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ORIGINAL ARTICLE

Sleep changes during social isolation due to the Covid-19 pandemic in individuals with chronic respiratory diseases

Alterações do sono durante o isolamento social devido à pandemia de Covid-19 em indivíduos com doenças respiratórias crônicas

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KEYWORDS
Sleep
Chronic Obstructive Pulmonary Disease
Asthma
Interstitial Lung Disease

ABSTRACT

Objective: To analyze and compare the impact of social isolation due to the COVID-19 pandemic on sleep assessed at two time points (visit 1: during strict social isolation; visit 2: after the relaxation of social isolation measures) in individuals with stable chronic obstructive pulmonary disease (COPD), asthma, and interstitial lung disease (ILD), all of whom were not infected with COVID-19. **Method:** In a one-year prospective cohort study, individuals were evaluated concerning lung function (via spirometry), demographic and clinical data, and sleep objectively assessed through actigraphy over 7 consecutive days at both visits. **Result:** A total of 36 individuals (12 with COPD, 10 with asthma and 14 with ILD) were included. There was significant decline in sleep quality at visit 2 compared to visit 1 across all three diseases, primarily in the parameters of sleep efficiency, fragmentation and wake time after sleep onset; however, the total sleep duration did not change. Furthermore, individuals with ILD exhibited a smaller variation in both the number and duration of vigilance blocks compared to those with the other two diseases, indicating lower sleep fragmentation. **Conclusion:** Regardless of the disease (COPD, asthma, or ILD), individuals with chronic respiratory conditions who were not infected with COVID-19 experienced decline of sleep quality following the period of social isolation. Additionally, individuals with ILD appear to have been less impacted (with lower sleep fragmentation) compared to those with the other diseases.

PALAVRAS-CHAVE
Sono
Doença Pulmonar Obstrutiva Crônica
Asma
Doença Pulmonar Intersticial

RESUMO

Objetivo: Analisar e comparar o impacto do isolamento social devido à pandemia de COVID-19 nos parâmetros do sono. **Método:** Em uma coorte prospectiva de 1 ano, os indivíduos foram avaliados quanto à função pulmonar (por meio da espirometria), dados demográficos e clínicos e avaliação objetiva do sono, realizada por meio de actigrafia durante 7 dias consecutivos em duas visitas: visita 1 (período de isolamento social rigoroso) e visita 2 (após relaxamento das medidas de isolamento social) em

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indivíduos com doença pulmonar obstrutiva crônica estável (DPOC), asma e doença pulmonar intersticial (DPI), todos sem COVID-19. **Resultado:** Foram incluídos 36 indivíduos (12 com DPOC, 10 com asma e 14 com DPI). Houve piora significativa na qualidade do sono na visita 2 em comparação à visita 1 nas três doenças, principalmente nos parâmetros de eficiência do sono, fragmentação e tempo de vigília após o início do sono; no entanto, a quantidade do sono não mudou. Os indivíduos com DPI apresentaram variação menor tanto na quantidade quanto na duração dos blocos de vigília em comparação aos indivíduos com as outras duas doenças, indicando menor fragmentação do sono. **Conclusão:** Independentemente da doença (DPOC, asma ou DPI), os indivíduos portadores dessas condições respiratórias crônicas que não foram infectados pela COVID-19 apresentaram piora na qualidade do sono após o período de isolamento social. Indivíduos com DPI parecem ter sido menos afetados quanto à fragmentação do sono quando comparados àqueles com as outras doenças.

INTRODUCTION

Social isolation is a strategy for controlling high-potentially contagious infectious diseases, as seen in 2003 in North America during the outbreak of severe acute respiratory syndrome and again in 2014 in West Africa due to the Ebola virus outbreak[1]. More recently, the global COVID-19 pandemic caused by the SARS-CoV-2 virus, which began in 2020 and continued for the following years, has highlighted this scenario once again[2].

During the COVID-19 pandemic there were significant changes in daily routines worldwide, requiring adaptations in work and school environments, for example. Furthermore, the suspension of leisure activities also contributed markedly to the decline in social interactions. The repercussions of this period quite striking. Studies indicate that mental health issues, characterized by elevated levels of anxiety and depression, were a common feature, impacting individuals ranging from the pediatric population[3] to the elderly[4]. There was also a notable decline in physical activity in daily life and a rise in sedentary behavior among adults[5] and elderly[6]. Finally, sleep was also significantly impacted, which makes sense, as sleep is a behavior reliant on a consistent routine and can thus be easily disrupted by the changes brought about by social isolation[7].

