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Insomnia and nightmare profiles during the COVID-19 pandemic in Portugal: characterization and associated factors

M. Goncalves [a, b], A. Henriques [a, b, *], A.R. Costa [a, b], D. Correia [a, b], M. Severo [a, b], R. Lucas [a, b, c], H. Barros [a, b, c], on behalf of the Task Force COVID-19 ISPUP – INESC TEC[1]

[a] EPIUnit – Instituto de Saúde Pública, Universidade do Porto, Rua das Taipas, nº 135, 4050-600 Porto, Portugal
[b] Laboratório para a Investigação Integrativa e Translacional em Saúde Populacional (ITR), Porto, Portugal
[c] Departamento de Ciências da Saúde Pública e Forenses e Educação Médica, Faculdade de Medicina, Universidade do Porto, Alameda Prof. Hernâni Monteiro, 4200-319 Porto, Portugal

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ABSTRACT

Objective/background: To describe and characterize insomnia symptoms and nightmare profiles in Portugal during the first six weeks of a national lockdown due to COVID-19.
Patients/methods: An open cohort study was conducted to collect information of the general population during the first wave of SARS-CoV-2/COVID-19 pandemic in Portugal. We analyzed data from 5011 participants (≥16 years) who answered a weekly questionnaire about their well-being. Two questions about the frequency of insomnia and nightmares about COVID-19 were consecutively applied during six weeks (March–May 2020). Latent class analysis was conducted and different insomnia and nightmare profiles were identified. Associations between individual characteristics and both profiles were estimated using odds ratios (ORs) and 95% confidence intervals (CI).
Results: Five insomnia (No insomnia, Stable-mild, Decreasing-moderate, Stable-severe, Increasing-severe) and three nightmares profiles (Stable-mild, Stable-moderate, Stable-severe) were identified. Being female, younger, perceiving their income as insufficient and feelings of fear towards COVID-19 were associated with higher odds of insomnia (Women: OR = 6.98 95%CI: 4.18–11.64; ≥60 years: OR = 0.30 95%CI: 0.18–0.53; Insufficient income: adjusted OR (aOR) = 8.413 95%CI: 3.93–16.84; Often presenting fear of being infected with SARS-CoV-2 infection: aOR = 9.13 95%CI: 6.36–13.11), and nightmares (Women: OR = 2.60 95%CI: 1.74–3.86; ≥60 years: OR = 0.45 95%CI: 0.28–0.74; Insufficient income: aOR = 2.60 95%CI: 1.20–5.20; Often/almost always presenting fear of being infected with SARS-CoV-2 infection: aOR = 6.62 95%CI: 5.01–8.74). Having a diagnosis of SARS-CoV-2 virus infection was associated with worse patterns of nightmares about the pandemic.
Conclusions: Social and psychological individual factors are important characteristics to consider in the development of therapeutic strategies to support people with sleep problems during the COVID-19 pandemic.

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1. Introduction

By the end of 2019 and the beginning of 2020, the world experienced a highly pathogenic viral infection caused by SARS-CoV-2 generating the COVID-19 pandemic [1]. The fear of infection, the changes in social relationships characterized by social distance, the financial loss and the uncertainty about the future spread worldwide [2]. To reduce the transmission of the infection and the pressure on the Portuguese National Health System, Portugal decreed the state of emergency and later of calamity to frame national lockdown that included a "stay-at-home" order from March 19th to May 3rd, 2020 [3].

* Corresponding author. Instituto de Saúde Pública – Universidade do Porto (ISPUP), Rua das Taipas nº 135, 4050-600 Porto, Portugal. Fax: +351 222 061 821.
E-mail address: ana.henriques@ispup.up.pt (A. Henriques).
[1] Task Force COVID-19 ISPUP – INESC TEC Scientific Committee: Ana Cristina Santos, Ana Isabel Ribeiro, Artur Rocha, Carla Lopes, Daniela Correia, Elisabete Ramos, Gonçalo Gonçalves, Henrique Barros, Joana Araújo, Makram Talih, Margarida Tavares, Milton Severo, Nuno Lunet, Paula Meireles, Raquel Duarte, Raquel Lucas, Rui Camacho, Sílvia Fraga, Sofia Correia, Susana Silva, Teresa Leão.

In past lockdowns experiences, during SARS-CoV in 2003 and Ebola in 2014, high levels of anxiety, acute stress disorders, psychological distress, depressive and insomnia symptoms were observed [2]. During the COVID-19 pandemic, besides insomnia symptoms, that was reported in 20—45% general population worldwide [4], oneiric activity has been strongly influenced by the lockdown, characterized by a marked increase of dream frequency, as well as a change in dream qualitative features [5]. This fact is in line with the "continuity hypothesis": dreams reflect waking experience and in particular the emotional characteristics of daily mental activity [6]. Additionally, nightmares related to traumatic events can also emerge in these periods and outlast for a long period of time [7,8]. Poor sleep is also a predisposing factor for mental health problems, namely depression, anxiety, alcohol abuse, and psychosis [9], but is often underrecognized as a public health issue [10].

