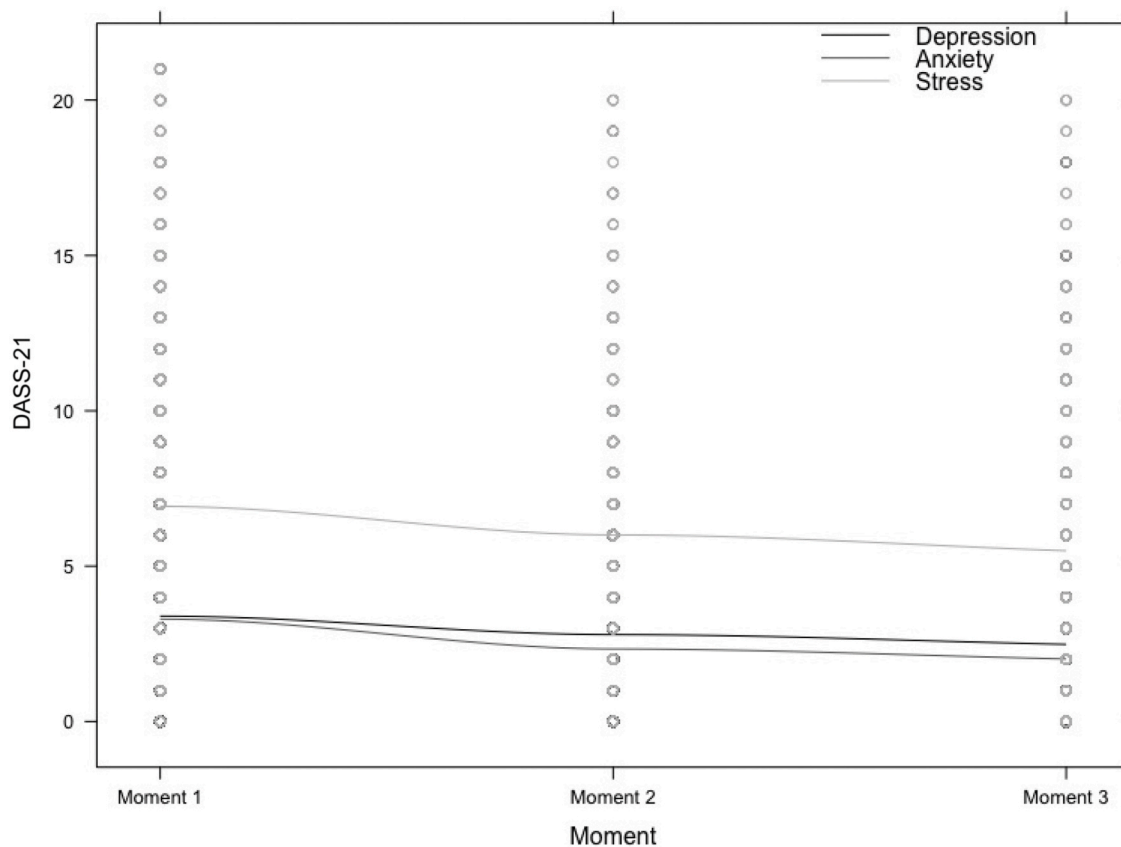
**Fig. 1.** DASS-21 depression, anxiety and stress scores over time.

- Stress

Based on the univariable model, the potential predictive factors of change in stress score were gender, age, nursing speciality, number of gloves, quality of face masks, quality of gowns, quality of glasses/visors, fear to be infected and fear to infect others. In the multivariable model, gender, age, nursing specialist, number of gloves, quality of glasses/visors, fear to be infected and fear to infect others remained significant predictors of change for stress score. The mean score for stress remained almost stable over time, after adjustment of potential confounders.