In children and adolescents, a recent systematic review with meta-analysis indicated an increase in sleep duration during the pandemic compared to the previous period; however, this was accompanied by poorer sleep quality, later bedtimes, and a tendency towards reduced sleep efficiency[8]. In adults, there was a considerable prevalence of sleep disorders[9] accompanied by a significant decline in quality[10]. In the elderly, social isolation had a significant negative impact on quality of life, which is directly affected by the quality of sleep[11]. However, it must be acknowledged that the effects on sleep may have varied among specific populations. For instance, individuals with pre-existing chronic respiratory diseases should be carefully considered since they were classified as being in a "high risk group".

In individuals with chronic obstructive pulmonary disease (COPD), insomnia was found to be a common complaint, impacting 71% of the sample in a cross-sectional study conducted via telephone contact[12]. In the asthmatic population, there was a rise in sleep disorders during the pandemic, as measured by the Pittsburgh Sleep Quality Index questionnaire, compared to healthy individuals[13]. Research involving aspects of sleep in other less common chronic diseases, such as interstitial lung disease (ILD), was very limited in the pre-pandemic period[14], and more specifically in the time of social isolation due to the pandemic it appears to be non-existent to the best of our knowledge. Therefore, it is evident that research on sleep in individuals with chronic respiratory diseases during the COVID-19 pandemic remains limited, and when it does exist, it often suffers from significant methodological shortcomings such as the subjective assessment. Hence, the primary issue is that no study has utilized objective assessment methods to investigate sleep. Moreover, available studies have employed a cross-sectional design, and the lack of longitudinal research indicates a substantial scientific gap.

Therefore, the objectives of this study were to analyze and compare the impact of social isolation due to the COVID-19 pandemic on sleep parameters (total sleep time, sleep efficiency, time awake after sleep onset (WASO) and sleep fragmentation) assessed in two moments in individuals with stable COPD, asthma and ILD, all of them non-infected by COVID-19.

METHODS

This was a longitudinal study involving a convenience sample of patients associated with the Laboratory of Research in Respiratory Physiotherapy, State University of Londrina. Recruitment was done through a list of known individuals who participated in previous projects carried out in the research laboratory. Initially, individuals on the list were randomly selected and invited, thus forming a convenience sample. Contact and invitation were done by telephone, and after verbal consent to participate in the study, the home visit commenced. The visit included two days of evaluation; on the first day, demographic and clinical information was gathered, and the sleep monitor was provided. The second day of evaluation was brief, solely to collect the equipment. To prevent the spread of the virus and ensure the individual's health, all materials used were sterilized with 70% alcohol before and after collection. The researchers wore personal protective equipment (gloves, apron and mask) and also supplied these to patients and their families. Finally, 2 meters between individuals was maintained.

Visit 1 occurred between mid-September and October 2020; at that time, government and health agencies advised individuals with chronic diseases to maintain strict social isolation. Visit 2 took place between mid-August and

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October 2021, following the commencement of vaccinations and the partial easing of social isolation measures as officially announced by government institutions.

The study was approved by the local ethical committee (CEEA 36966920700005231) and written informed consent was obtained from all participants. Inclusion criteria included a formal diagnosis of COPD[15], asthma[16] and ILD[17], as assessed by spirometry conducted no more than six months prior to the onset of the pandemic; no COVID-19 infection before visit 1; no acute exacerbation in the past three months; absence of severe and/or unstable cardiac disease; and absence of musculoskeletal conditions that could impair assessments. Exclusion criteria comprised being infected with COVID-19 or experiencing an acute exacerbation between visits 1 and 2; unavailability of data regarding assessment of sleep (e.g., technical failure) or other variables from either visit; and loss of contact during follow-up.

