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Original Article

The endless quarantine: the impact of the COVID-19 outbreak on healthcare workers after three months of mandatory social isolation in Argentina

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A R T I C L E I N F O

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A B S T R A C T

Objectives: At the end of 2019 the SARS-CoV-2 outbreak spread around the globe with a late arrival to South America. The objective of this study was to evaluate the impact of the long period of mandatory social isolation that took place in Argentina on the general psychological well-being of healthcare workers due to the COVID-19 pandemic.
Methods: A survey was conducted during June 2020, in healthcare workers. Pittsburgh Sleep Quality Index, Insomnia Severity Index, Sleepiness-Wakefulness Inability and Fatigue Test, and Goldberg depression and anxiety scale, were used to analyze the effects of the SARS-Cov 2 outbreak after three months of mandatory social isolation. Analyses were performed by logistic regression and a clustering algorithm in order to classify subjects in the function of their outcome's severity.
Results: From 1059 surveys, the majority reported symptoms of depression (81.0%), anxiety (76.5%), poor sleep quality (84.7%), and insomnia (73.7%) with 58.9% suffering from nightmares. Logistic regression showed that being in contact with COVID-19 patients, age, gender and the consumption of sleep medication during the mandatory social isolation were relevant predictors for insomnia, anxiety, and depression. Clustering analysis classified healthcare workers in three groups with healthy/mild, moderate, and severe outcomes. The most vulnerable group was composed mainly of younger people, female, non-medical staff, or physicians in training.
Conclusion: An extremely high proportion of Argentinian healthcare workers suffered from sleep problems, anxiety, and depression symptoms. The clustering algorithm successfully separates vulnerable from non-vulnerable populations suggesting the need to carry out future studies involving resilience and vulnerability factors.

1. Introduction

By the end of 2019, in Wuhan, China, the outbreak of COVID-19 emerged, and rapidly spread throughout the entire globe. On March 3rd 2020, the first case of COVID-19 was reported in Argentina and increased to a total of 31 positive patients by March 31st when the president of the nation declared mandatory social isolation (MSI) which included closing borders and suspending any type of activity that was not considered essential. After 90 days of isolation, by the end of june there were about 2000 new cases of COVID-19 per day, rising to a total of 64.530 positive cases with an occupation of 50% of the intensive care beds in the country and 55% in Buenos Aires [1]. At the end of July, the number of cases increased dramatically, being circa 6000 new cases per day. As is well known, in addition to the respiratory complications generated by the viral infection, there is cumulative evidence of the psychological consequences of living in social isolation. It is remarkable the increase of anxiety and depression observed in the general population [2–4], as well as in healthcare professionals who must face the risk of infection on a daily basis [5]. In May, the Argentinian government reported that healthcare professionals represented 16.7% of the infected population in the country [6]. Moreover, the strenuous work in healthcare facilities during a pandemic added to the permanent attention to the correct application of the strict protocols to avoid the propagation of the virus could boost the levels of anxiety and depression. Anxiety

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and depression are closely related to the generation of some sleep disorders such as insomnia and nightmares, among others. In addition, the change in routine and confinement, associated with less exposure to sunlight could induce alterations in circadian rhythms [7].

A study published in 2018 estimates prevalence in USA healthcare workers of 40.9% of sleep disorders, 20% insomnia, 11% depression, and 17% anxiety [8]. However, during the COVID-19 outbreak higher values were reported in New York City [9]. Additionally, authors from China [5], Spain [10], and Italy [11] reported insomnia in 36%, 28,9% and 8.27% respectively in their countries during the outbreak. It is well known that sleep is essential for proper daily functioning and it is indispensable for the adequate functioning of the brain [12]. In addition, there is evidence that the presence of sleep disorders, anxiety, and depression is associated with medical errors and accidents [8]. Sleep is involved in learning, decision making, and is fundamental for adequate mental functioning, which is imperative for those activities that require to make relevant decisions for people's lives.

There is a lack of studies on the prevalence of psychological distress and sleep disorders in Argentina, especially in selected groups. Nevertheless, recently published studies establish that 48.8% (n = 30,269) of the general population in Argentina report a worsening of their sleep in the COVID-19 period [13].

To our knowledge, all published surveys that have been conducted to assess the presence of anxiety and depression and their impact on sleep were carried out within a month or month and a half of the onset of social Isolation [2–5,10,11]. Since the MSI in Argentina has been one of the longest in the world, we undertook the survey in healthcare workers three months after the beginning. The results of our study will allow us to evaluate the need for interventions to mitigate sleep alterations and psychological symptoms related to anxiety and depression in our population of health workers.

2. Methods

2.1. Study design and participants

An anonymous, voluntary web-based cross-sectional survey distributed through social media and email to healthcare workers (nurses, physicians, administrative staff, physicians in trainee, technicians, security personnel, nutritionists, kinesiologists, psychologists, etc) was collected from June 5 to June 25, 2020. All subjects reported demographic and social data, COVID-19 related information, and completed standardized questionnaires to evaluate the presence of generalized anxiety disorder, depressive symptoms, and sleep quality. The questionnaire was set to proceed only when each option was completed before the final submission.

2.2. Ethical statement

This study was conducted in accordance with the Declaration of Helsinki, and was approved by the Ethics Committee of "Centro de Educación Médica e Investigaciones Clínicas "*Norberto* Quirno" (*CEMIC*) in Buenos Aires, Argentina. Prior to starting the questionnaire, the objectives of the study were explained. Participants could withdraw from the survey at any moment without providing any justification.