Men presented a lower mean score for stress when compared to women. The older nurses and nurse specialists also presented a lower mean score for stress. Nurses that agreed or partially agreed that the number of gloves was adequate presented a higher mean score for stress than nurses who disagreed. Nurses that partially agreed that the quality of glasses/visors was adequate, presented a lower mean score for stress than nurses who disagreed. The higher the fear (to be infected or to infect others), the more symptoms of stress.

A similar conclusion related to the comparison of the final model and the full model was obtained for this outcome (Table 2).

### 3.3. Sleep quality

Fig. 2 presents the distribution of the sleep quality assessment per moment. As observed, we can identify an association between moments and sleep quality, with a higher number of nurses with poor sleep quality at Moment 1, reducing significantly over time (p < 0.001).

### 4. Discussion

According to the Portuguese Order of Nurses (Order of Nurses, 2020), the statutory professional association which regulates the

nursing profession in Portugal, at the end of 2019, 82.2% of the nurses working in Portugal were women, which is in line with the sample of our study (81.4% of female nurses). Also, according to the Portuguese Order of Nurses (Order of Nurses, 2020), the most prevalent age ranges were 31–35 (n = 13,607) and 36–40 (n = 13,164). In our study, the nurses included in the sample were slightly older (mean = 39.9, sd = 9.4) when compared to the national data. Concerning the academic degree, our sample seems to be more literate when compared to the national data on nurses. For instance, 28.3% of the nurses included in our sample held a Master degree, while in Portugal only 4.9% of nurses held that degree; 1.2% of the nurses included in our sample held a PhD degree, while in Portugal only 0.1% of nurses held that degree. Finally, only 26.3% of nurses in Portugal are nurse specialists, while our sample comprises 53.3% of nurse specialists. The data available in the 2019 statistical yearbook of the Portuguese Order of Nurses are not comprehensive enough to allow the comparison with other demographic data of our study. Therefore, as expected, and considering these results are mostly due to the sampling technique, our sample cannot be considered representative of the population.

At the level of the variations in nurses' sleep quality and nurses' mental health status over the COVID-19 outbreak, there is a positive tendency in all the variables (depression, anxiety, stress, and sleep quality). Despite the COVID-19 outbreak has had an immediate impact on nurses' mental health (Hu et al., 2020), including in the country surveyed by this study (Portugal) (Sampaio et al., 2020), there seems to have been a psychological adaptation phenomenon, which had already been suggested in previous studies (Zhang et al., 2020b). The same phenomenon occurred, for instance, during the SARS outbreak in Taiwan, in which a longitudinal periodic study demonstrated a time effect on nurses' depression, anxiety, PTSD and sleep disturbance, with a gradual symptom (35–65%) reduction from baseline reflecting a psychological adaptation (Su et al., 2007). However, when using a

**Table 1**

Adjusted linear mixed-effects models to identify predictive factors of changes in outcome scores.

