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Carolina Lopes Araújo

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Dissertação no âmbito do Mestrado em Psicologia Clínica e da Saúde, Subárea de Especialização em Intervenções Cognitivo-Comportamentais nas Perturbações Psicológicas e Saúde orientada pela Professora Doutora Ana Cardoso Allen Gomes e apresentada à Faculdade de Psicologia e Ciências da Educação da Universidade de Coimbra.

Julho de 2021

Faculdade de Psicologia e Ciências da Educação
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Abstract

This research focused on the impact of the COVID-19 pandemic on the sleep of the Portuguese population, first wave. We aimed to inspect the sleep schedules, durations, quality, insomnia symptoms, and related variables, after the first lock-down. During June and July 2020, a final sample of 1079 participants from both sexes (18≤years old≤86) answered on-line questions regarding sleep patterns together with the Insomnia Severity Index (ISI) and the Basic Scale on Insomnia Symptoms and Quality of Sleep (BaSIQS). Sociodemographic-information, basic health, family/domestic and pandemic circumstances were also collected. From this large sample, a subsample (n=410) was also extracted and compared with an equivalent subsample selected from a larger one collected in 2017. Statistical analyses were performed using IBM-SPSS. Results suggest that sleep-wake schedules shifted to later hours during the week, decreasing the social jet lag, and the restriction-extension pattern. Time in bed on weeknights increased comparing 2017 and 2020 subsamples. Clinically relevant insomnia symptoms (as suggested by the ISI score) achieved a prevalence of 18.3% in 2020. As a possible explanation, when people work and study from home, they have greater flexibility in defining their routine and sleep-wake schedules. Thus, on the one hand, they can follow their natural biological rhythm, which can be a protective factor for sleep. On the other hand, it can be a risk factor for the aggravation or development of insomnia, as it allows to adopt counterproductive behaviors like more time in bed without sleep. The present research also reveals that the subjective impact of COVID-19 pandemic on sleep may be variable: although a significant portion of people reports poorer sleep, there are also sleep improvements. The experience of improvement, worsening or maintenance of sleep patterns seems to be related to sociodemographic characteristics and specific domestic/family and occupational contexts during the pandemic.

Keywords: COVID-19; Insomnia; ISI; Sleep-wake schedules; Sleep quality

Resumo

Esta investigação focou-se no impacto da pandemia COVID-19 no sono da população portuguesa, durante a primeira vaga. O objetivo foi examinar os horários de sono, durações, qualidade, sintomas de insónia e variáveis relacionadas, após o primeiro confinamento. Uma amostra final de 1079 participantes de ambos os sexos (18≤idade≤86) respondeu durante junho/julho de 2020 a um inquérito on-line abrangendo padrões de sono, o Índice de Gravidade da Insônia (ISI) e a Escala Básica de Sintomas de Insônia e Qualidade do Sono (BaSIQS). Foram recolhidas informações sociodemográficas, sobre saúde, contexto familiar/doméstico e pandémico. Desta amostra global, uma subamostra (n=410) foi extraída e comparada com uma subamostra equivalente selecionada de uma amostra mais abrangente recolhida em 2017. Os dados foram submetidos a análise estatística com o IBM-SPSS. Os resultados sugerem que os horários de sono-vigília se deslocaram para mais tarde à semana, diminuindo o *jet lag* social e o padrão de restrição-extensão. À semana, o tempo na cama mostrou algum aumento de 2017 para 2020. Os sintomas de insónia clinicamente significativa (pontuação na ISI) foram reportados por 18.3% dos participantes de 2020. Como possível explicação, quando as pessoas trabalham/estudam em casa, têm maior flexibilidade para definir a sua rotina e horários de sono-vigília. Por um lado, podem respeitar seu ritmo biológico endógeno, o que pode ser um fator protetor para o sono. Por outro lado, tal pode ser um fator de risco para o agravamento ou desenvolvimento da insónia, ao permitir comportamentos como ficar mais tempo na cama sem dormir. O presente trabalho revelou também que o impacto da pandemia COVID-19 sobre o sono pode ser bastante diferenciado: boa parte dos inquiridos sentiu piorias, mas também houve melhorias. A melhoria, manutenção ou pioria do sono parece relacionar-se com características sociodemográficas e contextos familiares, domésticos ou laborais específicos durante a pandemia.

Palavras-chave: COVID-19; Insónia; ISI; Horários de sono-vigília; Qualidade de sono

Introduction

Scientific evidence points to sleep being a key factor in individuals' health, both physical and mental. Sleep is a protective factor not only for psychological problems, but also for physical health, by strengthening the immune system (Silva et al., 2020). During a pandemic, defined by The International Epidemiology Association's (2008) as "an epidemic occurring worldwide, or over a very wide area, crossing international boundaries and usually affecting a large number of people", one of the main priorities is to ensure a positive health condition and a strong immune system to prevent further spread of the disease. As such, sleep may play a vital role in promoting and/or maintaining, both physical and psychological health. Considering the important role of sleep in the immune system and overall mental and physical health, it is important to understand how the COVID-19 pandemic may have impacted sleep so that the necessary measures can be taken to prevent or remedy any possible damage.

Most of the investigations carried out to date, suggest that the COVID-19 pandemic has caused a significant impairment of sleep. The range of sleep problems targeted in studies about the impact of the pandemic is vast (e.g., Miller & Cappucio, 2021; Thorpy et al., 2020) but results concerning sleep quality and insomnia symptoms are particularly interesting given the known association between insomnia and psychological problems (American Academy of Sleep Medicine, 2014; American Psychiatric Association, 2013; Miller-Mendes et al., 2019). Regarding sleep quality, studies show that there was a significant reduction, however a consensus about the prevalence of poor sleep has not been established with prevalence values varying between 13.5% and 56.3% (Bigalke et al., 2020; Hetkamp et al., 2020; Huang & Zao, 2020; Wang et al., 2020; Yu et al., 2020; Zhao et al., 2020). When evaluating insomnia symptoms and sleep related aspects, different research methodologies were used. Most studies used instruments such as the

Insomnia Severity Index (ISI), the Pittsburgh Sleep Quality Questionnaire (PSQI) and the Epworth Sleepiness Scale (ESS). In some studies, only certain items of the referred scales were used, instead of a standardized method to assess insomnia symptoms, which seems a limitation that may explain the discrepancies found in the results. Even though, despite the varying prevalence values found (16% to 56%), these studies point to a clear significant impact of the pandemic in insomnia as a clinical condition (Idrissi et al., 2020; Lin et al., 2020; Morin et al., 2020; Pieh et al., 2020). Psychological symptomology was also addressed in some studies and the same tendency was found. Levels of anxiety and depression increased, with values ranging from 17.1% to 68% and 12.4% to 50%, respectively (Bigalke et al., 2020; Idrissi et al., 2020; Li et al., 2020; Lin et al., 2020; Morin et al., 2020; Pieh et al., 2020), as would be expected in view of the previously mentioned associations between sleep and psychopathology (e.g., American Academy of Sleep Medicine, 2014; American Psychiatric Association, 2013; Miller-Mendes et al., 2019). Morin et al. (2020) presented two main reasons that can justify the loss of sleep in individuals, (1) the direct effects of confinement, that is, the stress and anxiety felt, concerns about health, financial and working conditions, and uncertainty about the future; and (2) changes in the individuals' daily routine associated with different working hours than those performed before confinement. Other reasons for these changes were also suggested such as the reduction in exposure to sunlight, since it is the main source of synchronization of the circadian sleep-wake rhythm (Morin et al., 2020). In addition, research also includes other risk factors for the development of sleep problems, such as being old, being female (Wang et al., 2020) and having biased beliefs about sleep (Idrissi et al., 2020). These findings are particularly relevant since suffering from some type of sleep deficit during the pandemic may be a risk factor for the later development of chronic clinical insomnia and/or other sleep pathologies, as pointed out by Innocenti et al. (2020).

Despite the above-mentioned studies that underscore the harmful effect of the pandemic on sleep, some studies also reveals improvements in sleep. Kocevska et al. (2020) state that, in fact, whoever was a good sleeper before the pandemic saw their sleep being impaired, but, on the contrary, whoever suffered from clinical insomnia prior to the emergence of COVID-19, found an increase in sleep quality. Also, Gao and Scullin (2020) present data that support an improvement of sleep and sleep quality, mainly on those that before the pandemic context restricted their sleep due to school/work schedules that were not compatible with their diurnal type. While in confinement, these individuals enjoyed greater flexibility of school/working schedules and were able to adapt their sleep schedules to their preferred time which may explain the improvements found. Studies also suggest that this flexibility led to an approximation between the sleep-wake schedules during the week and the weekend (Raman & Coogan, 2021; Lee at al., 2020), resulting in a decrease of sleep restriction-extension pattern and in social jet lag.