2.3. Measurement tools

2.3.1. Sleep quality

a. The Spanish version of the PSQI (Pittsburgh Sleep Quality Index) [14,15]

This is a 24 items scale that is divided into seven subcomponents (subjective sleep quality, sleep duration, sleep latency, habitual sleep efficiency, use of sleep medications, sleep disturbance, and daytime dysfunction). The score for each subcomponent ranges from 0 to 3 points. The global PSQI score ranges from 0 to 21, with higher scores indicating more severe sleep disorder. Scores of five or less were considered good sleepers while a score greater than five categorizes participants as bad sleepers. A scale of 5–7 was considered mild insomnia, a scale of 8–14 implied moderate insomnia, and a scale of 14–21 suggested severe sleep disturbance.

b. The Spanish version of the Insomnia severity index (ISI) [16]

This is a seven items scale, that targets the severity of sleep onset difficulties, sleep maintenance difficulties, and early morning awakening; satisfaction with current sleep; interference with daily functioning; noticeability of impairment attributed to the sleep problem, and degree of distress or concern caused by the sleep problem. The score for each component ranged from 0 to 4. The global score ranged from 0 to 28. A total score below seven indicates the absence of insomnia, 8–14: mild insomnia, 15–21: moderated insomnia, 22–28 severe insomnia.

c. To evaluate the REM sleep behavior disorder, we chose three questions(number 1, 5 and 6) from the Innsbruck RBD inventory [17] that we considered being the most representative of the classic clinical symptoms of this disorder.

2.3.2. Fatigue and sleepiness

2.3.2.1. Sleepiness-Wakefulness Inability and Fatigue Test (SWIFT) [18]. This is a 12-item questionnaire. Divided into two subscales: subscale A has six questions related to the difficulty staying awake and subscale B has six questions related to fatigue, answers labeled as "not at all", "just a little", "pretty much" and "very much" corresponded to a score between 0 and 3.The global score ranges from 0 to 36. The cutoff is > 12 for SWIFT, in young adults (ages 18–45 years), and with cutoffs of >9 for SWIFT, in middle-aged to older adults (age > 45 years).

2.3.3. Anxiety and depression

2.3.3.1. Spanish version of Goldberg depression and anxiety scale (GADS) [19–21]. This is an 18 item-questionnaire with two nine-questions subscales: anxiety and depression. The fourth initial questions of each subscale were conditioning questions. From these, at least two affirmative answers were required for anxiety to continue the subscale, while for depression, only one positive answer was needed. The cut-off points are four or more for the anxiety subscale and two or more for the depression subscale, being more severe the higher the score.

2.4. Data analysis

2.4.1. Logistic regression

The prevalence of low sleep quality (Pittsburgh), Insomnia (ISI), Anxiety, and depression (Goldberg Scale), were reported, and logistic regressions were performed to explore the influence of demographic factors, age, the role of workers in the healthcare system (physician, resident, nurse, administrative worker, etc), whether if there was an increase in frequency for taking sleep medication, and degree of contact with COVID-19 patients in determining risk for sleep quality. For the logistic regression, scores cutoff were taken into account. Logistic regressions and Analysis of Variance (ANOVAs) were done using the R language. P-values of less than 0.05 were considered statistically significant.

2.4.2. Clustering analysis

Sleep quality, fatigue, anxiety, and depression scores were processed using clustering analysis through Principal Component Analysis (PCA) and K-means clustering algorithm [22] which is usually employed for pattern recognition [23,24]. The number of clusters was estimated graphically by the Elbow method [25]. For the analysis, 49 surveys were removed due to inconsistencies in the Pittsburg test (N = 1010). PC components were computed after data reduction where each test outcome was normalized between 0 and 1. The normalization was done to avoid artifacts in the K-means algorithm since the technique measures the distance between each point inside the cluster with respect to its centroid. Analysis of variances (ANOVAs) were performed to cross-check the differences between the obtained clusters. Clustering analysis was performed using the scikit-learn library implemented in Python 3.7 [26].

3. Results

A total of 1095 questionnaires were obtained. Consecutively surveys that have equal entries were assumed to be duplicate responses and were therefore eliminated. This left a total of 1059 surveys.

3.1. Demographic characteristics

The demographic characteristics of participants are shown in Table S1. From 1059 surveys only 49 (4,5%) professionals were not currently working at the time of filling out the questionnaire. Of the samples analyzed, 770 (72.7%) were females, 287 (27.1%) were males, and 2 (0.2%) non-binary. The mean (standard deviation, std) age of the participants was 41.7 (10.7) years within a range of 21–70 where 103 (9.7%) were less than 30, 428 (40.4%) between 30 and 40, 261 (24.7%) between 40 and 50, 182 (17.2%) between 50 and 60 and 80 (8.0%) above 60 years old by the time of the survey. Among these samples, most people work in AMBA (Buenos Aires city and surrounding municipalities): 871 (82.2%) and Buenos Aires province (outside AMBA) 60 (5.7%), while the rest were distributed across 15 provinces (Table S1). As for the living situation, 436 (41.2%) live with other adults, 196 (18.5%) live alone, 160 (15.1%) with children over 10 years old, 148 (14.1%) with children between 4 and 10 years old and 118 (11.1%) with children under four years old.

All participants were healthcare workers where the larger group was composed by physician 583 (55.1%) or physician in trainee: 121 (11.4%). The rest worked as nurses 79 (7.5%), technician, phlebotomist 50 (4.7%), administrative staff: 85 (8.0%), security personnel: 1 (0.1%), other 140 (13.2%) which were composed by kinesiologists, nutritionists, speech therapists, psychologists, etc. More than half of the sample, 690 (65.2%), worked in contact with COVID-19 patients, but only 19 (1.8%) reported getting COVID-19 at the time of the questionnaire. Regarding the workplace, 328 (31.0%) worked in the public sector, 425 (40.1%), in the private sector while 306 (28.9%) in both. Interestingly, only 100 (9.4%) professionals used to take sleep medication before the outbreak, this proportion drastically increased up to 34.2% (361) during social isolation. 18% of the participants referred to sleep's unsatisfaction before MSI which increased to 46% during the MSI.