Assessments

Pulmonary function data collected shortly before the pandemic began was obtained from all subjects in the laboratory database (maximum exam date: 6 months prior). The test was conducted using a portable spirometer (Spirobank G-MR, Italy), following the guidelines set by the American Thoracic Society[18]. This equipment has previously been used and validated for COPD and asthma[19]. The following variables were considered: forced expiratory volume in one second (FEV_1), forced vital capacity (FVC) and the ratio between the two (FEV_1/FVC) as a percentage.

Objective assessment of sleep was performed by actigraphy using the Actiwatch (Philips Respironics, Murrysville, United States of America [USA]). This equipment is suitable for adults, both with and without chronic diseases, and is the most commonly used worldwide in sleep research[20]. The equipment was used on the non-dominant wrist for 24 hours for seven consecutive days. During the days while wearing the device, individuals were instructed to fill out a usage diary. The variables derived from actigraphy were: sleep start and end times, total time in bed, total sleep time, sleep efficiency (i.e., ratio of total sleep time to total time in bed), WASO, latency, number and duration of blocks of sleep and wakefulness during sleep. The minimum time considered for the analyzes was 4 nights using the monitoring device. Actigraphy represents a valid and useful diagnostic tool which allows for assessment of sleep over extended periods of time in the natural sleep environment[21].

Simultaneously with the use of the sleep monitor, participants were instructed to complete a sleep diary, which involved recording bath times and sleep routines throughout the week. This tool was developed by the authors themselves, who opted for simple and clear language, complemented by visual resources to enhance participant understanding. The information was used alongside the actigraphy to ensure the accuracy of the sleep data measured by the actigraph, as recommended by the Brazilian Sleep Association[22]. Additionally, routine phone calls were made to the participants during the evaluation week, ensuring that any questions regarding the diary or the use of the equipment were thoroughly addressed.

Additionally, clinical and anthropometric data were gathered during the initial assessment to characterize the sample, including sex (male and female), age (years), weight (kg), and height (m). This information was then used to calculate the body mass index (BMI) using the formula: weight (kg) ÷ height $(m)^2$, with the unit of measurement being kg/m^2.

Assessments were conducted at the individuals' homes, and all evaluators were properly trained to conduct the assessments. The same evaluator collected data at both home visits to reduce the risk of bias. Additionally, the same equipment was used at both assessment moments, receiving regular maintenance and calibration.

Statistical analysis

Analysis of normality in data distribution was conducted using the Shapiro-Wilk test. Data were presented as median [IQR]. The Wilcoxon test was employed to compare clinical and sleep variables between visits 1 and 2. Additionally, the change in sleep variables over time, referred to as delta, was calculated (visit 2 - visit 1). Deltas were compared among the three diseases using the Kruskal-Wallis test with Bonferroni post-hoc adjustments. There was no need to address missing data, as the absence of sleep data served as an exclusion criterion. Furthermore, no statistical adjustments for confounding variables were made. Statistical analysis was carried out using IBM SPSS 20.0, and a p-value < 0.05 was deemed significant.

RESULTS

Initially, 53 individuals with the three diseases were evaluated; however, due to losses, 36 individuals were included in the analyses: 12 with COPD, 10 with asthma, and 14 with ILD. The entire study flowchart with the respective reasons for exclusion can be seen in Figure 1.

Table 1 shows the general sample characterization and sleep data from visits 1 and 2. As expected due to the diseases' characteristics, individuals with asthma were significantly younger and individuals with ILD had higher FEV_1/FVC ratio when compared to individuals with COPD. There was no significant change between visits in the amount of sleep in any of the three diseases. However, a significant decline in sleep quality was observed during visit 2 compared to visit 1 across all three diseases. Importantly, individuals with COPD, asthma and ILD increased their WASO by more than three times at visit 2.

Table 2 shows the comparison of change (delta) of sleep parameters among the three lung diseases. Sleep efficiency had a (non-significant) pattern of reduction during the pandemic period in the three diseases. Individuals with ILD exhibited a lower delta in both the quantity and duration of wake blocks compared to those with the other two diseases. This indicates that while sleep fragmentation was still evident, it was less pronounced than the fragmentation observed in COPD and asthma.

DISCUSSION

Results of this study showed that, after the period of social isolation due to the COVID-19 pandemic, individuals

Table 1 – Clinical data and sleep parameters at Visits 1 and 2 in individuals with chronic obstructive pulmonary disease (COPD), asthma and interstitial lung disease (ILD).