| | Depression | | Anxiety | | Stress | |
|---|---|---|---|---|---|---|
| *Fixed Effects* | Est. (se) | p | Est. (se) | p | Est. (se) | p |
| Time | 0.08 (0.10) | 0.398 | −0.33 (0.09) | **<0.001** | −0.11 (0.11) | 0.322 |
| Gender [male] | −0.68 (0.01) | **0.029** | −1.27 (0.31) | **<0.001** | −1.60 (0.35) | **<0.001** |
| Age | −0.02 (0.01) | 0.196 | −0.02 (0.01) | 0.251 | −0.06 (0.02) | **<0.001** |
| Specialist [yes] | −0.85 (0.26) | **0.001** | −0.74 (0.26) | **0.005** | −0.61 (0.29) | **0.040** |
| Quantity – Face masks [+/−] | −0.28 (0.31) | 0.360 | −0.07 (0.31) | 0.830 | | |
| Quantity – Face masks [Agree] | −0.27 (0.34) | 0.429 | −0.05 (0.34) | 0.879 | | |
| Quantity – Gloves [+/−] | | | | | 1.33 (0.54) | **0.014** |
| Quantity – Gloves [Agree] | | | | | 1.10 (0.54) | **0.042** |
| Quantity – Glasses/Visors [+/−] | | | −0.16 (0.30) | 0.586 | | |
| Quantity – Glasses/Visors [Agree] | | | −0.02 (0.35) | 0.946 | | |
| Quality – Face masks [+/−] | 0.03 (0.29) | 0.920 | −0.34 (0.27) | 0.210 | −0.22 (0.32) | 0.495 |
| Quality – Face masks [Agree] | −0.35 (0.33) | 0.281 | −0.77 (0.31) | **0.013** | −0.51 (0.36) | 0.152 |
| Quality – Gowns [+/−] | 0.34 (0.31) | 0.266 | 0.07 (0.30) | 0.810 | 0.33 (0.36) | 0.364 |
| Quality – Gowns [Agree] | −0.27 (0.34) | 0.426 | −0.07 (0.33) | 0.825 | −0.09 (0.40) | 0.814 |
| Quality – Glasses/Visors [+/−] | −0.26 (0.28) | 0.365 | 0.07 (0.33) | 0.826 | −0.76 (0.33) | **0.022** |
| Quality – Glasses/Visors [Agree] | −0.15 (0.30) | 0.623 | 0.01 (0.38) | 0.968 | −0.66 (0.35) | 0.061 |
| Displaced from home [yes] | | | 0.48 (0.31) | 0.123 | | |
| Fear to be infected | 0.20 (0.04) | **<0.001** | 0.19 (0.04) | **<0.001** | 0.27 (0.05) | **<0.001** |
| Fear to infect others | 0.17 (0.05) | **0.001** | 0.16 (0.05) | **0.001** | 0.24 (0.06) | **<0.001** |
| *Random effects* | | | | | | |
| σ(intercept) | 3.798 | | 3.935 | | 3.743 | |
| σ(time) | 1.173 | | 0.921 | | 1.045 | |
| σ(residual) | 1.702 | | 1.664 | | 2.161 | |
| ρ | −0.591 | | −0.665 | | −0.395 | |

Est.: estimate.

Note: In the quality and quantity of the PPE, the category "disagree" was considered as the reference category.

- Depression

multivariable model, time was considered a potential predictive factor of change in anxiety symptoms, but not in stress or depression; nevertheless, time should not be interpreted by itself, as the changes occurring over time are explained by several factors and not by time *per se*. For instance, the anxiety disorders change from childhood through adulthood into old age, not because of the time by itself, but as a result of the neurodevelopmental changes over the lifespan (Lenze and Wetherell, 2011).

Importantly, despite the abovementioned psychological adaptation phenomenon and although anxiety and depression, for instance, can have an adaptive role, they are not always adaptive symptoms. Thus, in the individual that is functioning normally, these symptoms can lead to a balance and create the necessary space to process (conscious and non-conscious), increasing positive outcomes. However, in the person who is experiencing clinical significant distress and/or impairment, this space may appear symptomatic, replete with maladaptive levels of anxiety and depression (Cannon, 1932; Anselme, 2010). This means that, while most nurses were able to develop an adaptive role when facing greater depression, anxiety, and stress symptoms at the beginning of the COVID-19 outbreak, others may have experienced the triggering of psychiatric disorders.

Concerning the predictive factors for change in depression, anxiety and stress symptoms, some factors, like age, gender, or being a nurse

**Table 2**

Goodness-of-fit indicators.

| | Depression | | Anxiety | | Stress | |
|---|---|---|---|---|---|---|
| | Final model | Full model | Final model | Full model | Final model | Full model |
| AIC | 7656.3 | 7686.5 | 7582.2 | 7606.2 | 8070.4 | 8091.6 |
| BIC | 7756.9 | 7876.7 | 7698.6 | 7796.4 | 8171.0 | 8281.8 |
| LogLik | −3809.2 | −3807.2 | −3769.1 | −3767.1 | −4016.2 | −4009.8 |
| LRT | χ(17) = 3.8; p = 0.999 | | χ(14) = 4.0; p = 0.996 | | χ(17) = 12.8; p = 0.750 | |

AIC: Akaike Information Criterion; BIC: Bayesian Information Criterion; LogLik: Log Likelihood; LRT: Likelihood ratio test.