3.2. Survey general description

Table 1 shows the score outcomes for 1059 surveys except for the Pittsburgh score (N = 1010) due to inconsistencies in the bedtime/wake up hours. This problem arises from a wrong “AM/PM” filling. Thus, 39 surveys were eliminated from this test. Most of the responses referred to depression (81%), anxiety (76.5%), poor sleep quality (84.7%), and insomnia (73.7%) where most of the surveys with poor sleep quality and insomnia showed mild and moderate outcomes. However, only 230 (21.7%) referred to fatigue/wakefulness problems obtained from the SWIFT score. Nevertheless, by splitting SWIFT in two, fatigue (9 questions) was more significant in the total score than wakefulness (nine questions) (Table 1). From the Innsbruck's selected questions, 58.9.% referred to suffering nightmares or violent dreams. Moreover, 3.4% of the subjects referred to injure their bed partner and only 1.2% fell out of bed.

Logistic regressions (LG) were done overall surveys taking the cut-off points described in methods for Pittsburgh, SWIFT, ISI, and GADS scores with demographic aspects, age, contact with COVID-19 patients, and the use of sleep medication as predictors. This allows us to analyze which variables had an impact on the score outcomes (p-value < 0.05). Predictors association was analyzed using Cramér's V coefficient [27] (Table S2) which is derived from the χ^2 Pearson statistics. The variables showed low association where the largest one, as expected, was the association between the consumption of sleep medication before and during MSI with a coefficient of 0.42 because the first population was fully included in the second one (0 means unassociated and one fully associated). Moreover, age was compared with the categorical variables using the Mann Whitney and Kruskal–Wallis test (Table S3). In the last case, the low p-values may suggest not-equal distribution among different cohorts. LR results (Table 2) were used to identify relevant parameters rather than to model outcomes. From this analysis the most relevant predictors, with significant p-values<0.05, in at least four scores, were the Contact with COVID-19 patients, the consumption of sleep medication during the MSI, and the gender. Moreover, age was a relevant predictor for ISI and GADS scores. There was no difference between workers from AMBA vs the rest of the country except for the SWIFT score. However, 80% of the participants lived in AMBA by the time of the survey, which resulted in a limitation of the present study. Healthcare workers living alone showed more depression and insomnia than those who lived with other adults while those who lived with young children showed to be significant for both depression and anxiety scores. Finally, working in a public sector was a predictor for insomnia (ISI) but there was no significance in the other scores. A deeper insight into the relationships of these variables is obtained from the clustering analysis.

Regarding the time spent in bed, it was seen, on average, a slight reduction in comparison with pre-pandemic and bedtime shifts to later hours, moreover, the bedtime and wake up time were more spread during the MSI as it is shown in Table 3 and Fig. 1. These results were restricted to night sleepers (915 over 1059).

3.3. Clustering analysis

In order to obtain a detailed description of the results, a clustering analysis was done to classified healthcare workers by their score results. Fig. 2 shows the two principal components (PC) obtained from PCA. The number of clusters was three, estimated by the Elbow graphical method, and are represented in different colors in the plot.

Table 1
Scores outcomes over a total of N = 1059 subjects, except for Pittsburgh N = 1010 subjects.

		Pittsburgh N (%)	ISI N (%)	SWIFT N (%)	GADS Depression N (%)	GADS Anxiety N (%)
Healthy	yes	155 (15.3)	279 (26.3)	829 (78.3)	201 (19.0)	249 (23.5)
	no	855 (84.7)	780 (73.7)	230 (21.7)	858 (81.0)	810 (76.5)
scale	mild	246 (24.4)	432 (40.8)	–	–	–
	moderate	519 (51.4)	291 (27.5)	–	–	–
	severe	90 (8.9)	57 (5.4)	–	–	–

Table 2
Logistic regression results from the five scores employed with different predictors. (p-values, Odd Ratio (OR) and Confidence interval (CI: $CI_{2.5\%}$-$CI_{97.5\%}$) are informed). p-values< 0.05 are in bold.

		Pittsburgh	SWIFT	ISI	GADS Anxiety	GADS Depression
Working Place	p-value	0.061	**0.01**	0.318	0.73	0.95
(AMBA vs rest of the country)	OR	6.31	**3.94**	2.88	3.29	4.28
	CI	4.19–9.53	**2.76–5.64**	2.03–4.09	2.28–4.75	2.86–6.39
Lives with:	p-value	0.155	0.238	**0.013**	0.35	**0.009**
with adults >10 vs Alone	OR	0.73	0.80	**1.63**	1.20	**1.81**
	CI	0.47–1.14	0.55–1.17	**1.11–2.43**	0.83–1.76	**1.17–2.89**
Lives with:	p-value	0.705	0.92	0.077	**<0.001**	**0.012**
with adults >10 vs with childrens <10	OR	0.92	1.02	1.35	**1.90**	**1.64**
	CI	0.61–1.41	0.72–1.46	0.97–1.89	**1.32–2.79**	**1.12–2.44**
Work sector	p-value	0.102	0.06	**0.009**	0.216	0.73
Private vs public	OR	1.44	0.71	**1.56**	1.25	1.07
	CI	0.94–2.24	0.50–1.01	**1.12–2.19**	0.88–1.77	0.73–1.56
Role within the healthcare environment:	p-value	**0.034**	**0.04**	0.414	0.82	0.085
physician vs other roles	OR	**4.87**	**3.24**	2.68	3.22	3.89
	CI	**3.09–7.166**	**2.35–4.47**	2.00–3.60	2.37–4.35	2.77–5.54
Contact with COVID-19 patients	p-value	0.15	**0.001**	**0.044**	**<0.001**	**0.02**
	OR	6.08	**3.03**	**3.11**	**4.27**	**4.88**
	CI	4.29–8.63	**2.19–4.21**	**2.35–4.12**	**3.19–5.7**	**3.58–6.71**
Sleep medication previous MSI	p-value	**0.003**	0.94	**0.008**	0.34	0.79
	OR	**92.0**	3.54	**5.67**	4.00	4.55
	CI	**12.7–665**	2.15–5.83	**3.21–9.99**	2.40–6.67	2.67–7.78
Sleep medication during MSI	p-value	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**
	OR	**67.00**	**2.34**	**7.80**	**7.39**	**9.61**
	CI	**27.2–165**	**1.74–3.16**	**5.44–11.20**	**5.17–10.57**	**5.49–14.2**
Gender	p-value	**0.009**	0.118	**<0.001**	**<0.001**	**<0.01**
	OR	**6.4**	3.36	**4.31**	**4.11**	**5.22**
	CI	**4.46–9.20**	2.38–4.74	**2.54–4.58**	**3.04–5.56**	**3.78–7.23**
Age	p-value	0.67	0.336	**<0.001**	**<0.001**	**<0.001**
	OR	1.00	1.00	**0.97**	**0.95**	**0.95**
	CI	0.99–1.02	0.99–1.02	**0.96–0.98**	**0.94–0.97**	**0.94–0.97**