Variables	COPD			ASTHMA			ILD		
	V1	V2	*P*	V1	V2	*P*	V1	V2	*P*
	(n=12)	(n=12)		(n=10)	(n=10)		(n=14)	(n=14)	
Male sex, n (%)	7 (58)	-	-	4 (40)	-	-	4 (27)	-	-
Age, years	67 [64 – 71]	-	-	51 [46 – 62]*	-	-	62 [49 – 72]	-	-
BMI, kg/m²	28 [25 – 31]	-	-	28 [26 – 36]	-	-	28 [24 – 32]	-	-
FVC, %pred	77 [64 – 86]	-	-	80 [67 – 84]	-	-	85 [69 – 98]	-	-
FEV_1, %pred	61 [41 – 66]	-	-	61 [53 – 80]	-	-	73 [66 – 86]	-	-
FEV_1/ FVC	62 [49 – 65]	-	-	70 [63 – 81]	-	-	90 [77 – 104]*	-	-
Sleep									
Time of use of the monitor, days	8[7-8]	8[7-8]	0,480	8[6-8]	7[6-8]	0.854	8[8-8]	7[7-8]	0.078
Start time, hh:mm	22:40 [21:57-23:54]	22:36 [21:30-23:14]	0.093	23:40 [22:09-24:18]	23:28 [22:46-24:19]	0.341	23:29 [22:15-24:36]	22:52 [22:04-24:12]	0.190
End time, hh:mm	6:45 [6:06 - 7:33]	6:44 [5:58 - 7:16]	0.448	6:56 [5:32 – 8:15]	6:30 [6:11 – 7:06]	0.646	6:12 [5:34 – 7:07]	6:39 [5:59 – 7:50]	0.333
TIB, min	494 [437 – 504]	499 [457 – 554]	0.630	473 [406 – 517]	444 [384 – 508]	0.350	440 [347 – 485]	470 [382 – 516]	0.181
TST, min	457 [415 – 486]	440 [377 – 486]	0.067	408 [388 – 488]	396 [279 – 447]	0.094	434 [340 – 468]	429 [361 – 471]	0.523
Efficiency, %	95 [91 – 97]	84 [77 – 90]	**0.003**	98 [81 – 98]	90 [63 – 97]	0.071	90 [88 – 93]	82 [79 – 85]	0.417
WASO, min	24 [12 – 47]	74 [49 – 94]	**0.002**	11 [8 – 57]	42 [11 – 136]	**0.030**	10 [7 – 18]	33 [21 – 55]	**<0.001**
Sleep Bouts, n	22 [13 – 37]	41 [34 – 53]	**0.001**	11 [10 – 29]	32 [16 – 39]	0.240	11 [7 – 15]	30 [26 – 40]	**<0.001**
Avg Sleep Bouts, min	31 [15 – 36]	10 [8 – 16]	0.909	54 [13 – 74]	12 [6 – 48]	**0.019**	40 [28 – 65]	14 [13 – 17]	**0.006**
Wake Bouts, n	21 [12 – 36]	40 [33 – 52]	**0.001**	10 [8 – 29]	31 [15 – 38]	0.245	10 [6 – 14]	29 [25 – 40]	**<0.001**
Avg Wake Bouts, min	1.09 [0.96 – 1.24]	1.64 [1.22 – 2.02]	0.081	1.26 [0.77 – 1.67]	1.07 [0.73 – 4.51]	0.148	1.02 [0.86 – 1.30]	1.20 [0.72 – 1.70]	0.223

BMI: body mass index; FEV_1: forced expiratory volume in one second; FVC: forced vital capacity; TIB: total time in bed; TST: total sleep time; WASO: wake time after-sleep onset; Avg: average. Visit 1 occurred at the moment when government and health agencies recommended people with chronic diseases to remain in strict social isolation, whereas Visit 2 occurred immediately after the first moment of relaxation of social isolation measures as officially announced by government institutions. *p<0.05 vs COPD.

Table 2 – Comparison of deltas (visit 2 minus visit 1) regarding sleep parameters of individuals with chronic obstructive pulmonary disease (COPD), asthma and interstitial lung disease (ILD).