Studies conducted in Southern European countries suggest that insomnia and poor sleep quality have been widespread complaints among adults during the COVID-19 pandemic [11]. In Greece, a web-based study performed during April 2020, three weeks after the lockdown, showed that 37.6% of the adult participants reported insomnia [12], suggesting an exacerbation of sleep disturbances during this period. In Italy, another online survey with 2291 participants revealed that 57.1% of participants reported poor sleep quality, 32.1% high anxiety, 41.8% high distress, and 7.6% reported post-traumatic stress disorder symptomatology linked to the COVID-19 pandemic [13]. Moreover, during this period in China, in addition to the occurrence of new insomnia complaints, a 37% increase in the rates of clinical insomnia was observed, compared to before the peak of the COVID-19 pandemic [14], suggesting that the pandemic may have aggravated preexisting sleep problems.

Furthermore, particularly during the COVID-19 pandemic, it should be noted that age and gender are two important features associated with oneiric activity and insomnia, with women presenting higher dream recall rate, higher negative emotions [15] and, together with young adults, presented higher probability of severe insomnia [14,16], but more characteristics, namely regarding the SARS-CoV-2 infection need to be studied.

Since sleep is a dynamic process that changes throughout time [11], it is expected that fluctuations in its quality might occur during the pandemic. At the same time, there have been reports of sleep changes from many countries around the world, but there appears to be no single universal response that applies to all people: some have experienced improvements, others have had more complaints, and many individuals have exhibited little or no change [17]. Thus, monitoring sleep and dream-related aspects over time seems to be of high relevance, not only because it allows a more complete description of individual sleep profiles and a better characterization of sleep patterns, but also because it will contribute to the development of more tailored interventions to support people with sleep problems during the COVID-19 pandemic. Also, better identifying population subgroups with higher chances of presenting unhealthy sleep trajectories could help to delineate prevention measures targeting specific strata within the general population. Therefore, this longitudinal study aimed to characterize insomnia symptoms and nightmare profiles and the associated factors in the Portuguese population throughout the first six weeks of lockdown due to the COVID-19 pandemic.

2. Methods

2.1. Study design, participants and definition of variables

The Institute of Public Health of the University of Porto (ISPUP) and the Institute of Systems and Computers Engineering,

Technology and Science (INESC TEC) designed an internet-based open cohort study (*Diários de uma Pandemia*, in English, Diaries of a Pandemic) that aimed to collect daily information on different aspects of the life of the Portuguese population during the first wave of SARS-CoV-2/COVID-19 pandemic in Portugal. We used a dynamic cohort design, participants being allowed to enter and leave the study at any time during follow-up and fill in any number of questionnaires, with any periodicity. The study was primarily designed for residents in Portugal, even though a minority (n = 59) of Portuguese nationals living in other countries were also included. A non-probabilistic sampling method was used, where the dissemination of the survey and a call for participation were made primarily through a national daily newspaper (PÚBLICO), which published several news pieces on the study and posted a temporary banner on their website, as well as through the institutional websites of ISPUP and INESC TEC, their social network accounts, and mailing lists. In addition, key opinion leaders were contacted to contribute to the dissemination through their own networks.

Persons aged 16 years or more were eligible to participate. Potential participants were asked to provide an email address which was used to generate a unique pseudonymized token that directed them to an informed consent page. Participation was considered valid only if the respondent had scrolled through the whole privacy policy and consent document. Each participant was re-sent their unique token every day as part of a reminder to fill in that day's questionnaire.

Besides the daily survey, between 26th of March and first of May (six weeks), participants received a weekly questionnaire in order to characterize their well-being and the impact that the pandemic might have on their daily life. Specifically, insomnia symptoms and nightmares were assessed in the weekly module through the questions "During the past week, did you experience difficulties falling asleep or staying asleep?" and "During the past week, did you have any nightmares about the current situation?", respectively. For both questions, the answer options were "never/almost never", "occasionally", "often", "always/almost always". These questions were applied weekly during six weeks. During the same weeks and using the same answer options, participants were inquired about the frequency of feeling fear of being infected with SARS-CoV-2. Since these answers were considerably stable over time, we used only the information collected at baseline. A confirmed infection by SARS-CoV-2 (yes/no) was also registered every day.

At the beginning of the study, participants were asked to fill in a short module on sociodemographic characteristics, comprising gender, age, household size, household composition, educational attainment, and perceived income adequacy, by asking respondents the following question: "How do you consider your household income. The answer options were a) insufficient, b) cautious with expenses, c) enough to make ends meet, and d) comfortable.

For this particular analysis, we considered information retrieved from 5011 participants that provided information about insomnia symptoms and nightmares in three or more time points throughout the six weeks and their characteristics are depicted in Table 1. Among the participants who provided information during the six weeks of the study, 73.4% were women, 68.3% had less than 50 years of age, 81.3% had a University degree, 82.3% were not living alone, and the majority did not have any child (80.0%) or a person with a chronic disease (58.7%) in their household. A quarter of this sample considered their household income as insufficient or reported the need to be cautious with expenses. During the study period, 3% of the sample was diagnosed with SARS-CoV-2 infection and 23.8% reported to often/almost always/always feel fear of getting infected (Table 1).