Table 3
Bed and wake up time hours pre and during the COVID-19 pandemic restricted to night sleepers (N = 915).

	Sleeping time (pre-MSI)	wake up time (pre-MSI)	Difference (hours)	Sleeping time (MSI)	wake up time (MSI)	Difference (hours)
mean	23:40	6:50	7.50	00:15	7:40	7.4
median	23:30	6:45	7.25	00:00	6:45	6.75
most frequent value	23:00	6:00	7.00	00:00	6:00	6.00
standard deviation (hours)	1.8	1.4	–	2.8	2.1	–

Although the borders of the clusters were not well separated, these three clusters or subgroups of healthcare professional's surveys matched with an overall well-being subclass where participants from the cluster 1 (green, PC1> 0.3) had mild insomnia or were healthy 219 (21.7%), the cluster 2 (blue, −0.2 < PC1<0.3) corresponded with the medium-range 371 (36.7%) and the cluster 3 (red, PC1<−0.2) was the largest group 420(41.6%). The last cluster presented the most severe outcomes.

For a better understanding of the K-means clustering using PCA transformation, the mentioned cluster outcomes are shown in Fig. 3 where a) SWIFT, b) ISI, c) GADS/anxiety, and d) GADS/depression scales were arbitrarily plotted against the Pittsburgh score. The dashed vertical and horizontal lines showed the cut-off point of each scale. The figure showed that cluster 1 is under horizontal cutoffs, however, some of the surveys presented Pittsburgh and ISI values above the cutoff point (see Fig. 4). Cluster 2, in blue, was in the surroundings of the cutoffs where some surveys are below while others above. Finally, cluster 3, represented in red, showed worse results in all scores. Linear regression was done in Fig. 3b (continuous line) keeping the intercept fixed at 0. The

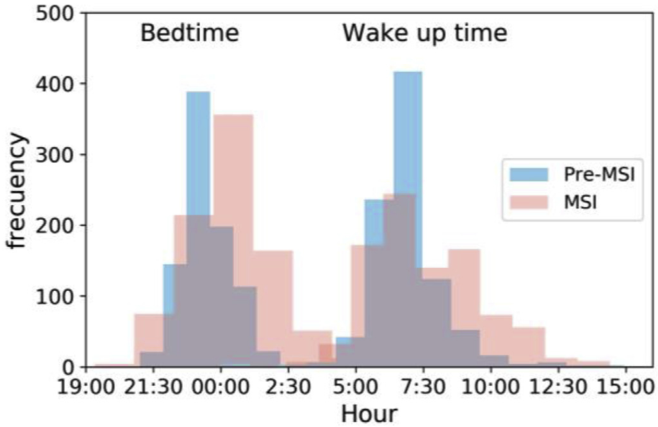

Fig. 1. Bed and wake up time pre and during MSI restricted to night sleepers (N = 915).

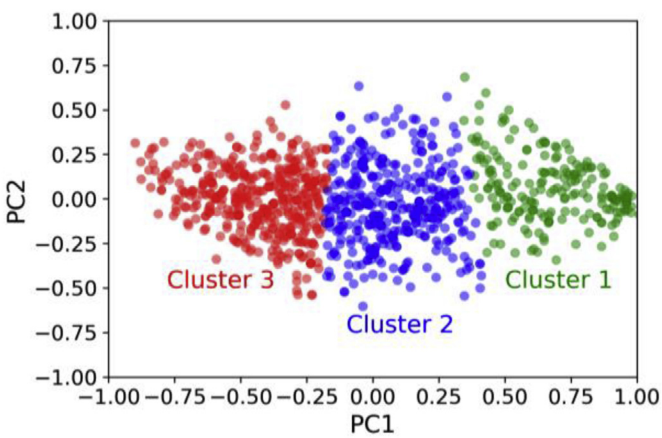

Fig. 2. Principal Components from PCA. Colors represent three different data clusters obtained by K-Means algorithm. Dots color intensity represents outcome frequency. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

calculated slope was 1.32 which is similar to the line which connects test extremes (expected slope max(ISI)/max(Pittsburgh) = 28/21 = 1.33). The strong linear correlation between Pittsburgh and ISI indicates that the principal sleep disorder evidenced by the Pittsburgh scale is due to insomnia.