Deltas	COPD (n=12)	ASTHMA (n=10)	ILD (n=14)	*P*
Sleep start time, hh:mm	- 0:22 [- 0:40 – 0:16]	0:21 [- 0:30 – 0:45]	- 0:03 [- 0:57 – 0:22]	0.215
Sleep end time, hh:mm	0:01 [-0:50 – 0:27]	- 0:01 [-1:04 – 0:37]	0:19 [-0:25 – 1:14]	0.431
TIB, min	1.2 [-26 – 48]	-12 [-54 – 26]	24 [-33 -124]	0.370
TST, min	-36 [-87 – 10]	-29 [-145 – 19]	7 [-50 – 78]	0.226
Efficiency, %	-10 [-18 - -3]	- 5 [- 27 – 0.76]	- 8 [- 11 – - 4]	0.681
WASO, min	46 [12 – 68]	21 [- 0.5 – 107]	22 [15 – 39]	0.640
Sleep Bouts, n	20 [7 – 31]	14 [-1.2 – 23]	22 [16 – 25]	0.317
Average Sleep Bouts, min	-11 [-25 – -0.25]	-20 [-55 – -2.0]	-25 [-55 – -10]	0.126
Wake Bouts, n	39 [33 – 52]*	30 [14 – 37]*	28 [24 – 39]	**0.017**
Average Wake Bouts, min	0.56 [0.04 – 1.0]	-0.01 [-0.41 – 3.40]	0.09 [-0.29 – 0.44]	0.501

TIB: total time in bed; TST: total sleep time; WASO: wake time after-sleep onset. Visit 1 occurred at the moment when government and health agencies recommended people with chronic diseases to remain in strict social isolation, whereas Visit 2 occurred immediately after the first moment of relaxation of social isolation measures as officially announced by government institutions. *p<0.05 vs ILD.

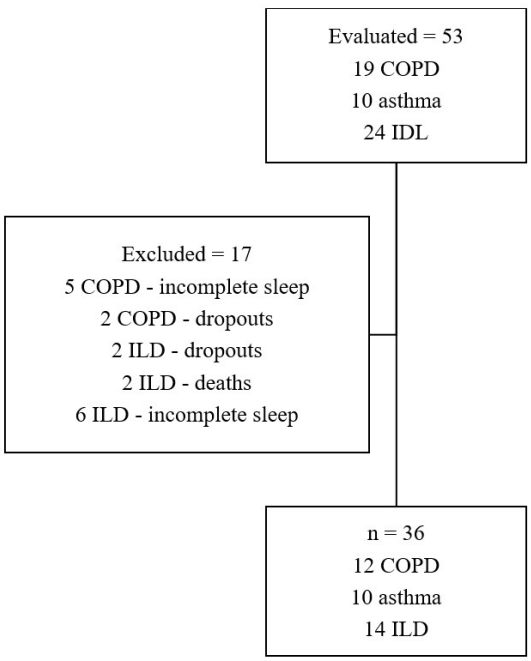

Figure 1 – Study flowchart.

with COPD, asthma and ILD significantly decreased their sleep quality without necessarily changing the quantity. When comparing deltas, individuals with ILD had less increase in the number of awake bouts during the night when compared to the other two diseases.

The National Sleep Foundation suggests that good indicators of sleep quality are a WASO of less than 20 minutes/night and a sleep efficiency greater than 85%[23]. In the present sample, sleep efficiency remained within the recommended values; however, there was an exponential rise in WASO, tripling the initial values across the three diseases, which deserves attention. WASO is a highly sensitive and representative measure of sleep quality, as identified by a recent study in which higher WASO was associated with increased subjective reporting of sleep disturbance in the PSQI tool in the elderly population[24]. Additionally, WASO has been linked to various negative outcomes, including an increased risk of obesity[25], elevated inflammation levels, and higher mortality rates[26]. Consequently, we propose that developing strategies and interventions aimed at reducing WASO should be prioritized, particularly for individuals with chronic respiratory diseases.