Table 1
Participants' sociodemographic characteristics (n = 5011).

	n (%)
Gender	
Men	1303 (26.6)
Women	3592 (73.4)
Age (years)	
16-39	2058 (42.1)
40-49	1284 (26.2)
50-59	885 (18.1)
≥ 60	665 (13.6)
Education level	
University	3980 (81.3)
High school	793 (16.2)
≤ Elementary	124 (2.5)
Living alone	
No	4038 (82.3)
Yes	868 (17.7)
Household with ≥ 1 child	
No	3926 (80.0)
Yes	980 (20.0)
Household with ≥ 1 person with chronic disease	
No	2878 (58.7)
Yes	2028 (41.3)
Perceived income adequacy	
Comfortable	1643 (33.5)
Enough to make ends meet	1970 (40.2)
Cautious with expenses	1151 (23.5)
Insufficient	134 (2.7)
Fear of SARS-CoV-2 infection	
Never/occasionally	3920 (78.2)
Often/almost always/always	1191 (23.8)
SARS-CoV-2 infection	152 (3.0)

Note: In each variable, the total may not add up to 5011 due to missing data.

2.2. Statistical analysis

Insomnia symptoms and nightmare profiles were obtained using latent class analysis based on the answers given to the two questions previously described, during six consecutively weeks. The Bayesian information criterion (BIC) was used for model selection. For both insomnia symptoms and nightmare profiles, we started by considering a one-class model, increasing the number of classes at each step up to six, searching for the lowest BIC value. Individuals were classified according to their probability of being in each latent class and each individual was assigned to the class with the highest probability. The best models obtained for insomnia symptoms and nightmare profiles were a five-class and three-class model, respectively (Supplementary file, Table S1).

The associations between sociodemographic factors and profiles of insomnia symptoms or nightmares were assessed using multinomial logistic regressions, and crude (OR) and adjusted odds ratio (aOR) with the respective 95% confidence intervals (95%CI) were computed. The sociodemographic factors considered were gender, age group, educational level, living alone, living in a household with children, living in a household with people with chronic diseases, and perceived income adequacy. Multivariate models were adjusted for potential confounders theoretically defined as documented causes of each exposure variable as well as of sleep problems (insomnia symptoms and nightmares), and that are not likely to mediate the main association. Thus, we built distinct multivariate models, for the relation of each potential determinant and sleep. For gender and age, only crude models are presented.

Statistical analyses were performed using R software [18] version 3·6.3 for Windows.

2.3. Ethics

The study received ethical approval by the Ethics Committee of the Institute of Public Health of the University of Porto (ref: CE20142). A Data Protection Officer was designated by the institutions involved and a formal Data Protection Impact Assessment was carried out.

3. Results

Five profiles of insomnia symptoms and three profiles of nightmares were identified. Insomnia symptoms' profiles were labelled as "No insomnia" (n = 1100, 22.0%), "Stable-mild" (n = 1334, 26.6%), "Decreasing-moderate" (n = 1207, 24.1%), "Stable-severe" (n = 1146, 22.9%) and "Increasing-severe" (n = 224, 4.5%). The three profiles that emerged for nightmares were named "Stable mild" (n = 3613, 72.1%), "Stable moderate" (n = 1153, 23.0%), and "Stable severe" (n = 245, 4.9%) (Fig. 1).

The "No insomnia" profile included mainly individuals stating that they never/almost never had difficulties to fall asleep or stay asleep throughout the study period, while half of the participants in "Stable-mild" profile occasionally presented insomnia symptoms during the six weeks. The profile entitled "Decreasing-moderate" included around a quarter of participants who referred to often experiencing insomnia symptoms but with decreasing frequency over time. The two profiles with the worst insomnia symptoms were "Stable-severe" and "Increasing-severe". Most participants in both profiles reported to struggle to fall asleep or stay asleep recurrently with the latter presenting a worsening of symptoms over time (Fig. 2 and Table S2). Regarding nightmares, the three profiles had a stable trajectory over time, with "Stable-moderate" and "Stable-severe" presenting a slight worsening of symptoms in the middle weeks. Most participants in the "Stable-mild" profile never/almost never had nightmares about COVID-19 during the study period, while people in "Stable-moderate" and "Stable-severe" mostly referred to have them occasionally and often, respectively (Fig. 3 and Table S2).

In the crude analysis, being female, having less than 50 years of age, belonging to a household with at least 1 person with a chronic disease, perceiving their income as less favorable, often presenting fear of being infected with SARS-CoV-2 was associated with a higher likelihood of presenting a worse profile for insomnia symptoms and nightmares during the first wave of the pandemic. Lower education was associated with the "Increasing-severe" insomnia profile (High school: OR = 1.54, 95%CI 1.07–2.23), but not with the "Stable-severe" nightmare profile (High school: OR = 1.17, 95%CI 0.84–1.65). Inversely, having a child in the household and being diagnosed with SARS-CoV-2 infection was associated with a worse nightmare profile (Stable-severe: OR = 1.71, 95%CI: 1.27–2.29) but not with insomnia symptoms; living alone was not associated with any insomnia or nightmare profiles (Insomnia/increasing-severe: OR = 1.15, 95%CI: 0.80–1.66; Nightmares/stable-severe: OR = 1.18, 95%CI: 0.85–1.63) (Tables 2 and 3).