Figure. 4 shows the boxplot representation of each score measured in the surveys. ANOVAs showed that the three clusters had significant differences in the five outcomes with p values << 0.05. Cluster 1 presents levels of anxiety (mean = 1.9, std = 1.8), depression (mean = 0.8, std = 1.7) and wakefulness/fatigue (mean = 2.7, std = 2.6) below the cutoff while part of the cluster population showed subclinical levels of insomnia ($mean_{ISI}$ = 5.4. std_{ISI} = 4.4, $mean_{Pittsburgh}$ = 5.0, $std_{Pittsburgh}$ = 3.2). Cluster 2 is characterized by presenting average mild levels of insomnia ($mean_{ISI}$ = 10.0 std_{ISI} = 4.1, $mean_{Pittsburgh}$ = 7.7, $std_{Pittsburgh}$ = 3.0), but they presented also anxiety (mean = 6.0, std = 4), depression (mean = 4.0, std = 1.9) levels above cutoffs but most part of professional health care in this group showed normal values of wakefulness/fatigue scores (mean = 6.2, std = 3.3). Finally, cluster 3 presented severe results in all scores: Anxiety (mean = 8.2, std = 0.8), depression (mean = 6.4, std = 1.4), insomnia ($mean_{ISI}$ = 16.4 std_{ISI} = 4.3, $mean_{Pittsburgh}$ = 11.4, $std_{Pittsburgh}$ = 3.0) and wakefulness/fatigue scores (mean = 11.6, std = 5.3).

A general cluster description is shown in Table 4. Although the clustering classification algorithm was employed only for scores with numerical outcomes, cluster description showed a clear tendency in several items. The proportion of female, non-physician, and in contact with COVID-19 patients increased among the subgroups. Moreover, health workers of cluster 3 were more prone to consume sleep medications and take naps during the MSI. Sleep satisfaction and it's interfering with daily functions were also analyzed. For these, weighted averages (*wa*) were obtained where health workers of cluster 1 were mostly satisfied with their sleep while *wa* shifted to unsatisfied for clusters 2 and 3.

Other marked differences between groups were the amount of nightmare and violent dreams which increased from cluster 1 to cluster 3 (Fig. 5a), moreover, only 1.4 and 1.9% from cluster 1 and cluster 2 referred to injury to their bed partner and scaled to 6% for cluster 3. Age was also a difference between groups, where the age decreased with scores severity (Fig. 5b), here ANOVAs showed significant differences with p-value < 0.05. These results are in accordance with logistic regression from the general population in Table 1.

In consequence, workers who scored higher in the anxiety, depression, insomnia scales, and who were considered poor sleepers in the Pittsburgh scale, were more likely to be younger, reported the presence of nightmares more than once a week, and worked in the healthcare field as physicians in trainee or non-medical staff, being in contact with COVID-19 patients a key factor. In contrast, those with better results in the anxiety, insomnia, and depression scales, cataloged as good sleepers in the Pittsburgh scale, were physicians, with older ages and that did not refer regular nightmares during the quarantine.

4. Discussion

Quoting a recent paper as a kind of news of the near future Brooks S.K. et al. [28] reviewed studies in people under quarantine for SARS, EBOLA, H1N1 and MERS and their devastating psychological impact. In that review, healthcare workers reported more anger, annoyance, fear, sadness, worry and in fact present more risk for post-traumatic stress disorder (PTSD) than the general population. Hence, we can consider working in health as an important risk factor of negative psychological impact during COVID-19 MSI.

This is the first study that examines sleep health from a multidimensional perspective in relation to symptoms of insomnia, somnolence, impairment of wakefulness, fatigue, anxiety, and depression in healthcare workers during prolonged COVID-19 MSI in Argentina. This survey was conducted after 90 days of MSI and for this task, we used the following validated scales: PSQI, ISI, Innsbruck, RBD Inventory, SWIFT, and GADS. One of the first findings was that the difference observed between bedtime and wake up time and the significant dispersion evidenced during pre and ongoing MSI times indicates an alteration of wake/sleep time (related sample t-test p-value <0.001). The effect of physical distancing and the consequent risk of circadian rhythm dysregulation has been pointed out by a recent paper [29]. Thus our study suggests an engagement of biological rhythms in the regulation of wake/sleep schedules of uncertain significance that need to be evaluated over time.

As for the quality of sleep in Argentina, it is estimated that about 20% of the general population sleeps poorly, that percentage may rise up to 50% or more in some specific groups (drivers, adolescents, population with a low or very low socioeconomic level) in the pre-COVID-19 period [30]. In order to compare the prevalence of insomnia, before the MSI, we found that to our knowledge, there are no studies in Argentina reporting this condition. Interestingly research carried out in general population in the Latin America,