Context and aims of the present work

The Government of Portugal implemented home confinement as a measure to contain the spread of the COVID-19 virus, which was mandatory from March 18, 2020 to April 30, 2020 and was followed by a gradual deconfinement. Stimulated by the Portuguese Sleep Association, this research took place in the period of gradual deconfinement of the first pandemic wave in Portugal.

Our research had as the main objective to examine the potential effect of the pandemic and confinement on the sleep, mainly regarding their sleep-wake schedules, sleep length, sleep quality, and presence of insomnia symptoms. Specifically, this study aimed principally to (1) analyze the possible differences related to sleep durations (inferred, e.g., from time in bed [TIB]; (2) examine sleep quality and insomnia symptoms; (3) assess possible changes in sleep-wake schedules; (4) inspect possible changes in the restriction-extension pattern before and after the pandemic; and (5) investigate possible changes in social jet lag before and after the pandemic. The data was expected to reveal a significant impairment in sleep quality, and a significant increase in complaints of insomnia; later sleep-wake schedules, compared to the pre-confinement period, in particular during the week (due to a different exposure to sleep-wake rhythm synchronizers, particularly sunlight, together with the saved time previously spent commuting, for those working/studying remotely, accompanied in some cases by greater freedom to choose schedules); a reduction of social jet lag (i.e., lower week-weekend sleep-wake schedules differences); an increase in TIB especially during the week; and reduced differences between TIB during the week and weekend, that is, reduction of the restriction-extension pattern. Additionally, we also aimed to examine nap frequency and duration, sleeping medication frequency, the percentage of individuals that consider they have a sleep problem, and if so, if it was associated with the pandemic circumstances. Several demographic and contextual variables were considered that could predict impairment, improvement, or maintenance of individuals' sleep, such as sex, age, education, and occupation status of participants, if they were assuming a caregiver role, what was their current work situation, any health problems, days in lock-down (if applicable), and if there were currently significant family/domestic changes due to the pandemic. As the literature indicates, it was expected to find a greater impairment in sleep in female participants, of older age and in those who took a caregiver role (babies/toddlers, sick or elderly relative), as well as in adults having school children confined at home needing their supervision.

To achieve these aims, this research comprised two studies: first, a global analysis on the effects of pandemic circumstances on sleep, considering a large sample of adults of the Portuguese population; second, a comparison between sleep-wake patterns during the pandemic circumstances, in 2020, and in a non-pandemic context, in 2017, by considering similar participants. Although both studies have similar objectives, the first inspects a larger sample and examines changes on sleep schedules and patterns retrospectively, whereas the second allows for a more impartial assessment of changes, without memory bias.

Methods

Participants

Study 1 comprised a final sample of 1079 Portuguese participants (see Table 1), out of 1174 who participated in the online survey. Shift/night workers (n=95) were excluded from the current work given the atypical sleep-wake schedules. The final sample includes 874 women and 205 men, between 18 and 86 years old (45.7 ±16.05), from all regions of the country in an approximately proportional manner. Mean age did not differ significantly between men (47.52 ±17.54, range 18 to 76 years old) and women (45.31 ±15.67, range 18 to 86 years old), $t_{(285.2)=}$1.66, p=.099. Most participants attend or completed higher education (79.1%), the average years of education being M=14.81 (SD=2.38), not differing statistically between sexes ($t_{(1077)}$= -1.57, p=.117). The majority are professionally active (67.9%), 13.7% are students, and 16.1% are inactive due to unemployment, retirement, or prolonged medical leave. About 14.5% maintain "face-to-face" work (i.e., they work on the usual workplace) and 55.9% are in remote work/distance learning.

From these 1079 participants, 763 has been in confinement, 79.7%. Comparing those who have (n=763) *versus* have not (n=298) been in confinement, the former group displayed a significantly lower mean age (M= 43.86 years old, SD=16.16, *versus* = 50.97 years old, SD = 14.71), $t_{(592.12)}$ = 6.872, = .000, and significant more years of formal education (M =15.02, SD = 2.30 *versus* M= 14.27, S= 2.50), $t_{(505.46)}$ = -4.48, p= .000. The distribution of both sexes by each group did not differ significantly (the confinement group was composed of 33.3% of the men and 29.9% of the women, χ^2= 3.41, p= .065).

Table 1

Sample characteristics

		N	%
Sex	Women	874	81.0
	Men	205	19.0
Geographic region	Alentejo	49	4.5
	Algarve	35	3.2
	Centre	325	30.1
	Lisbon and Tagus Valley	393	36.4
	North	230	21.3
	Azores Archipelago	26	2.4
	Madeira Archipelago	21	1.9
Occupational state	Student	148	13.7
	Active	733	67.9
	Inactive	174	16.1
	Not specified/ Not possible to determine	24	2.2
Occupation- major groups[a]	1. Managers	41	3.8
	2. Professionals	588	54.5
	3. Technicians and Associate Professionals	74	6.9
	4. Clerical Support Workers	70	6.5
	5. Services and Sales Workers	45	4.2
	6. Skilled Agricultural, Forestry and Fishery Workers	2	0.2
	7. Craft and Related Trades Workers	8	0.7
	8. Plant and Machine Operators and Assemblers	0	0.0
	9. Elementary Occupations	5	0.5
	10. Armed Forces Occupations	4	0.4
	Students	150	13.9
	Not specified/Other	41	3.8
	Unemployed/Retired	51	4.7
Educational Level	7-9th grades	39	3.6
	High school	187	17.3
	Higher Education	853	79.1
Reported significant health issues	Yes	322	29.8
	No	757	70.2
Total		1079	100.0

[a]Occupations according to the International Standard Classification of Occupations (ISCO-08); the following categories were added: Student, Not Specified, and Unemployed/Retired.

Study 2 comprises two subsamples matched by sex, age, educational level, region, and occupational status (see Table 2), one selected from study 1, and another selected from a 2017 study (cf. Miller-Mendes et al., 2019). Each subsample has 410 comparable participants (total n=820). In terms of sex, the subsamples are equivalent, both consisting mostly of female participants (81.7%). The average age of the 2017 subsample (31.04 ±10.65) is equivalent to the 2020 subsample (31.16 ±10.82), ranging from 18 to 62 years old, ($t_{(818)}$=-0.156, p>0.05). In both subsamples, women seemed younger than men, although there is no statistically significant difference (p>0.05). There were similar distributions of participants from both samples by region, educational level, and occupation status. Self-report health issues significantly interfering with sleep were more commonly reported by the 2020 subsample (22.9%), than by the 2017 subsample (9.0%).

Table 2

Subsamples characteristics

		2017		2020	
		n	%	n	%
Sex	Women	335	81.7	335	81.7
	Men	75	18.3	75	18.3
Geographic region	Alentejo	8	2.0	8	2.0
	Algarve	2	0.5	2	0.5
	Centre	200	48.8	197	48.0
	Lisbon and Tagus Valley	71	17.3	73	17.8
	North	106	25.9	107	26.1
	Azores Archipelago	15	3.7	15	3.7
	Madeira Archipelago	8	2.0	8	2.0
Occupational state	Student	140	34.1	135	32.9
	Active	255	62.2	253	61.7
	Inactive	15	3.7	17	4.1
	Not specified	0	0.0	5	1.2
Occupation-major groups[a]	1. Managers	12	2.9	10	2.4
	2. Professionals	173	42.2	177	43.2
	3. Technicians and Associate Professionals	19	4.6	18	4.4
	4. Clerical Support Workers	24	5.9	19	4.6
	5. Services and Sales Workers	19	4.6	31	7.6
	6. Skilled Agricultural, Forestry and Fishery Workers	0	0.0	0	0.0
	7. Craft and Related Trades Workers	1	0.2	3	0.7
	8. Plant and Machine Operators and Assemblers	2	0.5	0	0.0
	9. Elementary Occupations	3	0.7	1	0.2
	10. Armed Forces Occupations	2	0.5	1	0.2
	Students	140	34.1	136	33.2
	Not specified/Other	0	0.0	9	2.2
	Unemployed/Retired	15	3.7	5	1.2
Educational Level	7-9th grades	10	2.4	10	2.4
	High school	79	19.3	79	19.3
	Higher Education	321	78.3	321	78.3
Reported significant health issues	Yes	37	9.0	94	22.9
	No	373	91.0	316	77.1
Total		410	100.0	410	100.0

[a]Occupations according to the International Standard Classification of Occupations (ISCO-08); the following categories were added: Student, Not Specified, and Unemployed/Retired.

Instruments and measures

Sociodemographic data sheet

To capture the sociodemographic characteristics of the sample, information was collected regarding age, sex, geographic region of residence, education, profession, occupational state, and shift work.

Data sheet on the pandemic circumstances

To understand any changes caused by the pandemic circumstances in the lives of the participants, questions were asked about the start and end date of confinement, whether or not they were infected with COVID-19, changes in family dynamics, namely whether they took the role of caregiver for babies/toddlers, elderly or someone infected with the virus, whether they had to supervise school children at home, and the current employment and occupational situation.