In a multivariate model, and after adjusting for potential confounders theoretically defined as documented causes of each exposure variable and sleep problems, dose–response direct associations were found between insomnia symptoms or nightmares and, household with at least one person with chronic disease, perceived income adequacy and the fear of being infected with SARS-CoV-2. Those who perceived their income as insufficient and those who often felt fear about being infected with SARS-CoV-2 were the ones with higher chances of presenting the most severe profiles of insomnia symptoms (Insufficient income: aOR = 8.13 95%CI: 3.93–16.84; Often/almost always/always presenting fear of
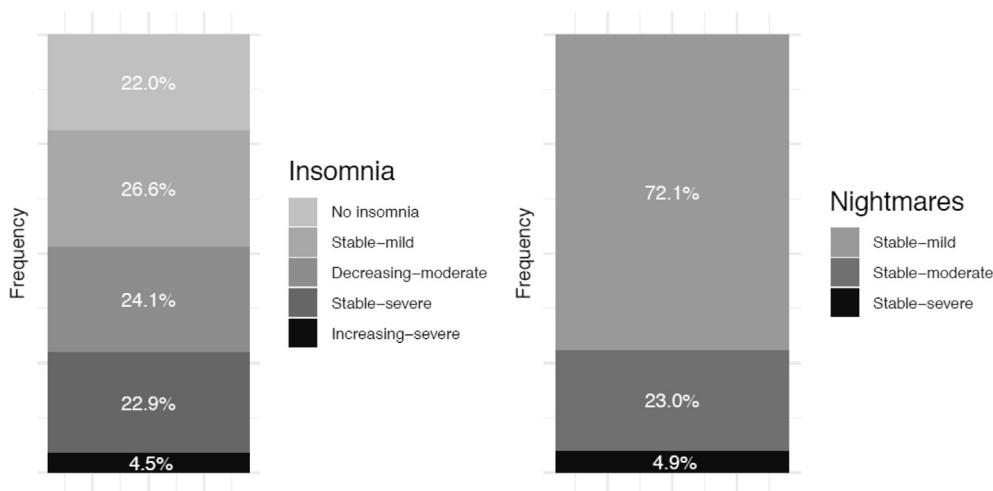
Fig. 1. Description of the proportion of participants in each insomnia symptoms' and nightmare profiles.
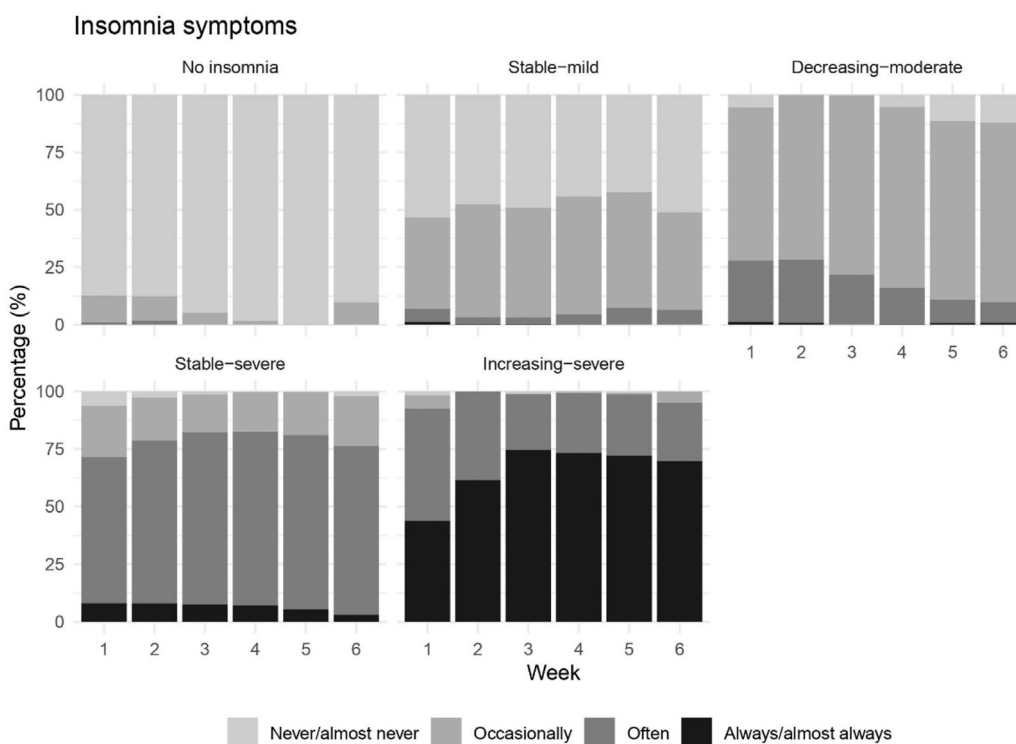

Fig. 2. Characterization of insomnia symptoms during the first wave of the COVID-19 pandemic.

being infected with SARS-CoV-2 infection: aOR = 9.13 95%CI: 6.36—13.11) and nightmares (Insufficient income: aOR = 2.60 95% CI: 1.30—5.20; Often/almost always/always presenting fear of being infected with SARS-CoV-2 infection: aOR = 6.62 95%CI: 5.01—8.74). Having a diagnosis of SARS-CoV-2 virus infection was associated with worse patterns of nightmares about the pandemic (Tables 2 and 3).