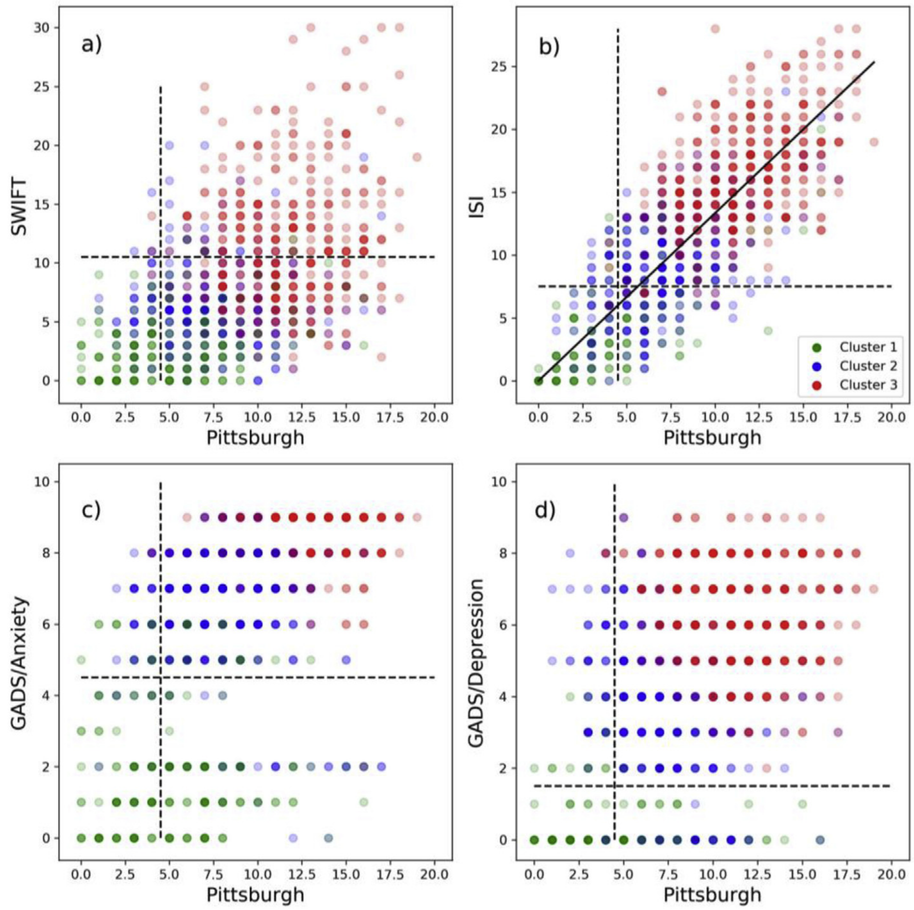

Fig. 3. Numerical Scores against Pittsburgh scale.Colors represent the three clusters obtained by K-Means algorithm, dots color intensity represents outcome frequency. Green dots is the cluster group of healthcare professionals with overall low scales values, the red dots indicate the group with more severe results (cluster 3) and in blue the intermediate cluster (cluster 2). horizontal and vertical dashed lines represent the cut-offs on each test. The continuous line in b is the result of the linear correlation between Pittsburgh and ISI with the intercept fixed at 0 (slope = 1.32–28/21). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

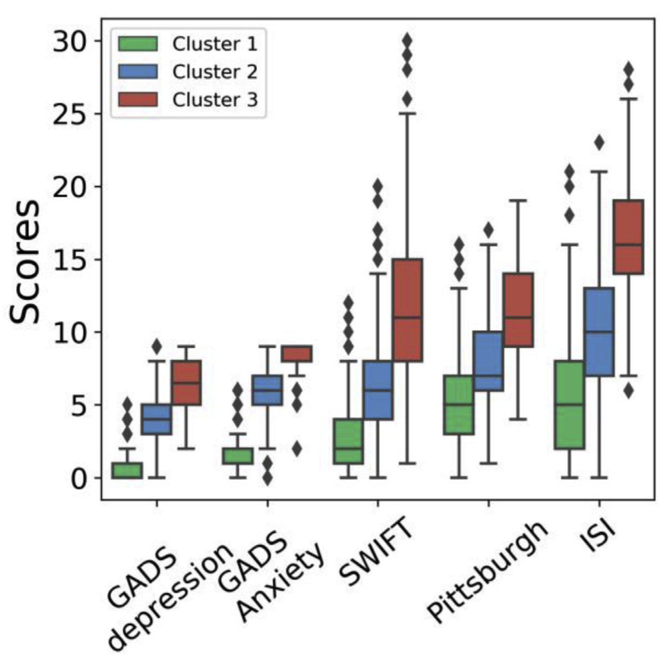

Fig. 4. Boxplot of the five numerical scores employed over the three clusters.

including metropolitan areas of Ciudad de México (México), Montevideo (Uruguay), Santiago de Chile (Chile), and Caracas (Venezuela), reported a prevalence of insomnia of about 34.7% (33.3%–36%) [31]. In our survey, 18% of the participants referred to sleep unsatisfaction before the outbreak which increased to 46% during the MSI (See Fig. S3).

Recently published studies from all over the globe reported that the presence of insomnia in healthcare workers during the COVID-19 outbreak was 36.1% [5], 28.9% [10], 32% [32], and 8.27% [11]. Although the population composition, in the studies previously mentioned and in the present work, were mostly female, and with a similar age range, our study showed a much higher percentage of insomnia (73.7%). We believe that this may be due, in part, to the time of MSI, while the previously quoted studies conducted the analysis within two months of the start of the social isolation, our survey was conducted at the third month. Another possible cause of this finding could be related to the environment where structural deficiencies or even cultural aspects may act as confounding factors.

The arrival of the first cases of COVID-19 occurred months later than in China and Europe. During the first months of 2020 Argentinian people were viewers of the real consequences of the outbreak in the first world countries, hence, a state of alert and anxiety about an inevitable outcome could have been prematurely generated. The impact observed with the scales used and its consistency with previous reports related to COVID-19/SARS/MERS/

Table 4
Clusters general description. For Gender F, M and NB correspond with female, male and non-binary, respectively. The percentage of physicians which were doing their residence during the survey is expressed in brackets. The interfering of sleep in daily functions and the sleep satisfaction during MSI were divided into four categories: not at all (0), a little (1), somewhat (2), much (3) and pretty much (4) for the first one and a continuous scale from very satisfied (0) to very unsatisfied (4) for the second question. "wa" is a weighted average. Nap question was divided before and during the pandemic and the difference [diff] represents new nap sleepers. Percentages are referred to the internal proportion in each cluster.