Basic sleep-wake pattern data pre-COVID-19 and during pandemic

Participants were asked to report: bedtime, wake up, and get up times, during week and the weekend, before and during the pandemic; to what extent they perceived any change in their sleep; current and preexisting sleep problems; and possible use of medication to help sleep, before and after the pandemic. The participants were also asked about possible naps, their frequency and duration, and about the existence of any significant clinical condition that interfere with their sleep.

Basic Scale on Insomnia and Quality of Sleep (BaSIQS)

This is a 7-item self-report scale assessing sleep onset, maintenance, early awakening, perceived depth and sleep quality pertaining a “typical week”, considering the previous month (Gomes et al., 2015; Miller-Mendes et al., 2019). Items are rated on a 5-point

Likert scale (score given from 0-4, the last two items being scored in an inverted way), and the total can reach 28 points. Higher values reflect more pronounced complaints of insomnia associated with poorer sleep quality. As its development was not restricted to the clinical population, the items on this scale do not assume the presence of sleep disturbance which allows a broader analysis of the scope of sleep quality, making it suitable for all participants, with and without sleep complaints. For this reason, it can be a useful scale to be applied in community populations, having a good power to assess sleep quality, even in individuals who do not have enough symptoms for the diagnosis of Insomnia Disorder (cf. Miller-Mendes et al., 2019). To assess individuals who reported poor sleep quality, cut-off categories are established by Gomes et al. (2015) for students, and by Miller-Mendes et al. (2019) to clinical and community samples of adults. In this study, Cronbach's alpha was 0.794, a value indicating a good consistency of the scale (Pallant, 2016).

Insomnia Severity Index (ISI)

ISI (Morin, 1993; Clemente et al., 2020) is a self-report questionnaire with 7 items that aim to assess the nature, severity, and consequences of insomnia. Each item is scored using a 5-point Likert scale, from 0 to 4. The sum of items provides a final score ranging from 0 to 28 points. Each scoring interval indicates a qualitative interpretation, which can vary between "absence of insomnia" (0-7), "subclinical insomnia" (8-14), "moderate insomnia" (15-21), and "severe insomnia" (22-28). Although ISI does not allow to diagnose a disorder (a clinical interview is mandatory), it is an instrument widely recommended for the assessment of Insomnia Disorder (e.g., Riemann et al., 2017), with a cut-off score of 15 indicating probable clinical insomnia (Bastien et al., 2001), in addition to the clinical interview. In the present study, this scale has a Cronbach's alpha of 0.883, a value indicating a good internal consistency (Pallant, 2016).

Procedures

Ethical and Sampling procedures

The present investigation was carried out as part of a collaboration between the Portuguese Sleep Association (APS) and the Center for Research in Neuropsychology and Cognitive-Behavioral Intervention (CINEICC). This study was approved by the Portuguese College of Psychologists, and the Research Ethics and Deontology Committee of the Faculty of Psychology and Educational Sciences of the University of Coimbra, and the treatment of the information collected was in accordance with the General Data Protection Regulation [Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016].

This study started with the collection of data from a community sample that took place through the Google Forms online platform and its dissemination was made through the network of contacts of the researchers involved in the study, via the websites and social networks of APS and CINEICC, and through the *Via Verde* of Support of the Portuguese College (*Ordem*) of Psychologists for Scientific Research in Psychological Health and Behavioral Change. In the last two weeks of sample collection, the study was also disseminated through a digital communication and marketing agency. Participants were informed of the objectives of the study and confidentiality through informed consent before progressing to the questionnaire that took an estimated time of 10 minutes to complete. At the end of the questionnaire, a link for the APS website was presented where participants could check the rules of sleep hygiene in times of pandemic. The collection took place between June 1, 2020 and July 31, 2020. Given the objective to study the adult population, the only exclusion criteria were age under 18 years old. After sample collection, only shift workers were excluded from the current study, due to the atypical and specific sleep patterns.

To get the paired subsamples used in study 2, for each 2020 participant, a corresponding participant from the 2017 sample, with the same sex, age, level of education, occupational state, and geographic region was randomly selected from the available cases sharing the same features.

Statistical analysis

For the statistical analysis, was used the software IBM SPSS (Statistical Package for the Social Sciences), version 25.0.

Initially, to characterize the sample and the two subsamples, descriptive statistics were computed, such as the frequencies, means and standard deviations (SD). To check the normality of the variables' distributions, the skewness and kurtosis were calculated, having as normality acceptance criteria values between -2 and +2 (Lomax and Hahs-Vaughn, 2012). The internal consistency of the instruments (BaSIQS and ISI) was analyzed- using Cronbach's alpha-coefficient, which should be above 0.7 (Pallant, 2016).

To compare the mean results between the pre-pandemic period and the pandemic context, in study 1 and the two subsamples in study 2, paired t-tests were calculated. Independent samples t-tests were also used, e.g., to compare participants who have/have not been in confinement. In study 1 to compare the two moments and evaluate the effect of sex, were performed mixed within-between factorial ANOVAs. To detect any interaction with sex in the comparison between 2017 and 2020, two-way between subjects ANOVAs were performed. Univariate ANOVA were also computed.

In all tests, the results were considered as statistically significant if $p \leq 0.05$, and non-statistically significant results are presented as "N.s.". To compare the proportions between the sexes or years in the variables studied, chi-square (χ^2) was calculated. To estimate effect sizes we use Cohen's *d* for t-tests, Eta square (η^2) for ANOVAs, and correlation coefficients (*r or* r_s) for Pearson's or Spearman correlation analyses, considering the interpretation criteria presented by Cohen (1988).

To calculate the variables related to sleep patterns, the following formulas were used: Time in bed (TIB) as the duration between bedtime and rise time; approximate Sleep Midpoint (MSF)=bedtime + TIB/2; approximate Sleep Midpoint in free days (MSFsc) to estimate the chronotype, approximate MSFsc = [MSF-0.5* (MSF-TIB_global week)]. The latter formula is similar to the one developed by Roenneberg et al. (2004), except that we have used bedtime and TIB, instead of sleep-onset time and sleep duration.

Results

Study 1 – Larger national sample

Sleep-wake schedules, and related variables

Overall results about sleep-wake schedules, and week/weekend shifts (social jet lag) considering the whole sample are shown in Table 3.

Table 3

Sleep-wake schedules and social jet lag

	Bedtime (BT) Week	Wake up time (WT) Week	Get up time (GT) Week	BT Week-end	WT Week-end	GT Week-end	Week/Weekend shift or Social Jet lag		
	During the pandemic								
n	1079	1077	1079	1079	1078	1078	ΔBT	ΔWT	ΔGT
M	**24:15**	**7:58**	**8:31**	**24:39**	**8:45**	**9:27**	23 min	46min	56min
SD	1:31	1:48	1:44	1:32	1:53	1:44			
Min	20:00	3:00	3:30	20:00	3:30	4:00			
max	12:00	20:30	21:00	12:00	20:30	21:00			
	Before the pandemic								
	1079	1077	1078	1075	1079	1079			
M	**23:42**	**7:27**	**7:46**	**24:28**	**8:53**	**9:29**	45min	1hr25	1hr42
SD	1:07	1:10	1:16	1:21	1:42	1:40			
Min	20:00	4:00	2:30	20:00	4:00	4:00			
max	04:00	13:15	23:30	06:00	16:30	23:00			
ΔM before/ during	33 min	32 min	45 min	11 min	-8 min	-2 min			

Both during the context of the current pandemic, and before (as assessed retrospectively), mean schedules were significantly later on weekends than on weeknights, as usually found in sleep research. However, the discrepancies between week' and weekend' nights were less pronounced during the pandemic, than previously: the displacement before the pandemic was roughly double compared to the displacement in pandemic times, as shown in the second part of the table. (Week/weekend differences according to paired-samples *t* tests: before the pandemic, $t_{(1074)}$ = -27.39, *p* = .000 for bed times, $t_{(1076)}$ = -34.96, *p* = .000 for wake times, and $t_{(1077)}$ = -35.58, *p* = .000 for get-up times; on the pandemic, $t_{(1078)}$ = -16.025, *p* = .000 for bedtimes; $t_{(1076)}$ = -24.41 for wake-up times, and $t_{(1077)}$ = -26.13, *p*= .000 for get-up times).