4. Discussion

During the first six weeks of lockdown, we identified five insomnia and three nightmare profiles in the adult population of Portugal. Those profiles showed considerable heterogeneity between individuals in relation to insomnia symptoms and nightmares about the pandemic, varying in severity and over time.

Women, younger individuals and those who perceived their income as insufficient had higher chances of presenting the most severe sleep profiles. Besides the sociodemographic characteristics, the fear of getting the SARS-CoV-2 infection influenced the observed patterns of insomnia symptoms and nightmares about the COVID-19 pandemic during lockdown.

Even though the sleep profiles that emerged from this particular work cannot be directly compared with other studies, we were able to show that more than a quarter of our sample stated that they often or always had difficulties falling asleep or staying asleep during the study period, making them part of the two most severe
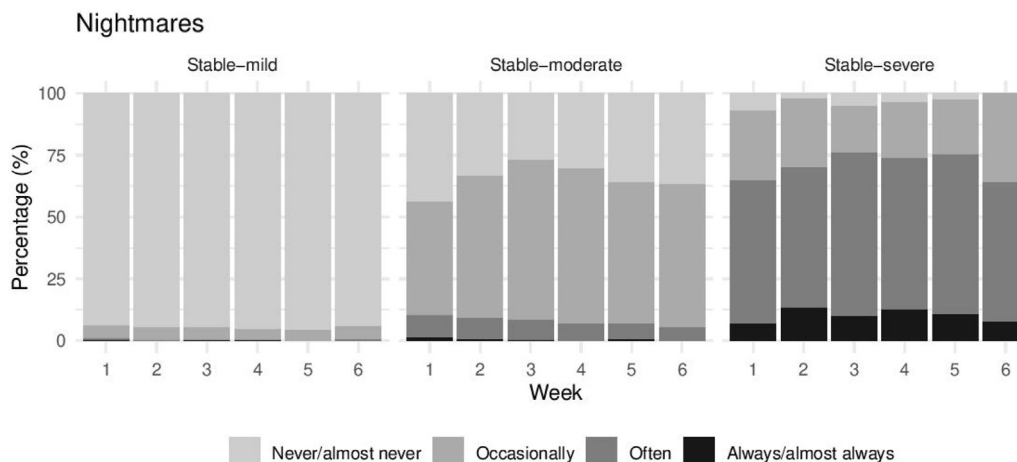
Fig. 3. Characterization of nightmares about COVID-19 during the first wave of COVID-19 pandemic.

insomnia profiles. A study published in Portugal in 2005 already presented a similar proportion of insomnia symptoms at least three nights per week, being reported by 28.1% of the general adult population [19].

In Europe, specifically during the COVID-19 pandemic, the prevalence of insomnia varied between 17.4% and 52.4% in Italy [11,20] and 37.6% in Greece [12]. In China, it was observed not only the occurrence of new insomnia complaints but also a 37% increase in the rates of clinical insomnia compared to before the peak of the COVID-19 pandemic [14]. Even though a comparison between studies is a challenging task, since each study referred to different time periods, used different measurement tools and had samples with different age ranges, all of them underline the high prevalence of insomnia symptoms worldwide, not only during the COVID-19 pandemic but also before that period and highlights that sleep problems are a major public health concern.

According to our findings, five percent of the participants reported to have nightmares about COVID-19 pandemic often, almost always or always. In a Brazilian study, they observed almost a three-fold increase in the number of participants reporting nightmares "once a week or more" comparing the periods before and after the pandemic and over two thirds of these participants described nightmares with a pandemic content [21], which is considerably higher compared to our present findings. Previous theoretical conceptualizations reported dreams and nightmares as adaptive biological responses with an adjustment function [22] that have been shown to be associated with psychopathology [23]. Additionally, an association between the frequency of nightmares and the chance of suicidal ideation was found during the pandemic [21]. Insomnia and nightmares triggered by stressful life events are frequent symptoms of psychiatric disorders that can persist over time [7]. Therefore, individuals who develop insomnia and nightmares during the COVID-19 pandemic may be at a greater risk for long-term psychiatric disorders, as it was observed in the prior SARS-CoV-1 epidemic [24] and could indicate the need for preventive public health interventions [25]. Moreover, these nightmare patterns were relative stable over time, contrasting with other studies showing an increase in dream recall and nightmares along the pandemic [15]. One possible explanation for our results could be the short study period at an early stage of the pandemic.

Our data suggest that there is a considerable heterogeneity between individuals in insomnia and nightmare profiles during lockdown as we identified five and three different profiles of insomnia and nightmares among Portuguese adults, respectively.

These different profiles, that vary within- and between-persons, are in line with previous evidence showing that there is considerable night-to-night variability within the same person as well as significant heterogeneity between adults [26], and future research should explore long-term trajectories of such sleep variability. Independently of the lockdown, these results highlight the need to consider other factors which vary from day-to-day within older adults (eg, mood, daily demands, sleep environment) to better understand sleep variability. In any case, the fluctuation in insomnia and nightmare profiles during the pandemic is somehow expected, as sleep is a physiological process that depends on environment and social cues with a high variation according to the level of stress and the consequent physiological arousal over time [27,28].