In terms of sleep quantity, the National Sleep Foundation emphasizes that sleep characteristics and needs differ by age group[27]. Given the similar median age of individuals with COPD and ILD in this study, the optimal amount of sleep is 7-8 hours per night, although sleeping less than 5 hours or more than 9 hours is not advised. For younger individuals with asthma, the recommended amount of sleep is 7-9 hours per night, with values below 6 or above 10 hours not being advised[27]. We should note that the present results fall within the ideal range for the COPD and ILD group, and are slightly below the ideal for the asthmatic group. In contrast, studies conducted before the pandemic indicate that these populations typically experienced short sleep durations. In COPD, the average total sleep time was 5.5 hours, as measured by actigraphy[28]. In ILD (unpublished results), individuals averaged about 6.4 hours of sleep per night, also measured by actigraphy. Lastly, in asthma, around 26% of individuals reported sleeping less than 5 hours[29]. We believe that this notable increase in sleep duration during the pandemic can be attributed to the new, more flexible routines, which provided individuals with greater opportunities to sleep due to more adaptable schedules, both for those engaged in the labor market and retirees. Furthermore, this increase

in sleep duration was a global trend, as highlighted by a recent systematic review[30].

We identified that individuals with ILD had less increase in waking bouts during the night when compared to the other two diseases. This can be associated, at least in part, to previous findings showing that individuals with ILD reduced the number of exacerbations and hospitalizations during the pandemic period, unlike what happened in COPD and asthma[31]. This hypothesis is also based on the known fact that more frequent exacerbations and hospitalizations are associated with worse sleep quality in COPD[32]. Furthermore, the differing pathophysiology between the diseases is also a crucial point. For instance, COPD is characterized by persistent airflow obstruction due to the destruction of lung parenchyma and chronic inflammation, which together lead to lung hyperinflation[15]. In ILD, there is a deposition of extracellular matrix in the lung parenchyma, which, along with inflammation, leads to a fibrotic process, being characterized by a restrictive ventilatory disorder, with more significant changes in total lung capacity[33]. Although changes in the respiratory system during sleep are physiological and occur in all individuals, including those who are healthy, it seems somewhat disproportionate not to acknowledge that COPD causes significant airflow obstruction, while ILD encounters difficulties with lung expansion. We hypothesize that, in this context, the respiratory system in ILD may have been less burdened at night compared to other conditions, potentially leading to a reduced impact on sleep.

Given this scenario, measures must be implemented. We recommend incorporating sleep assessments into the routine monitoring of chronic respiratory diseases before, during and after periods of social isolation. This can be facilitated by utilizing simple screening questionnaires and conducting objective investigations for individuals at high risk of sleep disorders. Additionally, sleep hygiene orientations are straightforward yet effective measures to enhance sleep patterns can be provided by any trained health professional. This can be attempted through discussion groups, lectures or the distribution of booklets that are applicable from primary to tertiary care. Finally, the literature continues to present conflicting results regarding the effects of pulmonary rehabilitation on sleep aspects[34,35]. One possible reason for this is that the structure of traditional programs may not be adequate to influence sleep. For instance, rehabilitation programs could also be sleep-oriented and individualized, considering adequate assessment methods, type of exercise and specific objectives, interventions and orientations (e.g., education on sleep).

This study has both strengths and limitations. We conducted an objective sleep assessment during a particularly sensitive period of social isolation, whereas most research relied solely on questionnaires, which can eventually distort reality, especially in the individual level. Additionally, utilizing a sleep diary enhances the reliability of our data. Regarding the limitations, individuals were not evaluated for the presence of sleep-disordered breathing, as it was not feasible to utilize polysomnography/polygraphy during the social isolation imposed by the pandemic. Additionally, the study could benefit from a comparison with a healthy control group and had a limited sample size for each disease, which demands caution in the generalization of the results. Finally, we acknowledge that the lack of control for some confounding variables (e.g., medication and age) may influence the results.

CONCLUSION

Individuals with COPD, asthma, and ILD who were not infected with COVID-19 experienced a decline in sleep quality following the period of social isolation, particularly regarding WASO, sleep efficiency, and sleep fragmentation. Additionally, individuals with ILD exhibited less sleep fragmentation compared to those with COPD and asthma (though it was also present). Further research on this field will be certainly useful, especially involving larger samples and a comprehensive sleep investigation, including the assessment of sleep-disordered breathing and controlling for confounding variables.