All comparisons of sleep-wake schedules between the pandemic and the pre-pandemic periods reach statistical significance, except for weekend get-up time: During the pandemic, bedtime, rise time, and get-up times, on weeknights, were significantly later than before pandemic, 33, 32, and 45 minutes later, respectively $t_{(1078)}$ = -15,256, *p*= .000; $t_{(1074)}$ = -11,973, *p* = .000; $t_{(1077)}$ = -16,449, *p*= .000. On weekends, bedtime was only 11 minutes later in comparison to the pre-pandemic period, whereas wake up time was a bit sooner (8 minutes before), and both differences reached statistical significance, respectively $t_{(1074)}$ = -6,177, *p*= .000, and $t_{(1077)}$ = 3,693, *p*= .000. Weekend rise times were equivalent, only differing 2 minutes, which was not significant ($t_{(1077)}$ = 0,669, *p*= .504).

We also repeat these comparisons using mixed within-between factorial ANOVAs introducing sex as between-subjects factor. There were no significant differences between men and women in sleep-wake schedules, and no interactive effects, excepting for pre-pandemic betimes which were sooner in women than in men, so that women showed greater pre-/during-pandemic shifts than men for bedtimes; a significant interaction was also found for week get-up time shift, that was more pronounced in women than in men.

In sum, the main differences before and during the pandemic in terms of sleep-wake schedules are occurring on weeknights, with later schedules, whereas on weekend nights schedules differences are low, and did not reach significance for risetime.

Variables related do sleep quantity/amount

Although the questionnaires did not ask directly for sleep amounts, we computed the approximate sleep periods based on the answers to bedtime and wake-up time questions, during the pandemic and before (retrospective estimation). Mean results are displayed in Table 4. Paired t-tests comparing the approximate sleep periods, during the pandemic and previously (considering the retrospective perception), revealed no significant differences during weeknights, but there were significant differences on weekend nights and when considering the 7 nights' week sleep period, so that higher means were found before the pandemic, albeit modest (on average, more 7 minutes/night for the whole week, and more 18 minutes/night during the weekend). Conversely, sleep restriction-extension patter was significantly reduced during the pandemic, comparing to previously (less 16 minutes, on average).

Table 4

Comparison of variables related to sleep quantity/amount between pre and during pandemic

		Pre-pandemic (retrospective)		Pandemic		*t*	*d.f.*	*p*	*d*
	n	M	SD	M	SD				
Sleep period, week (approximately)	1075	7:44	1:07	7:42	1:29	-0.95	1074	.340	0.02
Sleep period, weekend (approximately)	1074	8:24	1:21	8:06	1:31	-8.67	1073	.000	0.26
7-nighs sleep period (approximately)	1071	7:56	1:04	7:49	1:24	-3.34	1070	.001	0.10
Sleep-restriction-extension pattern (approximately)	1071	0:39	1:11	0:23	1:06	-7.42	1070	.000	0.23

Distributions of answers for frequency of *enough slee*p, and *naps,* during the pandemic, are displayed in Table 5.

Table 5

Frequency of enough sleep to feel well, and of naps

Enough sleep	**n**	**%**	**Naps**	**n**	**%**
Never [0]	0	0	Never / seldom	917	85.0
Rarely [1]	293	28.6	2-3 days per week	107	9.9
1-2 nights per week [2]	177	17.3	4-5 days per week	10	0.9
3-4 nights per week [3]	185	18.0	All or almost all days	45	4.2
Almost all or all nights [4]	**371**	**36.2**	*Total*	*1079*	*100.0*
Total	*1026*	*100.0*			
(Missing answers)	(53)				

More than a third of the sample, 36.2%, declared that they have been sleeping enough to feel well "almost all or all nights". On the contrary, 28.6% (over one quarter) of participants "rarely" slept enough. It is relevant to note that there were no participants answering "never" - see detailed response distribution in the left part of Table 5. Mean frequency of enough sleep was significantly higher in *men* (2.88, SD = 1.18), compared to *women* (M = 2.55, SD= 1.24), $t_{(309.2)} = 3.483$, $p = .001$. On the whole sample, the mean was 2.62 (SD = 1.24) – these values were somewhere between "1-2 nights a week" and "3-4 nights a week". There were no significant differences in the frequency of enough sleep by *educational level*, $F_{(2, 1025)} = 1.322$, $p = .267$ (albeit mean values suggest a subtle rise from basic to higher education).

As to *naps,* a total of 375 participants, 37.5% of the whole sample, have mentioned nap behaviors during the pandemic period (33.64% of the women, and 39.51% of the men) – see Table 5, right half. Regular napping, as defined by a frequency of a least two per week, was mentioned by 162 participants, i.e., 15.0% of the sample (vs. 85.0% "never" or "seldom" napped). Regular napping was reported by 13.84% of the women (121) and

20.0% of the men (41). Considering those who napped (n=375), nap mean duration was 54 min (SD = 36 min), and it did not differ significantly by *sex* (women, n=294, M= 55.12±37.41; men, n = 81, M = 48.01±31.32, $t_{(362)}$ = -1.499, *p*= .135). Maximum values were 240 min in women and 150 min in men (corresponding to 4h and 2hr30min). There were no significant differences in napping time by occupational state, that is, comparing students, professionally active and retired/unemployed ($F_{(2, 355)}$=0.10, *p*= .908).

Sleep quality, insomnia symptoms and severity, sleeping medication and problems

Mean values for ISI and BaSIQS are shown in Table 6. There were significant differences by *sex*, with women scoring higher than men in both scales.

Table 6

BaSIQS and ISI scores in whole sample (n=1079) and each sex

		Whole sample	Women	Men	$t_{(1077)}$	*p*	*d*
BaSIQS	M	12.68	13.08	10.96	-5.39	.000	0.42
	SD	5.14	5.11	4.92			
	N	1079	874	205			
	Min	1	1	2			
	Max	28	28	26			
ISI	M	9.88	10.27	8.20	-4.53	.000	0.35
	SD	5.94	5.87	5.94			
	N	1079	874	205			
	Min	0	0	0			
	Max	27	26	27			

The mean BaSIQS scores, both in the whole sample and each sex, corresponds to an “average to poor” sleep quality (Miller-Mendes et al., 2019). ISI mean scores correspond to the category “subclinical insomnia” (ISI total score from 8 to 14, cf. Clemente et al., 2021). There were statistically significant correlations between BaSIQS scores and *age*, so that higher age is associated with an increase in BaSIQS scores meaning poorer sleep quality. This correlation was moderate in men (*r*=.325) and small in women (*r*= .165).

The correlations between ISI scores and age were statistically significant in women but very low ($r < |0.1|$) to be considered relevant. More *years of education* were significantly associated with lower BaSIQS and ISI scores in women (in men, coefficients were near 0), i.e., fewer symptoms of insomnia or poor sleep quality. However, the associations were small ($r < .3$).

Next, it was examined the distribution of ISI scores considering four categories: no insomnia; subclinical insomnia symptoms; insomnia symptoms of moderate severity; severe insomnia symptoms (see Table 7). In the current sample, 24.1% of the participants obtained an ISI score suggestive of clinically significant symptoms of insomnia (21.6% moderate insomnia; 2.5% severe insomnia). As to sex distribution, there were more women in the category “moderate insomnia” (23.7%, vs. 12.7% men), whereas “severe insomnia” levels were similarly distributed in men (2.9%) and women (2.4%).

Table 7

Insomnia severity categories frequency distribution (n=1079)

ISI severity categories	**n**	**%**
“Absence of insomnia”	410	38.0
“Subclinical insomnia” symptoms	409	37.9
Insomnia symptoms – Moderate severity	233	**21.6**
Insomnia symptoms –Severe	27	**2.5**
Total	1079	100.0

As to *sleeping medication*, there was a significant rise during the pandemic regarding the mean frequency, from M = 0.53 ± 0.96 (before) to M = 0.66 ± 1.08 (paired samples $t_{(1078)} = 7.45$, $p= .000$). Retrospectively, 87.6% of participants estimated that they “never” or “occasionally” took medication before covid-19, whereas during the pandemic situation, the respective percentage is 81.6%; likewise, the percentages of those who took medication “sometimes”, “always or almost all nights”, rose from 12.5% (before the pandemic) to 18.4% (during the pandemic) - see Table 8.

Table 8

Frequency of medication to sleep, before and during the pandemic

Before pandemic	n	%	During pandemic	n	%
Never [0]	757	70.2	Never [0]	721	66.8
Occasionally [1]	188	17.4	Occasionally [1]	159	14.7
A few nights / week [2]	19	1.8	A few nights / week [2]	48	4.4
Almost all nights / Always [3]	115	10.7	Almost all nights / Always [3]	151	14.0
Total	*1079*	*100.0*	*Total*	*1079*	*100.0*

Sleeping medication was, on average, significantly higher in *women*, both before and during the pandemic context (M = 0.57 ± 0.98, and M= 0.70±1.09), in comparison to *men* (M = 0.35 ± 0.85, and M = 0.47 ± 0.98), $t_{(342.22)}$ = -3.22, p = .001, and $t_{(334.20)}$ = -2.91, p = .004, respectively – which seem consistent with women higher scores in insomnia symptoms and quality of sleep. However, the magnitude of the differences was low, both before (d=0.24) and during the pandemic context (d=0.22). There were also statistically significant differences in sleeping medication between the three *educational levels*, albeit of small magnitude, so that lower formal education is associated with more medication consumption, both before ($F_{(2, 1078)}$ = 8.02, p = .000, Eta^2 = 0.015) and during ($F_{(2, 1078)}$ = 9.55, p = .000, Eta^2 = 0.017) the pandemic. Across basic, secondary, and higher education groups, the mean frequency of sleeping medication usage was respectively 0.85, 0.73, and 0.47 before the pandemic, and 1.08, 0.89 e 0.58, during the pandemic.