In our study, being a female increased the odds of have a worse insomnia profile, which corroborates most of the studies conducted during lockdown [14,29]. A possible explanation is their higher propensity to stress related disorders and anxiety disorders [30], which could be due to biological and society-driven risk factors [31]. However, there are studies suggesting that men and women might have their sleep equally affected during the COVID-19 pandemic [32], which can also be explained by differences in study periods, contexts and sleep measurement methods.

Adults with less than 40 years of age were more likely to present worse insomnia symptoms and a higher frequency of nightmares about COVID-19 pandemic. These results can be, at least, partially explained by the high levels of mental health concerns in the younger population, namely due to the added stress of dealing with academic changes and a potential delay in their career due to the lockdown [33,34]. Additionally, the fact that young people are frequently engaged in precarious employments [35], and absorb a large amount of information from social media, can contribute to an increased stress level and lead to poor sleep [36]. Previous research has reported that a large proportion of college students already had poor sleep habits [37], and the COVID-19 pandemic has further worsened those sleep habits by allowing them to have less structured daily activities, including more hours free from school, staying up late, increase the use of mobile phone, and more frequent online games that were already recurrent [38].

Another important finding regarding social determinants was that participants that considered their income insufficient had higher chances of presenting the most severe profiles of insomnia symptoms and nightmares, independently of all other individual characteristics considered in the analysis. Socioeconomic

Table 2
Crude and multivariate-adjusted odds ratio for the association between individual characteristics and insomnia symptoms' profiles during the first wave of the COVID-19 pandemic.

	Insomnia symptoms							
	Crude OR[a] (95%CI)				Adjusted OR[a] (95%CI)			
	Stable mild	Decreasing moderate	Stable severe	Increasing severe	Stable mild	Decreasing moderate	Stable severe	Increasing severe
Gender								
Men	1	1	1	1	1	1	1	1
Women	1.52 (1.28–1.80)	2.07 (1.72–2.48)	3.08 (2.53–3.75)	7.33 (4.46-12.05)	–	–	–	–
Age (years)								
16-39	1	1	1	1	1	1	1	1
40-49	0.98 (0.80–1.21)	1.09 (0.88–1.35)	1.21 (0.98–1.26)	0.84 (0.59–1.19)	–	–	–	–
50-59	0.93 (0.74–1.16)	0.93 (0.73–1.17)	0.92 (0.73–1.16)	0.44 (0.28–0.69)	–	–	–	–
≥ 60	0.76 (0.60–0.97)	0.83 (0.65–1.06)	0.51 (0.39–0.67)	0.30 (0.18–0.53)	–	–	–	–
Education level[b]								
University	1	1	1	1	1	1	1	1
High school	1.14 (0.91–1.43)	1.07 (0.85–1.35)	1.21 (0.96–1.52)	1.54 (1.07–2.23)	1.21 (0.97–1.52)	1.19 (0.94–1.51)	1.40 (1.10–1.77)	1.90 (1.35–2.77)
≤ Elementary	1.25 (0.69–2.25)	1.83 (1.04–3.20)	1.68 (0.94–2.98)	2.25 (0.97–5.22)	1.46 (0.80–2.64)	2.24 (1.27–3.97)	2.35 (1.29–4.26)	4.20 (1.75–10.05)
Living alone[b]								
No	1	1	1	1	1	1	1	1
Yes	1.06 (0.86–1.30)	0.95 (0.76–1.18)	0.97 (0.78–1.21)	1.15 (0.80–1.66)	1.06 (0.86–1.32)	0.93 (0.74–1.16)	0.99 (0.79–1.25)	1.21 (0.83–1.76)
Household with ≥ 1 child[c]								
No	1	1	1	1	1	1	1	1
Yes	0.94 (0.76–1.15)	1.02 (0.83–1.26)	1.11 (0.90–1.36)	0.97 (0.68–1.40)	0.88 (0.71–1.09)	0.94 (0.76–1.18)	0.96 (0.77–1.19)	0.76 (0.52–1.11)
Household with ≥ 1 person with chronic disease[c]								
No	1	1	1	1	1	1	1	1
Yes	1.22 (1.03–1.44)	1.32 (1.12–1.57)	1.32 (1.11–1.56)	1.59 (1.19–2.13)	1.26 (1.06–1.49)	1.36 (1.15–1.62)	1.39 (1.17–1.67)	1.77 (1.31–2.38)
Perceived income adequacy[d]								
Comfortable	1	1	1	1	1	1	1	1
Enough to make ends meet	1.21 (1.01–1.45)	1.29 (1.06–1.55)	1.56 (1.29–1.90)	1.44 (0.98–2.10)	1.19 (0.99–1.43)	1.27 (1.04–1.54)	1.50 (1.23–1.83)	1.32 (0.90–1.94)
Cautious with expenses	1.43 (1.14–1.79)	1.81 (1.44–2.28)	2.49 (1.97–3.14)	3.62 (2.45–5.34)	1.37 (1.09–1.74)	1.79 (1.41–2.27)	2.28 (1.79–2.91)	3.31 (2.21–4.94)
Insufficient	1.35 (0.75–2.42)	1.87 (1.05–3.32)	2.53 (1.43–4.46)	8.09 (4.06–16.14)	1.40 (0.76–2.55)	1.99 (1.10–3.61)	2.60 (1.44–4.70)	8.13 (3.93–16.84)
Fear of SARS-CoV-2 infection[e]								
Never/occasionally	1	1	1	1	1	1	1	1
Often/almost always/always	2.11 (1.60–2.79)	4.55 (3.49–5.92)	7.47 (5.76-9.68)	10.76 (7.59–15.26)	2.03 (1.53–2.68)	4.20 (3.21–5.49)	6.60 (5.06–8.62)	9.13 (6.36–13.11)
SARS-CoV-2 infection[f]								
No	1	1	1	1	1	1	1	1
Yes	0.72 (0.43–1.19)	1.11 (0.69–1.77)	1.20 (0.75–1.91)	1.35 (0.64–2.87)	0.65 (0.39–1.10)	1.06 (0.66–1.72)	1.19 (0.73–1.93)	1.29 (0.57–2.89)