- Anxiety

specialist did not change over the data collection period, so the data analysis only points out to the existence/absence of association between these factors and depression, anxiety and stress symptoms. Thus, these are factors which cannot be directly related to the COVID-19 outbreak. For instance, women are about twice as likely as men to develop depression during their lifetime and there are several genetic, hormonal, physiological, psychological and environmental factors explaining this phenomenon (Kuehner, 2016). Similarly, and in line with our findings, younger nurses tend to have more stress than older nurses (Purcell et al., 2011). This can be explained by the fact that younger nurses may feel still poorly prepared for their occupational role (Duchscher, 2009; Laschinger et al., 2009) and by the fact their ideals or values are often in conflict with the tremendous demanding everyday reality at work (Maben et al., 2006; Mackintosh, 2006).

Nurses who agreed or partially agreed that the number of gloves was adequate presented more stress symptoms over time than nurses who considered the number of gloves was inadequate. Nevertheless, this finding, which does not seem to be theoretically or empirically explainable, can act as a confounder, as using gloves has always been part of the daily nursing practice, and is not exclusive of the COVID-19 outbreak scenario, so further research is needed to enable a clear interpretation.

Nurses who agreed that the quality of face masks was adequate presented fewer anxiety symptoms than those who disagreed. Thus, and despite a rapid systematic review on the efficacy of medical masks in protecting healthcare workers against coronaviruses suggested they were not effective (MacIntyre and Chughtai, 2020), they can provide a sense of security (Chan, 2020). Considering that the sense of security is one of the most important determinants of mental health and is considered a basic human need (Maslow et al., 1945), this can potentially explain the fewer anxiety symptoms felt by nurses who agreed that the quality of face masks was adequate.

The only variables which can be directly related to the COVID-19 outbreak and that were predictive factors of change, over time, in depression, anxiety and stress symptoms were the fear to infect others and the fear to be infected. These fears had already been reported in several studies, both related to the COVID-19 outbreak (Hu et al., 2020)
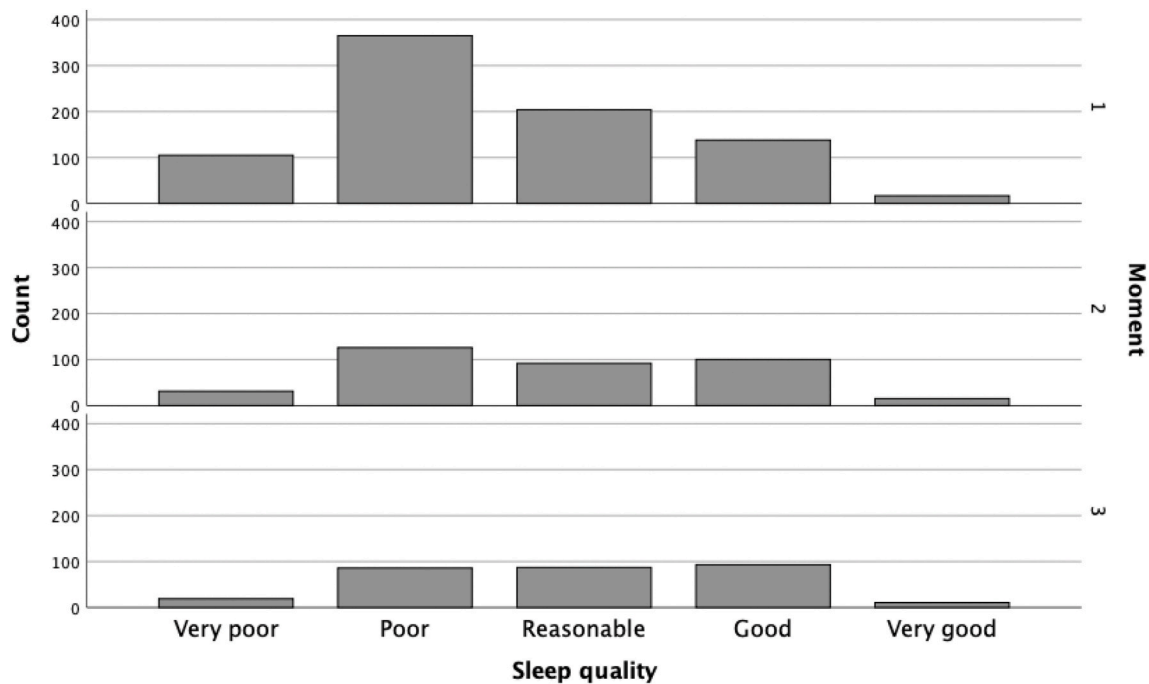
**Fig. 2.** Sleep quality per moment over time.