In what concerns *self-reported sleep problems*, the majority of participants, 56.3%, did not report any sleep problem in the current pandemic context, whereas 43.7% answered affirmatively, and 39.1% have mentioned sleep problems before the pandemic context. When asked directly if the current sleep problem was present before the pandemic, 18.0%

of the participants answered “no”. As to *sex* differences, 45.2% of the women, against 37.1% of men, complaint of a current sleep problem, $\chi^2 = 4.45$, d.f. = 1, $p = .035$. The group declaring having current sleep problems is on average significantly *older* (M = 50.49 years-old, SD = 14.66) than the ones denying sleep problems (M = 42.04 years old, SD = 16.13), $t_{(1049.99)} = -8.98$, $p = .000$, and completed slightly but significantly less years of formal *education* (M = 14.46, SD = 2.44 vs. M = 15.07, SD = 2.30), $t_{(980.34)} = 4.22$, $p = .000$ – the distribution by the three educational groups was 40.9% in the higher education group, 55.1% in the secondary education group, and 48.7% in the basic education group ($\chi^2 = 12.94$, d.f. = 2, $p = .002$). As to sleep problem perception by the *occupational status*, 27.6% of the students consider having a sleep problem, against 44.04% of those professionally active, and 57% in the group of the retired/unemployed, and these differences were statistically significant, $\chi^2 = 26.57$, d.f. = 2, $p = .000$).

Perceived change of the sleep-wake patterns due to the pandemic

When asked if, and in what direction, sleep has changed with the pandemic situation, 45.7% of the participants considered their sleep was poorer now, 37.8% consider they were sleeping as usual, and 14.6% declared that now they were sleeping better. Examining the 37.8% declaring that their sleep remained unchanged, this group subdivides into 13.1% that declared a sleep problem currently or in the past, and 24.7% that declared not having any current/previous sleep problem (see Table 9).

Table 9

Perceived sleep changes

Sleep change with the pandemic context	n	%	**Age** M (SD) | Min-max	Women	Men
Poorer / much poorer	493	46.6	44.83 (15.14) | 18-85	50.3%	30.7%
The same (current / past sleep problems)	141	13.3	56.18 (13.17) | 18-86	12.7%	15.8%
The same (no current/past sleep problems)	267	25.2	45.65 (17.03) | 18-81	21.8%	39.6%
Better	158	14.9	39.29 (15.10) | 18-77	15.2%	13.9%
Total	*1059*	*100.0*	*45.72 (16.04) | 18-86*	*100.0%*	*100.0%*

Notes: % computed disregarding the inconclusive answers, given that for 1.6% of participants it was not clear whether the change was a positive or a negative one. No participant answered "much better".

According to ANOVA ($F_{(3, 1058)} = 31.46$, $p = .000$, followed by post-hoc tests), the group declaring better sleep with the pandemic showed a significantly younger mean age. On the contrary, the oldest group corresponds to those who considered that sleep remained unchanged with the pandemic, and have simultaneously declared any sleep problem (in the past, present, or both). The remaining two groups were in between, within similar mean ages, roughly 45 years old on average - the group declaring poorer sleep, and the group declaring to be sleeping the same way (without sleep problems in the present and/or in the past). The group experiencing poor sleep was composed of half (50.3%) of the women of the sample, and 30.7% of the men. Then, 34.5% of women and 55.4% of men have maintained their usual sleep patterns. In the group experiencing sleep improvement, there were 15% of the women and 14% of the men.

The *main sociodemographic features of each group* were as follows:

● The minority group experiencing *sleep improvements* was significantly younger, and showed a higher level of education (concluded a higher degree or is currently attending higher education); it represented 23.6% of the students (whereas lower percentages were found in the remaining occupational groups: 15.2% of those professionally active, and 4.9% of those non-professionally active), and 19.4% of those working or studying remotely (against 9.6% of those doing "face-to-face" work);

● The group who *maintained* their sleep as usual, and have mentioned any *sleep problem*, was the oldest one (see Table 9);

● The group who *maintained* their sleep as usual, and have *not* mentioned any sleep problem, comprised 33.3% of participants that remained in "face-to-face" work;

● Joining together those who *maintained* the same sleep-wake patterns, this subset represents 52.5% of the participants maintaining "face-to-face" work, and 72.0% of those working/studying remotely; it also encompasses 54.3% of the group not professionally active (contrasting to only 26.0% of the students, and 37.7% of those professionally active);

● The group mentioning *poorer sleep* comprised:

- half the women of the sample, 50.3% (in contrast with less than one-third of men);
- half of the students (50.0%) - even if this occupational group also displayed the highest percentage of those experiencing sleep improvements (see above), followed by 47.0% of those professionally active, and 40.7% of those not professionally active (retirement/unemployment/prolonged leave);
- about 56.9% of adults that currently had school children needing their supervision at home due to the pandemic;

- about 53.3% of those who were taking care of family members directly due to the pandemic context;
- 63% of those assuming caregiver roles at home unrelated to the covid-19 context (such as taking care of babies, toddlers, or someone with chronic disease);

    Note: These three latter percentages were somewhat conservative estimates, as we did not include mixed situations in the percentage's computation (e.g., those who have children at home and who are also caregivers);

- 21.3% of those maintaining "face-to-face" working, and only 8.6% of those in remote working/studying.

Those professionally active are distributed in a similar way by all groups of "sleep change". Those experiencing *sleep improvements* were composed in great part of people working or studying "at distance", 72.8% - but it should be recalled that, within the group working/studying remotely, those experiencing sleep improvements were still in minority, 19.4%.

Comparing the sleep patterns between the four groups of sleep change, the group reporting sleep improvements showed later sleep-wake schedules comparing to other groups. The higher sleep quality was displayed by the group reporting sleep as usual and that do not complain of sleep problems, followed by the group experiencing sleep improvements during the pandemic situation. Lower sleep quality was found in two groups: those reporting poorer sleep with the pandemic, and those who reported sleeping the same way and displaying any sleep problem.

Confinement and sleep patterns

Considering the 763 participants who have been in lockdown, we have computed Spearman correlation coefficients to examine the associations between days in lock down and sleep patterns. Significant associations emerged between days in confinement and total ISI score (r= .150, p= .000), total BaSIQS score (r= .089, p= .014), sleep restriction-extension pattern (r= -0.089, p= .014), sleep midpoint on weeknights (r= .077, p= .033), and frequency of enough sleep (r= -0.084, p= .023), albeit of low or very low magnitude. Thus, more days in confinement were associated with a slight increase in insomnia severity, a negligible decrease in sleep quality, and on the restriction-extension pattern, a negligible increase in the frequency of enough sleep, and a negligible delay in week' nights' sleep midpoint. As to the remaining sleep patterns, most coefficients were very low and not significant, p> 0.05 (week sleep period, r = .07; weekend sleep period, r= .004; weekend sleep midpoint, r= .048; sleeping medication, r = .054; nap frequency, r = .052; nap duration, r = .009 in the subgroup n =267 reporting 2 or more naps per week). There were two near significance correlations of very low magnitude, concerning global week sleep midpoint (r = .069, p= .057), and approximate sleep phase corrected / MSFsc (r = .070, p= .053), suggesting a negligible tendency for a delay, as days in confinement increased.

In sum, among those in confinement, the duration of lockdown seems basically unrelated to sleep patterns, being the main coefficient with the ISI still small in magnitude, indicating a discrete association between insomnia severity and days in confinement.

Then, comparing participants who have/have not been in confinement due to the pandemic (independent t-tests), there were no significant differences between the two groups, either on sleep quality variables (BaSIQS score, ISI score), or on sleep duration variables (sleep periods during the pandemic, frequency of enough sleep, sleep restriction-extension pattern). The only significant differences emerged for the sleeping medication (slightly more frequent in the non-confinement group), and sleep phase variables (sleep midpoints for weeknights, weekend nights, and the whole week, and MSFsc), translating significant later schedules in the lockdown group compared to participants who have not been in confinement. In sum, the sleep differences between participants that have experienced confinement and those who did not, were significant only for sleep-wake schedules variables (later in the formers), and for the sleeping medication (more frequent in the latter). No other relevant differences emerged (see Table 10).