95%CI, 95% confidence interval, OR, odds ratio.
[a] No insomnia as the reference category.
[b] Multivariate model adjusted for gender and age.
[c] Multivariate model adjusted for gender, age and education.
[d] Multivariate model adjusted for gender, age, education and living alone.
[e] Multivariate model adjusted for gender, age, education, household with ≥ 1 child; household with ≥1 person with chronic disease, perceived income adequacy and SARS-CoV-2 infection.
[f] Multivariate model adjusted for gender, age, education, perceived income adequacy and living alone.

Table 3
Crude and multivariate-adjusted odds ratio for the association between individual characteristics and nightmare' profiles during the first wave of COVID-19 pandemic.

	Nightmares			
	Crude OR[a] (95%CI)		Adjusted OR[a] (95%CI)	
	Stable moderate	Stable severe	Stable moderate	Stable severe
Gender				
Men	1	1	1	1
Women	2.29 (1.92—2.72)	3.04 (2.07—4.46)	–	–
Age (years)				
16-39	1	1	1	1
40-49	1.03 (0.88—1.21)	0.90 (0.66—1.23)	–	–
50-59	0.69 (0.57—0.84)	0.62 (0.42—0.91)	–	–
≥ 60	0.61 (0.49—0.77)	0.45 (0.28—0.74)	–	–
Education level[b]				
University	1	1	1	1
High school	0.94 (0.78—1.13)	1.17 (0.84—1.65)	1.02 (0.84—1.23)	1.28 (0.91—1.80)
≤ Elementary	0.87 (0.56—1.36)	0.98 (0.42—2.26)	1.06 (0.67—1.67)	1.35 (0.58—3.16)
Living alone[b]				
No	1	1	1	1
Yes	0.95 (0.80—1.14)	1.18 (0.85—1.63)	0.97 (0.81—1.17)	1.23 (0.88—1.71)
Household with ≥ 1 child[c]				
No	1	1	1	1
Yes	1.37 (1.16—1.61)	1.71 (1.27—2.29)	1.21 (1.02—1.44)	1.50 (1.10—2.04)
Household with ≥ 1 person with chronic disease[c]				
No	1	1	1	1
Yes	1.16 (1.01—1.33)	1.07 (0.82—1.40)	1.23 (1.07—1.42)	1.14 (0.87—1.49)
Perceived income adequacy[d]				
Comfortable	1	1	1	1
Enough to make ends meet	1.27 (1.09—1.50)	1.37 (0.98—1.91)	1.25 (1.06—1.47)	1.30 (0.93—1.82)
Cautious with expenses	1.47 (1.23—1.76)	2.13 (1.51—3.02)	1.44 (1.19—1.74)	2.01 (1.40—2.87)
Insufficient	1.59 (1.06—2.39)	2.65 (1.34—5.22)	1.66 (1.10—2.53)	2.60 (1.30—5.20)
Fear of SARS-CoV-2 infection[e]				
Never/occasionally	1	1	1	1
Often/almost always/always	2.60 (2.24—3.03)	7.09 (5.42—9.27)	2.48 (2.12—2.91)	6.62 (5.01—8.74)
SARS-CoV-2 infection[f]				
No	1	1	1	1
Yes	1.54 (1.06—2.21)	2.89 (1.69—4.93)	1.73 (1.19—2.53)	3.09 (1.76—5.43)

95%CI, 95% confidence interval, OR, odds ratio.
[a] Stable-mild as the reference category.
[b] Multivariate model adjusted for gender and age.
[c] Multivariate model adjusted for gender, age and education.
[d] Multivariate model adjusted for gender, age, education and living alone.
[e] Multivariate model adjusted for gender, age, education, household with ≥ 1 child; household with ≥1 person with chronic disease, perceived income adequacy and SARS-CoV-2 infection.
[f] Multivariate model adjusted for gender, age, education, perceived income adequacy and living alone.

disadvantage, which goes beyond objective measures of social position and encompasses the subjective perception of indicators of disadvantage, is known for its adverse impacts on health and has the potential to affect sleep [39]. The associations between poor sleep and low income are in line with previous evidence [39,40] and the COVID-19 pandemic does not change this robust association. Curiously, we did not find such a strong association between education and both types of sleep profiles, suggesting that the results regarding perceived income might reflect specific concerns and fear about losing the job and not having enough money for basic needs if confinement continues.