	Gender (%)	Physicians (%) [Residents %]	Work sector (%)	In contact with COVID-19 patient (%)	Live Alone (%)	Live with others (>10 years)	Live with childrens under 10 years old (%)	Sleep medication before MSI (%)	Sleep Medication during MSI (%)	Interfering of sleep in daily function (%)	Nap (%) [diff]	Sleep satisfaction during MSI (%)
Cluster 1 N = 219	F: 58.4 M: 41.6	69.5 [9.8]	public 24.9 private 48.8 both 26.3	53.9	16.4	65.0	18.6	5.9	12.8	0 : 49.3 1: 24.7 2: 17.4 3: 6.4 4: 2.2 wa: 0.87	before 19.6 during 35.6 [16.0]	0: 21.4 1:38.8 2:31.5 3:7.8 4: 0.5 wa: 1.27
Cluster 2 N = 371	F: 75.5 M: 24.5	67.1 [15.7]	public 25.8 private 39.9 both 24.4	60.4	14.6	57.1	28.3	8.6	30.7	0: 13.0 1: 27.2 2: 42.6 3: 14.0 4: 3.2 wa: 1.67	before 15.4 during 36.7 [21.3]	0: 1.9 1: 18.3 2: 49.6 3: 26.4 4: 3.8 wa: 2.12
Cluster 3 N = 420	F: 77.0 M: 22.8 NB: 0.2	64.5 [20.9]	public 35.9 private 34.9 both 34.9	73.4	23.5	49.9	26.6	11.4	47.3	0: 0.7 1: 8.1 2: 32.9 3: 36.0 4: 22.3 wa: 2.71	before 21.9 during 48.9 [27.0]	0: 0.2 1: 3.0 2: 17.7 3: 56.5 4: 22.6 wa: 3.00

Ebola outbreaks points to the role of stress activating the hypothalamus-pituitary-adrenal (HPA) system could promote a vicious cycle of stress and insomnia and their consequences effects on anxiety and depression [28,33–35]. The prevalence of depression and anxiety in the general population of Argentina was estimated at 4.7–23% and 6.3–33% pre-MSI [36,37]. A study conducted one week after the onset of MSI showed depressive and anxiety symptoms of 23% and 33%, respectively [38]. The present study evidenced increased anxiety and depression levels targeted by the GADS characterized our population of healthcare workers with more than 70% and 81% of positive responses after 90 days of MSI. With this observation, the risk of PTSD, already identified in previous studies, emerges as an imminent problem to consider [39–41] Depressive symptoms were elevated, measured by GADS\Depression score, but to a lesser degree than those observed with anxiety measured by GADS\Anxiety (Fig. 4 and Fig. S2).

Logistic regression analysis demonstrates that the working place according to the region of the country was a predictor of impairment of wakefulness and fatigue symptoms, detected by SWIFT, in large urban centers (Table 2). This was probably related to the activity of urban centers with a larger number of inhabitants (14.5 millions in AMBA) and its association with higher stress levels and social and economical conflicts [42]. Being in contact with patients with COVID-19 was a strong predictor of worsening of insomnia symptoms, impairment of wakefulness, fatigue, and increased values for symptoms of anxiety and depression. If we considered the population of health workers as a pre-MSI vulnerable population [28], the effect of prolonged MSI could be thought of as a perfect storm producing deleterious effects in all the dimensions measured. There was a strong association between the consumption of sleep medication and increased symptoms of insomnia, somnolence, fatigue, anxiety, and depression. The use of sleep medications was considered a predictor of the severity of insomnia. In this study, we evidenced an increase in the intake of sleep medications by 360% (from 9.4% pre-MSI to 34.1% during MSI). The present study also evidences that women presented worse results in all the scales used with no significant statistical difference in terms of age, with an average age of 43.3 ± 11.3 for men and 41.3 ± 10.3 for women. Moreover, the logistic regression over sleep satisfaction (Fig. S3) showed no gender related before pandemic (p-value = 0.50) while women were more affected during the MSI with a p-value < 0.001 (OR: 1.00, CI: 0.76–1.33). In relation to these findings, it is well known that sex hormones such as estrogens and progesterone in females affect emotions and cognition and produce a different response to stress, contributing to sex differences in behavior [43].

The association between nightmares and stressful situations is widely known [44]. In support of this, we observed a close relationship between the presence of anxiety, nightmares and violent dreams, which was reported in 58.9%. In addition, we found that 3.4% injured their bed partner and 1.2% fell out of bed. These findings lead us to think that the presence of nightmares and violent dreams could be considered a risk factor for PTSD.

As mentioned in a recently published study [9], our study evidenced that being physician showed less association with anxiety, depression and insomnia than being a physician in trainee, nurse or any other function in the health field. This could be due to less exposure to COVID-19 patients.

Our study provides a three cluster-based severity classification of the health workers surveyed using sleep, wakefulness impairment/fatigue, anxiety and depression domains. Using this approach, a group showed values considered as normal on the