Table 10

Comparison of sleep quality and sleep duration variables between participants who have/have not been in confinement

	Confined	N	Mean	SD	*t*	df	*p*	*d*
Total ISI	No	298	9.93	5.98	.17	1058	.868	0.00
	Yes	762	9.86	5.96				
Total BaSIQS	No	298	12.96	4.78	1.24	593.732	.215	0.01
	Yes	762	12.54	5.27				
~Sleep duration-week	No	296	7:38	1:33	-1.08	1056	.280	0.07
	Yes	762	7:44	1:28				
~Sleep duration-weekend	No	297	8:03	1:35	-.53	1057	.599	0.03
	Yes	762	8:06	1:30				
~Sleep duration-global week	No	296	7:45	1:28	-.98	1056	.330	0.07
	Yes	762	7:51	1:24				
~Restriction-Extension pattern	No	296	0:25	1:14	.73	1056	.464	0.04
	Yes	762	0:22	1:04				
~Sleep midpoint-week	No	296	27:35	1:15	-8.17	653.225	.000	0.54
	Yes	762	28:20	1:32				
~Sleep midpoint-weekend	No	297	28:15	1:21	-6.53	619.792	.000	0.43
	Yes	762	28:53	1:34				
~Sleep midpoint-global week	No	296	27:46	1:14	-7.94	651.991	.000	0.52
	Yes	762	28:29	1:30				
~MSFsc	No	296	28:06	1:23	-6.59	606.923	.000	0.44
	Yes	762	28:45	1:35				
Enough sleep to feel well	No	283	2.57	1.271	-.79	1006	.430	0.06
	Yes	725	2.64	1.222				
Naps frequency	No	298	.58	1.448	1.32	500.116	.188	0.09
	Yes	762	.46	1.318				
Naps duration	No	103	50.476	33.5868	-1.01	368	.315	0.01
	Yes	267	54.715	37.2762				
Medication to sleep	No	298	.85	1.187	3.33	478.490	.001	0.23
	Yes	762	.59	1.022				

Study 2 – Matched subsamples

*Sleep pattern*s related to sleep duration and schedules

Regarding possible changes in sleep-wake schedules, according to the year considered, there were statistically significant differences regarding *bedtime* on week and weekend nights, and *rise time* during the week, which all moved to later hours (see Table 11). In addition, week and weekend bedtimes appeared to be significantly different between the sexes. In line with what was already happening in 2017, in 2020 men continue to practice later bedtimes. No significant differences by year were found for weekend *rise time*.

In respect to *sleep midpoint*, there were statistically significant differences between the subsamples - during the week, and the seven days of week, these differences being associated with the year considered (see Table 11). In 2020 these sleep midpoints are located at a later hour than in 2017, and the same happened for both sexes (no statistically significant effects were found either for sex or for the interaction, $p>0.05$). However, no significant differences were found between 2017 and 2020 for sleep midpoint on weekends. Regarding the *corrected midpoint (MSFsc) between sleep onset and risetime on free days*, there were no significant differences between 2017 and 2020 (see Table 11), even though, the mean values suggested that MSFsc is located earlier in general. At sex level, both women and men show an earlier MSFsc, resulting in almost statistically significant differences. Concerning *social jet lag*, a statistically significant difference was found between the subsamples and between the sexes, but not in their interaction (see Table 11). When analyzing the year difference, it is possible to note that social jet lag decreased in 2020, compared to 2017.

Time in bed (TIB; approximation to sleep period) during the week, revealed to be different at a statistically significant level between 2017 and 2020, increasing about 30 minutes (see Table 12). At the *weekend*, TIB did not increase possibly due to an approximation of the estimated sleep durations during week and weekend nights. Similarly, the *restriction-extension* pattern also decreased in 2020, compared to 2017. Regarding the subjective perception of *getting enough sleep* (frequency in terms of nights a week), in 2020 women revealed sleeping on average a higher number of nights to feel good (3-4 nights a week), compared to 2017, in which they reported sleeping the needed amount of nights to feel good only "1-2 nights" a week, approximately.

Table 11

Comparison of sleep-wake schedules, approximate sleep midpoint, MSFsc and social jet lag between 2017 and 2020

			2017		2020		ANOVA	Summary		
			Mean	SD	Mean	SD		*F*	*p*	*Eta*^{2}
Bed-time	Week	Women	00:05	1:15	00:23	1:45	Year	4.19	**0.041**	0.005
		Men	00:25	1:19	00:41	1:54	Sex	5.14	**0.024**	0.006
		Total	00:09	1:16	00:26	1:47	Interaction	0.01	N.s.	0.000
	Weekend	Women	01:06	1:30	00:51	1:41	Year	1.19	N.s.	0.001
		Men	01:28	1:35	01:23	1:50	Sex	9.3	**0.002**	0.011
		Total	01:10	1:31	00:57	1:43	Interaction	0.30	N.s.	0.000
Rise-time	Week	Women	8:06	1:29	9:03	1:56	Year	33.40	**0.000**	0.039
		Men	7:52	1:15	8:44	2:16	Sex	3.09	N.s.	0.004
		Total	8:03	1:26	8:59	2:00	Interaction	0.08	N.s.	0.000
	Weekend	Women	10:01	1:39	9:59	1:46	Year	0.55	N.s.	0.001
		Men	10:08	1:41	9:57	2:16	Sex	0.07	N.s.	0.000
		Total	10:03	1:40	9:58	1:52	Interaction	0.20	N.s.	0.000
~Sleep midpoint	Week	Women	03:05	1:13	03:43	1:40	Year	19.36	<**0.01**	0.023
		Men	03:08	1:11	03:42	2:00	Sex	0.02	N.s.	0.000
		Total	03:06	1:13	03:43	1:44	Interaction	0.05	N.s.	0.00
	Weekend	Women	04:34	1:27	04:25	1:34	Year	0.79	N.s.	0.001
		Men	04:48	1:32	04:40	1:58	Sex	3.01	N.s.	0.004
		Total	04:36	1:28	04:28	1:38	Interaction	0.00	N.s.	0.000
	Global week	Women	03:30	1:12	03:55	1:36	Year	8.72	<**0.05**	0.011
		Men	03:37	1:09	03:59	1:56	Sex	0.41	N.s.	0.001
		Total	03:32	1:12	03:56	1:40	Interaction	0.02	N.s.	0.000
~MSFsc		Women	04:41	1:29	04:29	1:34	Year	2.42	N.s.	0.003
		Men	04:59	1:35	04:44	1:59	Sex	3.60	0.058	0.004
		Total	04:45	1:31	04:32	1:39	Interaction	0.01	N.s.	0.000
~Social Jet lag		Women	1:28	1:03	0:42	0:51	Year	66.03	<**0.01**	0.075
		Men	1:39	1:19	0:57	1:01	Sex	6.14	<**0.05**	0.007
		Total	1:30	1:06	0:44	0:53	Interaction	0.15	N.s.	0.000

Table 12

Comparison of duration, TIB, restriction-extension pattern and enough sleep amount to feel well between 2017 and 2020

			2017		2020		ANOVA		Summary	
			Mean	SD	Mean	SD		*F*	*p*	*Eta²*
TIB	**Week**	Women	8:00	1:13	8:39	1:32	Year	26.36	**0.000**	0.031
		Men	7:26	0:59	8:02	1:15	Sex	23.90	**0.000**	0.028
		Total	7:54	1:12	8:33	1:30	Interaction	0.05	N.s.	0.000
	Weekend	Women	8:55	1:13	9:07	1:28	Year	0.12	N.s.	0.000
		Men	8:39	1:09	8:33	1:15	Sex	11.60	**0.001**	0.014
		Total	8:52	1:13	9:00	1:27	Interaction	1.58	N.s.	0.002
	Global week	Women	8:16	1:03	8:47	1:23	Year	17.78	**<0.01**	0.021
		Men	7:47	0:50	8:11	1:10	Sex	24.90	**<0.01**	0.030
		Total	8:11	1:02	8:41	1:22	Interaction	0.3	N.s.	0.000
~Restriction-Extension		Women	0:54	1:21	0:26	1:20	Year	24.15	**0.000**	0.029
		Men	1:13	1:20	0:30	1:02	Sex	2.49	N.s.	0.003
		Total	0:58	1:21	0:27	1:17	Interaction	1.03	N.s.	0.001
Enough sleep		Women	2.46 ~1-2 nights/ week		2.66 ~3-4 nights/week		Year	2.47	N.s.	0.003
		Men	2.67 ~3-4 nights/week		2.81 ~3-4 nights/week		Sex	2.58	N.s.	0.003
		Total	2.5 ~3-4 nights/week		2.69 ~3-4 nights/week		Interaction	0.06	N.s.	0.000

BaSIQS

In the BaSIQS the total mean score was very identical in both subsamples, resulting in a non-significant difference (p>0.05). In 2020 the scores were slightly higher, which happens in both sexes. Women scored significantly higher than men, both in 2017 and 2020 (see Table 13). In an item-by-item analysis, only item 3 (night awakenings) and item 6.1 (perceived sleep quality) present statistically significant differences, with both items scoring higher in 2020 than in 2017, translating a greater number of night awakenings and a decrease in sleep quality (see Table 14). When analyzing the differences between sexes above specific cutoff point for each item, only difficulties regarding nocturnal awakenings (item 3) in women were statistically significant, increasing in 2020. Other results, although not statistically significant are worth mentioning: there was a great increase in difficulties in initiating sleep (item 2) and in sleep depth (item 6.2) for men, and both sexes showed a greater increase in early morning awakenings (see Table 15). The only decrease seen in 2020, compared to 2017, concerned night awakenings, which in men decreased from 24% to 22.7%, although not statistically significant (see Table 15).