Fear is an adaptive response in the presence of a threat and, when that threat is uncertain and continuous like the current pandemic situation, it can become chronic and burdensome [41]. Therefore, it is somehow expected that this feeling can lead to sleep problems, as shown in the present results. Fear was also related to regular and social media use [41]. Considering the current level of online misinformation, a sufficient level of accurate information is imperative. Despite recent research suggesting that the COVID-19-related fear can be reversed to the level before the shutdown, generalized anxiety remains elevated over time [42], and therefore this fear should not be neglected.

Finally, a diagnosis of SARS-CoV-2 infection was significantly related to a more severe profile of nightmares about the virus.

Daytime experiences with emotional content turn more easily into oneiric content therefore, a more severe profile of nightmares is expected with the increased ansiogenic context when experiencing the SARS-CoV-2 infection [43]. In addition, the absence of an association with insomnia symptoms might be due to the question format used to evaluate insomnia. We inquired about difficulties falling asleep or staying asleep during the past week, independently of being related to COVID-19 or not, while with nightmares the question was focused on the current context. Knowing that sleep disorders, including obstructive sleep apnea and insomnia, are common in patients hospitalized for SARS-CoV-2 infection [44], we would expect a more robust association with insomnia symptoms in our study if we had used more specific questions.

The question used to evaluate insomnia symptoms was not able to disentangle the specificities of insomnia subtypes: initial insomnia (difficulty in falling asleep at the beginning of the night), middle insomnia (difficulty in maintaining sleep) and terminal insomnia (early morning awakening) [45]. The question "During the past week, did you experience difficulties falling asleep or staying asleep?", which is one of the most common questions used in surveys to measure insomnia [46], only covers information about initial and middle insomnia together. However, it was expected that the subtypes of sleep initiation and middle insomnia to be the most frequent subtypes of insomnia during the pandemic, as they are

more related with a higher arousability due to the psychological distress experienced during the pandemic [13]. Knowing that insomnia subtypes might have differential effects in health [47], we recommend taking temporal effects of insomnia symptom subtypes into account in future investigations.

Some limitations should be highlighted. This sample was an opportunistic sample with limited representativeness of the general population. It comprises people with a comparatively high level of education and favorable income that may influence the prevalence estimates of insomnia and nightmares, ie, sleep problems might be underestimated. Moreover, this national study aimed to characterize a considerable number of health-related aspects of the Portuguese population during the first wave of the COVID-19 pandemic, and, for that reason, the questionnaire comprised a broader health characterization. In fact, sleep was not the primary outcome and, due to time constraints, it was not possible to apply a more complete and validated scale to measure sleep. As such, for a better sleep characterization, further studies should use validated scales such as Insomnia Severity Index or the Pittsburgh Sleep Quality Index for insomnia symptoms, and Nightmare Distress Questionnaire or Van Dream Anxiety Scale for nightmares. The improvement of these methodological aspects, will allow to assess other insomnia symptoms, such as early morning awakening with inability to return to sleep, daytime symptoms like attention, concentration, or memory problems and nightmares severity. Additionally, this internet-based open cohort was only stablished after the beginning of the pandemic and, for that reason, we were not able to collect information prior to the pandemic. This fact did not allow to disentangle the influence of the pandemic itself in this issues nor to assess important variables that could influence sleep patterns before the pandemic, such as depressive symptoms or anxiety. However, to the best of our knowledge, this is the first study characterizing, from a longitudinal perspective, insomnia symptoms and nightmare profiles among Portuguese population during the first weeks of the first national lockdown, allowing us to show the dynamics of those symptoms over time in this particular period.

5. Conclusion

The present study identified several different profiles of insomnia symptoms and nightmares during the first wave of the COVID-19 outbreak. We found strong social and psychological associated factors, namely age, gender, perceived income adequacy, a diagnosis of SARS-CoV-2 infection and the fear of a getting the infection influencing patterns of insomnia symptoms and nightmares about COVID-19 during lockdown.

Although some people will have only transient psychological and behavioral symptoms as a normal reaction to this traumatic event, if sleep problems persist over time, a pandemic of mental health problems might arise. With this work, we provide clues to early identify individuals at a higher risk of developing mental health problems triggered by poor sleep and help to act preventively.

Credit author statement

Each author participated sufficiently in the work to take public responsibility for its content and believes that the manuscript represents honest work. Gonçalves conducted the interpretation of the data and wrote the original draft of the article. Henriques, Costa and Lucas collaborated in the methodology of the study, reviewed and edited the article with important intellectual content. Severo and Correia collaborated in the formal analysis and interpretation of the data, and reviewed the article critically. Barros conceptualized the study and edited the article with important intellectual content.

Conflict of interest

The authors declare that they have no conflict of interest.

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: https://doi.org/10.1016/j.sleep.2021.12.018.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sleep.2021.12.018.

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