REFERENCES

1. Brooks SK, Webster RK, Smith LE, Woodland L, Wessely S, Greenberg N, et al. The psychological impact of quarantine and how to reduce it: rapid review of the evidence. Lancet. 2020;395(10227):912-20. http://doi.org/10.1016/S0140-6736(20)30460-8.
2. WHO: World Health Organization. Coronavirus disease (COVID-19) pandemic [Internet]. Geneva: WHO; 2019 [cited 2022 Nov 29]. Available from: https://www.who.int/emergencies/diseases/novel-coronavirus-2019
3. Meherali S, Punjani N, Louie-Poon S, Abdul Rahim K, Das JK, Salam RA, et al. Mental health of children and adolescents Amidst COVID-19 and past pandemics: a rapid systematic review. Int J Environ Res Public Health. 2021;18(7):3432. http://doi.org/10.3390/ijerph18073432.
4. Prommas P, Lwin KS, Chen YC, Hyakutake M, Ghaznavi C, Sakamoto H, et al. The impact of social isolation from COVID-19-related public health measures on cognitive function and mental health among older adults: a systematic review and meta-analysis. Ageing Res Rev. 2023;85:101839. http://doi.org/10.1016/j.arr.2022.101839.
5. Violant-Holz V, Gallego-Jiménez MG, González-González CS, Muñoz-Violant S, Rodríguez MJ, Sansano-Nadal O, et al. Psychological health and physical activity levels during the COVID-19 pandemic: a systematic review. Int J Environ Res Public Health. 2020;17(24):9419. http://doi.org/10.3390/ijerph17249419.
6. Oliveira MR, Sudati IP, Konzen VM, de Campos AC, Wibelinger LM, Correa C, et al. Covid-19 and the impact on the physical activity level of elderly people: a systematic review. Exp Gerontol. 2022;159:111675. http://doi.org/10.1016/j.exger.2021.111675.
7. Pilcher JJ, Dorsey LL, Galloway SM, Erikson DN. Social isolation and sleep: manifestation during COVID-19 quarantines. Front Psychol. 2021;12:810763. http://doi.org/10.3389/fpsyg.2021.810763. PMID: 5082732.
8. Richter SA, Ferraz-Rodrigues C, Schilling LB, Camargo NF, Nunes ML. Effects of the COVID-19 pandemic on sleep quality in children and adolescents: a systematic review and meta-analysis. J Sleep Res. 2023;32(1):e13720. http://doi.org/10.1111/jsr.13720.
9. Linh TTD, Ho DKN, Nguyen NN, Hu CJ, Yang CH, Wu D. Global prevalence of post-COVID-19 sleep disturbances in adults

at different follow-up time points: a systematic review and meta-analysis. Sleep Med Rev. 2023;71:101833. http://doi.org/10.1016/j.smrv.2023.101833.