Table 16 shows a categorical analysis of sleep quality, from 2017 and 2020. There was no statistically significant differences between 2017 and 2020, either considering the total sample ($\chi^2_{(3)}$= 2.334, p>0.05) or each sex (women $\chi^2_{(3)}$=3.273, p>0.05); men $\chi^2_{(3)}$=0.660, p>0.05). Even though not statistically relevant, results show a decrease in "good to average" and an increase in "poor/very poor" sleep quality in women and an increase of "good to average" in men (see Table 16).

Table 13

Comparison of mean results in BaSIQS total score between 2017 and 2020

	2017		2020		ANOVA Summary			
	Mean	SD	Mean	SD		*F*	*p*	*Eta square*
Women	11.42	4.915	11.98	5.052	Year of comparison	1.05	N.s.	0.001
Men	9.37	4.187	9.72	4.416	Sex	24.02	0.000	0.029
Total	11.05	4.851	11.57	5.014	Interaction	0.06	N.s.	0.000

Table 14

Comparison of mean/median results in BaSIQS items between 2017 and 2020

	2017		2020			
items BaSIQS	M	Md	M	Md	*Z*	*p*
Item 1	1.20	1	1.26	1	-0.301	N.s.
Item 2	1.77	2	1.88	2	-1.110	N.s
Item 3	1.09	1	1.2	1	-1.990	<0.05
Item 4	1.92	2	2.04	2	-1.453	N.s.
Item 5	1.68	2	1.6	1	-1.179	N.s.
Item 6.1	1.47	1	1.6	2	-2.437	<0.05
Item 6.2	1.94	2	1.98	2	-0.609	N.s.

Table 15

Comparison of BaSIQS items between 2017 and 2020: frequencies of complaints above cutoff-points, for each sex

	Sex	2017	2020	*Chi square*	*p*
Item 1- Sleep onset latency ≥30 min	Women	33.1%	33.4%	0.01	N.s.
	Men	18.7%	21.3%	0.17	N.s.
Item 2- Sleep onset difficulties ≥ 3 nights/week	Women	18.2%	21.8%	1.34	N.s.
	Men	9.3%	16%	1.51	N.s.
Item 3- Night awakenings ≥ 2 per night	Women	30.7%	41.5%	8.38	0.004
	Men	24%	22.7%	0.04	N.s.
Item 4- Early morning awakenings ≥ 3 nights/week	Women	21.5%	25.1%	1.20	N.s.
	Men	14.7%	18.7%	0.43	N.s.
Item 5- Early/night awakenings are a problem ("quite a bit"/ "extremely")	Women	21.5%	22.1%	0.04	N.s.
	Men	9.3%	9.3%	0.00	N.s.
Item 6.1- Sleep quality "poor"/ "very poor"	Women	12.8%	14.6%	0.45	N.s.
	Men	10.7%	14.7%	0.54	N.s.
Item 6.2- Sleep depth "light"/ "very-light"	Women	31.9%	32.8%	0.06	N.s.
	Men	14.7%	25.3%	2.67	N.s.

Table 16

Comparison of sleep quality categories between 2017 and 2020 in %

	2017			2020		
	Women	Men	Total subsample	Women	Men	Total subsample
Good/Very good	18.8	25.3	20.0	18.5	25.3	19.8
Good to Average	29.6	21.3	28.0	26.3	26.7	26.3
Average to Poor	22.7	30.7	24.1	20.0	28.0	21.5
Poor/Very poor	29.0	22.7	27.8	35.2	20.0	32.4
Total	100.0	100.0	100.0	100.0	100.0	100.0

ISI

In the ISI, significant differences were found between the two subsamples ($t_{(809.648)}$= -2.022, p<0.05), pointing to higher values of insomnia symptoms severity in 2020 (9.09±5.75), compared to 2017 (8.32±5.19) (see Table 17). Factorial ANOVA by sex and year showed significant differences by sex only, whereas year effect and year*sex interaction effect were not significant. When evaluating differences in insomnia complaints between the sexes, it was found that women obtained higher scores than men, both in 2017 and 2020. The mean values plot suggests that most accentuated increase in ISI scores from 2017 to 2020 was in men. However, this interaction sex*year did not reach statistical significance.

Analyzing the ISI differences item by item, the mean values appear to be higher in 2020 than in 2017, but the only statistically significant difference was in item 1.1 (U=76601, p<0.05) with greater time to fall asleep in 2020 compared to 2017 (see Table 18). This apparent increase in scores observed in 2020 seems reflected in the statistically significant differences found in the distribution of ISI categories ($\chi^2_{(3)}$=10.431, p<0.05). There was a decrease in the percentage of individuals with "absence of insomnia" and with complaints of "subclinical insomnia" (at risk of insomnia), and conversely an increase in "moderate" and "severe insomnia", in both sexes (see Table 19). Examining these categories, for each sex, only women show statistically significant differences ($\chi^2_{(3)}$=7.799, p=0.05) with an accentuated decrease of "subclinical insomnia" complaints and an increase of "moderate insomnia". Men revealed a marked decrease in the "absence of insomnia" category and small increases in all the other categories, which, however these did not prove to be statistically significant ($\chi^2_{(3)}$=5.612, p>0.05).

Table 17

Comparison of results in ISI total mean scores between 2017 and 2020

	2017		2020		ANOVA	Summary		
	Mean	SD	Mean	SD		*F*	*p*	*Eta square*
Women	8.62	5.311	9.30	5.714	Year of comparison	3.59	N.s.	0.004
Men	6.96	4.391	8.15	5.840	Sex	8.20	0.004	0.010
Total	8.32	5.191	9.09	5.747	Interaction	0.26	N.s.	0.000

Table 18

Comparison of ISI items between 2017 and 2020

	2017		2020			
Items ISI	M	Md	M	Md	*Z*	*p*
Item 1.1	0.93	1	1.10	1	-2.316	<0.05
Item 1.2	0.77	0	0.93	1	-1.897	N.s.
Item 1.3	0.82	1	0.90	1	-0.971	N.s.
Item 2	1.97	2	2.08	2	-1.658	N.s.
Item 3	1.76	2	1.83	2	-0.517	N.s.
Item 4	0.97	1	1.01	1	-0.127	N.s.

Table 19

Distribution differences between 2017 and 2020 on the severity levels of insomnia in %

	2017			2020		
Severity levels of insomnia	Women	Men	Total subsample	Women	Men	Total subsample
Absence of insomnia	43.9	64.0	47.6	44.2	50.7	45.5
Subclinical insomnia complaints	43.6	32.0	41.5	36.4	36.0	36.3
Moderate insomnia	11.9	4.0	10.5	17.6	10.7	16.3
Severe insomnia	0.6	0.0	0.5	1.8	2.7	2.0
Total	100.0	100.0	100.0	100.0	100.0	100.0

Discussion

The present research aimed to examined sleep-wake patterns in the context of the first wave of the COVID-19 pandemic in Portugal, more exactly sleep duration, schedules, sleep quality or symptoms of insomnia, and related sleep aspects (e.g., naps, sleeping medication), by collecting a large sample of adult participants from all regions of the country, both sexes, a variety of ages, education levels, occupational state, and professions. In addition to examining sleep-wake patterns and perceived changes in a large number of participants during the pandemic (the 1st study of the current work), it was also possible to compare current data with data collected in a previous sleep study in 2017 using a similar methodology (2nd study of the current work). The possibility of comparing independent but matched samples inquired in 2017 (before the pandemic) and 2020 (during the pandemic) constitutes an asset given that we can obtain more precise estimates about the possible sleep changes associated with the pandemic context.

Previous work has studied the effects of the pandemic on sleep, but few included a comparison sample from a pre-pandemic context (e.g., Gao & Scullin, 2020). In this manner, in this work, we considered a sample with participants of a variety of sociodemographic characteristics and contexts, and compared it with an equivalent sample collected in 2017 that evaluated the same variables under study, by extracting matched subsamples from each study.