and previous outbreaks (Lee et al., 2020), but they have never been found, consistently over time, in longitudinal studies. Nonetheless, a study previously carried out had already suggested that the main source of anxiety in nurses during the COVID-19 outbreak was the fear of becoming infected or unknowingly infecting others (Mo et al., 2020), a fear that could be reduced, for instance, by ensuring the availability of adequate PPE (Tzeng and Yin, 2006). The fear which is felt by frontline nurses should not be overlooked, especially if we consider they might express less fear than real condition due to social desirability (Hu et al., 2020). Finally, particular attention should be paid to this phenomenon, considering that previous studies pointed out that an increased level of fear of COVID-19 was associated with decreased job satisfaction, increased psychological stress and increased organisational and professional turnover intentions among frontline nurses (Labrague and Santos, 2020).

## 5. Conclusions

Nurses' sleep quality and mental health status (symptoms of depression, anxiety and stress) varied positively over the COVID-19 outbreak. The only factors which are directly related to the COVID-19 outbreak and that were associated with the positive variation in nurses' symptoms of depression, anxiety and stress were the fear to infect others and the fear to be infected.

The main limitation of this study relies on the sampling method (snowball sampling). This technique can be considered a limitation since it attracts respondents who are already interested in the topic and well engaged, potentially leading to sampling bias and, consequently, limit the potential generalisability of the findings.

Another limitation of the study is the absence of data collected, using the same measurement tool and in the same population (Portuguese nurses), before the COVID-19 outbreak, posing difficulties in identifying the impact on nurses' mental health which can be directly attributed to the pandemic.

Future research should focus on assessing Portuguese nurses, using the same measurement tool, in order to compare and contrast their depression, anxiety and stress symptoms during and after the COVID-19 pandemic.

Some potential health policy implications stem from this study, which seem to be particularly relevant for improving healthcare services to cope with successive waves of the COVID-19 pandemic. Firstly, it is crucial that governments systematically identify groups, such as nurses, who are at risk of presenting significant symptoms of depression, anxiety, and/or stress providing them with early intervention. Raising awareness and educating non-psychiatric medical teams towards mental health assessment can be crucial to allow timely diagnosis. Finally, it is also important to raise awareness of nurses' peers, managers, and chiefs towards the need to address their mental health with early and adequate support measures, such as normalizing emotions, communicating clearly, fulfilling basic needs, making working hours more flexible by enabling sufficient work breaks and providing psychological support.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.envres.2020.110620.

## Ethics approval

This study was approved by the Ethical Committee of the School of Health of the Setúbal Polytechnic Institute and by the Ethical Committee of University Fernando Pessoa, and all participants provided informed consent.

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