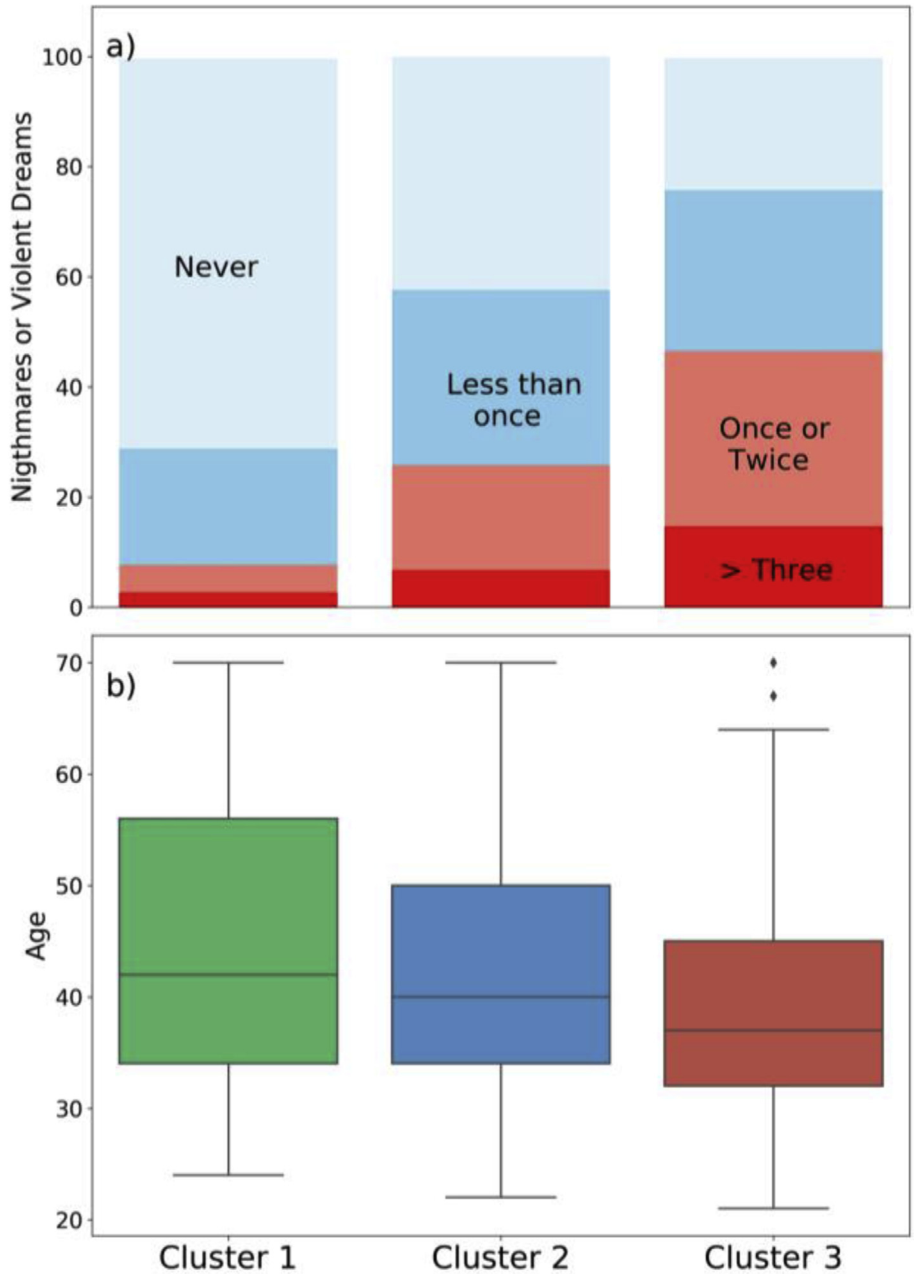

Fig. 5. a) Nightmares and violent dreams per week and b) Age distribution for the three clusters.

scales used. Cluster 2 and 3 present a progressive increase in the number of subjects, an age-related effect in which the youngest population was the most affected, a gender-related effect in which women were more affected, increase of consumption of sleep medications, and an increase in all the domains used. The observed escalation in the number of nightmares and violent dreaming was parallel to the cluster stratification with a significant increase in cluster 3 (Fig. S1). Thus, a worsening of sleep quality, altered REM sleep phenomenology, fatigue, symptoms of anxiety and depression growths as the severity of the clusters increased and the proportion of young people, women, training physicians and non-medical healthcare workers scales with it. According to what Chantal Martin-Soelch and Ulrich Schnyder mentioned in their article [45], the population that conforms cluster 1 could be considered as a resilient population group and those from cluster 3 as a vulnerable population.

Our study has several limitations. First, the survey was an online self-report questionnaire which can lead to a sample bias. Second, although the surveys used are validated in the Spanish language, they are not validated in the Argentinean population therefore the results should be evaluated with caution. Validated scores in this population are necessary for a better interpretation of the results. In addition, although there was participation from all over the country, most of the results are from the AMBA region. However, this area has the highest population in the country (about 36% of the total population) and concentrates most of the cases of COVID-19. An important limitation is the limited number of studies conducted on sleep disorders in the general population in the country. In fact, there are no studies conducted among healthcare professionals, therefore comparisons made with different populations should be carefully interpreted. Finally It is important to mention that in our sample there are 72% of women, which should lead us to take the results of differences by gender with caution.

Given the high levels of anxiety, depression and insomnia evidenced in our study even in comparison with other studies around the world, we consider it is relevant to create a therapeutic strategy, such as the one developed by Blake et al. [46] to mitigate the impact generated in health care professionals.

5. Conclusions

The present study showed that Argentinean healthcare workers have shockingly higher levels of insomnia, anxiety, depression, nightmares and violent dreams in comparison with studies conducted in other countries. Of note, K-Means clustering algorithms showed to be a robust method, since it allows to classify healthcare workers in function of scores severity and it showed tendencies in a clear and straightforward way. This algorithm successfully separates vulnerable from non vulnerable populations suggesting the need to carry out future studies involving resilience and vulnerability factors, mainly, in the most vulnerable population made up of the younger people, women, physicians in training and non-physician healthcare workers.

Author contributions

D.L.G. Ideas; formulation or evolution of overarching research goals and aims; data/evidence collection; Development or design of methodology; Writing - Original Draft; Visualization. **C.H.I**. Programming; implementation of the computer code and supporting algorithms; Data Curation; Writing - Original Draf; Visualization. **M.R**. Application of statistical, mathematical, computational, or other formal techniques to analyze or synthesize study data; Visualization. **A.G**. Writing - Review & Editing; Supervision; Visualization.

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Conflict of interest

On behalf of all authors, the corresponding author states that there is 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.2020.09.022.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sleep.2020.09.022.

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