Concerning *sleep duration-related* variables, study 1 suggests a slight reduction of sleep periods on weekends, whereas study 2, which compares 2017 and 2020 similar participants, indicates that TIB increases during the week in both sexes. Even so, participants continue to sleep more on the weekend than on the week, despite this difference having decreased compared to 2017 (lower sleep restriction-extension pattern).

In addition to these changes, the *schedules* practiced by individuals also suffered alterations, being located at later hours during the week, getting close to those practiced during the weekend both in 2017 and 2020, and both during pandemic and retrospectively. Thus, as expected, the social jet lag has been diminished. When comparing who was or was not confined, the differences are not found in sleep duration, but in the sleep midpoint. Thus, those who were confined demonstrate a delay in their sleep-wake schedules. All these changes can probably be explained by the fact that most individuals find themselves in remote work/distance learning and therefore do not have to spend time commuting, and may take advantage of this saved time to stay more time in bed during the week. Therefore, by reducing sleep restriction during the week, the individuals do not feel the need to compensate for the lack of sleep on the weekend. The possibility of making working hours more flexible also may influence sleep patterns, by probably allowing some people to adapt their sleep schedules to better fit their personal preferences, thus softening the rigidity of socially prescribed schedules. Probably because of these reasons, there seem to be a positive change from the pre- to the pandemic times in the frequency of enough sleep. Still, this flexibility of schedules may have caused some people to experience an excessive delay in their schedule, which may have been felt negatively (Robbilard et al., 2020).

Although study 1 suggests the symptoms of insomnia have increased and the sleep quality has decreased, study 2 show that very few differences reach statistical significance. The data showed a slight trend towards increased symptoms (in particular, difficulties in falling asleep and staying asleep- waking up during the night) and decreased quality of sleep, compared to 2017. These few differences might be relevant from a clinical point of view: since there is a positive association between symptoms of initial insomnia and anxiety symptoms (e.g., Bragantini et al., 2019), difficulties in falling asleep may be related to feelings of anxiety probably present, not to mention the stress that the entire pandemic context entails (Salari et al., 2020). However, the total scores of sleep quality (BaSIQS) and insomnia severity (ISI) appear to be similar in 2017 and 2020. Regarding sex differences, as expected, women report more sleep complaints and lower sleep quality, both in 2017 and 2020, which may explain the fact that women are also the ones with the highest levels of sleep medication intake.

When analyzing the levels of insomnia severity, we found that a decrease in the percentage of individuals without insomnia or with complaints of subclinical insomnia, and a parallel increase in moderate and severe insomnia. These results seem to indicate a slight increase in new cases of insomnia. These values may be explained by the different factors involved in sleep regulation. A possible explanation is related to the context of remote work/distance learning and greater freedom to choose times, not only for sleep, but also for habits and routines. While, on the one hand, this greater freedom may have had a beneficial effect, allowing a readjustment of schedules to the endogenous preferences of the individuals (with positive consequences on sleep, in terms of quality and quantity), which, in a way, may have compensated for the effect of stress and anxiety only natural in the context in question; on the other hand, in people at risk for the development of insomnia, this same factor may have contributed to the increase of inappropriate sleep behaviors and habits (e.g. naps, excessive time in bed) which, combined with the psychological factors already mentioned, may have enhanced the development or aggravation of already existing but subclinical complaints of insomnia, as seems to be the case of the two ISI categories that showed the greatest changes- groups of “subclinical insomnia” and of “moderate insomnia”.

These results show that there was only a small worsening of insomnia complaints and sleep quality during the COVID-19 pandemic period. It would be expected that, given the social context, the changes observed and the worsening of mental health, the impact of the pandemic on sleep would be more accentuated. Our results can be probably explained by the positive effect of teleworking on participants sleep patterns. The context lived had an impact on mental health, especially increasing stress and anxiety, and lead to a more sedentary lifestyle (Sang et al., 2020). Greater restrictions on access to sunlight, physical exercise and social interaction, might have harmful effects on sleep and can precipitate or aggravate insomnia complaints (Walker, 2018). However, working at home allowed the population to eventually reduce commuting time and better adapt their sleep schedule to their own pace and inner clock. Since social hours may not coincide with the natural rhythm of some people - which is evident in the social jet lag and in the restriction-extension pattern reflecting a need for weekend sleep compensation - this adjustment of sleep schedules due to pandemic may have functioned as a protective factor against the development or aggravation of insomnia complaints. Thus, it is likely that the negative effect of stress and anxiety in the context experienced would be to some extent offset by sleep patterns more adjusted to the circadian rhythm.

The results of this research have an added value in relation to others published on the same topic. While most of the published studies on the effects of the COVID-19 pandemic on sleep only show results associated with subjective perception of the time before and the time after (e.g., Idrissi et al., 2020; Pieh et al., 2020), this study presents a comparison with a baseline three years before the pandemic context. Results referring to a retrospective perception, especially when dealing with an emotionally charged context, can lead to biases in the responses. In this sense, as in the present study, Gao and Scullin (2020) used a baseline sample collected at a time before the COVID-19 pandemic, revealing results very similar to those of study 2. These authors state that if there were no previous data, they would wrongly assume that sleep worsened during the pandemic. In addition to the bias that naturally occurs in retrospective analysis, the authors also highlight the idea that there is an increased tendency for negative responses when subjects are inquired in a context of stress, as is in the context under research. Thus, it is possible to understand the discrepancy between the values presented by study 1, in which sleep impairment proved to be more marked, and those resulting from study 2, which revealed that the alterations are mild. In this way, the fact that, for example, many people report that theirs sleep has worsened but there are no significant changes using standardized instruments when comparing mean sleep quality and insomnia severity between 2017 and 2020, can be linked to this natural bias. By evaluating their sleep changes in a subjective way, people can do so as they feel at the moment. Thus, if they feel, for example, higher levels of stress and anxiety, they may also consider an impairment in their sleep that objectively did not occur.

Thus, although the COVID-19 pandemic represents a risk factor for the development or worsening of insomnia complaints and that it has had some effect on the Portuguese population's sleep, this negative effect does not seem to have been as significant as it would have been expected and how people subjectively perceived it.

Although a more serious scenario was expected, the increased prevalence of clinically significant insomnia symptoms suggested by the ISI score should not be underestimated. Considering the "moderate insomnia" and "severe insomnia" categories as assessed by ISI, in 2017 the prevalence of clinical insomnia symptoms was 11% (a value that is close to that which is generally pointed out for the prevalence of insomnia disorder, cf. American Psychiatric Association, 2013), whereas in 2020 the same prevalence rises to 18.3%. Due to insomnia consequences in individual functioning, mainly at the emotional and cognitive level (cf. Marques et al., 2016), it is important to consider the recommended treatment for insomnia - Cognitive Behavioral Therapy for Insomnia (CBT-I). CBT-I is a scientifically and clinically evidenced approach to the treatment of Insomnia Disorder in the short and long term, being the first treatment that should be offered to insomnia patients (Marques et al., 2016; Morin et al., 2017; Rienmann et al., 2017).

Among the strengths of this research, are the large sample size and its variety in what concerns regions of the country (relatively proportional), ages, and professions (although with an unequal representation). Also, a large number of people working/studing remotely was considered, which allowed for a better understanding of sleep patterns in this context. It is relevant to point out the use of instruments and measures that are properly validated for the Portuguese population. Furthermore, it is worth mentioning the possibility of comparing identical subsamples in terms of sex, age, education level, occupation state and region of residence, on pre-pandemic (2017) and another during pandemic context (2020).

Although interesting results were found, this study has some limitations. Regarding the sample, even though we collected a large sample from all regions of the country, males are underrepresented, as well as participants with an education level below higher education. Data collection took place in a period in which deconfinement had already began, so some data obtained may not match what happened precisely in the period when Portuguese people were confined at home. Although having two equivalent subsamples before (2017) and during (2020) the pandemic context is a strength of this research, they were not collected at the same time of year, showing differences in season, and therefore in light/dark hours, and in the winter *versus* summer clock times. These differences can influence the patterns, times and durations of sleep. Another limitation is the method of data collection, as online questionnaires are not accessible to everyone. In addition, respondents to this type of questionnaire are possibly the ones who experience more difficulties in sleeping. These reasons may lead to overestimated results of sleep difficulties and problems.

In respect to the variables studied, although the research is very complete in terms of sociodemographic information, confinement circumstances and sleep, it does not assess relevant aspects such as other type of psychological symptomatology (e.g., anxiety, depression and levels of stress) and other sleep problems (e.g., Obstructive Sleep Apnea). Although evaluating these aspects would yield relevant information, they were not considered in order to not make the investigation protocol too extensive. Lastly, lifestyle variables such as, exercise and nutrition, which can influence sleep were not controlled.

In future studies, it would be interesting to understand the evolution of sleep complaints, sleep quality and sleep patterns of individuals throughout the pandemic period, and the probable changes inherent to each wave.

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