10. Cui D, Zhang X, Guo J. The impact of the COVID-19 pandemic on physical activity and sleep among healthy adults: a systematic review and meta-analysis. Front Psychol. 2023;14:1149215. http://doi.org/10.3389/fpsyg.2023.1149215.
11. Abdalla PP, Neto ESQ, de Souza Lage ACS, et al. Sleep quality and quality of life among older adults during COVID-19 pandemic: a cross-sectional study. Curr Aging Sci. 2022;15(2):186-96. http://doi.org/10.2174/1874609815666220304195647.
12. Pedrozo-Pupo JC, Campo-Arias A. Depression, perceived stress related to COVID, post-traumatic stress, and insomnia among asthma and COPD patients during the COVID-19 pandemic. Chron Respir Dis. 2020;17:1479973120962800. http://doi.org/10.1177/1479973120962800.
13. Daşdemir KA, Suner-Keklik S. Physical activity, sleep, and quality of life of patients with asthma during the COVID-19 pandemic. J Asthma. 2022;59(7):1484-90. http://doi.org/10.1080/02770903.2021.1931303.
14. Agarwal S, Richardson B, Krishnan V, Schneider H, Collop NA, Danoff SK. Interstitial lung disease and sleep: what is known? Sleep Med. 2009;10(9):947-51. http://doi.org/10.1016/j.sleep.2009.01.004.
15. GOLD: Global Initiative for Chronic Obstructive Lung Disease. Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Pulmonary Disease [Internet]. 2022 [cited 2022 Nov 29]. Available from: www.goldcopd.org
16. GINA: Global Initiative for Asthma. Global Strategy for Asthma Management and Prevention [Internet]. 2022 [cited 2022 Nov 29]. Available from: https://ginasthma.org/
17. Baldi BG, Pereira CA, Rubin AS, Santana AN, Costa AN, Carvalho CR, et al. Highlights of the Brazilian Thoracic Association guidelines for interstitial lung diseases. J Bras Pneumol. 2012;38:282-91. http://doi.org/10.1590/S1806-37132012000300002.
18. Miller MR, Crapo R, Hankinson J, Brusasco V, Burgos F, Casaburi R, et al. General considerations for lung function testing. Eur Respir J. 2005;26(1):153-61. http://doi.org/10.1183/09031936.05.00034505.
19. Lusuardi M, De Benedetto F, Paggiaro P, Sanguinetti CM, Brazzola G, Ferri P, et al. A randomized controlled trial on office spirometry in asthma and COPD in standard general practice: data from spirometry in Asthma and COPD: a comparative evaluation Italian study. Chest. 2006;129(4):844-52. http://doi.org/10.1378/chest.129.4.844.
20. Conley S, Knies A, Batten J, Ash G, Miner B, Hwang Y, et al. Agreement between actigraphic and polysomnographic measures of sleep in adults with and without chronic conditions: a systematic review and meta-analysis. Sleep Med Rev. 2019;46:151-60. http://doi.org/10.1016/j.smrv.2019.05.001.
21. Martin JL, Hakim AD. Wrist actigraphy. Chest. 2011;139(6):1514-27. http://doi.org/10.1378/chest.10-1872.
22. Pedrazzoli M, Gonçalves B, coordenadores. Consenso Brasileiro de Actigrafia. São Paulo: Segmento Farma Editores; 2021.
23. Ohayon M, Wickwire EM, Hirshkowitz M, Albert SM, Avidan A, Daly FJ, et al. National Sleep Foundation's sleep quality recommendations: first report. Sleep Health. 2017;3(1):6-19. http://doi.org/10.1016/j.sleh.2016.11.006.
24. Zitser J, Allen IE, Falgàs N, Le MM, Neylan TC, Kramer JH, et al. Pittsburgh Sleep Quality Index (PSQI) responses are modulated by total sleep time and wake after sleep onset in healthy older adults. PLoS One. 2022;17(6):e0270095. http://doi.org/10.1371/journal.pone.0270095.
25. Zhao B, Sun S, He X, Yang J, Ma X, Yan B. Sleep fragmentation and the risk of obesity: the sleep heart health study. Obesity (Silver Spring). 2021;29(8):1387-93. http://doi.org/10.1002/oby.23193.
26. Piber D, Olmstead R, Cho JH, Irwin MR. Disturbance of sleep maintenance, but not sleep duration, activates nuclear factor-κB and signal transducer and activator of transcription family proteins in older adults: sex differences. Sleep (Basel). 2023;46(10):zsad130. http://doi.org/10.1093/sleep/zsad130.
27. Hirshkowitz M, Whiton K, Albert SM, Alessi C, Bruni O, DonCarlos L, et al. National Sleep Foundation's sleep time duration recommendations: methodology and results summary. Sleep Health. 2015;1(1):40-3. http://doi.org/10.1016/j.sleh.2014.12.010.
28. Hirata RP, Dala Pola DC, Schneider LP, Bertoche MP, Furlanetto KC, Hernandes NA, et al. Tossing and turning: association of sleep quantity-quality with physical activity in COPD. ERJ Open Res. 2020;6:00370-2020. http://doi.org/10.1183/23120541.00370-2020.
29. Luyster FS, Shi X, Baniak LM, Morris JL, Chasens ER. Associations of sleep duration with patient-reported outcomes and health care use in US adults with asthma. Ann Allergy Asthma Immunol. 2020;125(3):319-24. http://doi.org/10.1016/j.anai.2020.04.035.
30. Ceolin C, Limongi F, Siviero P, Trevisan C, Noale M, Catalani F, et al. Changes in sleep duration and sleep timing in the general population from before to during the first covid-19 lockdown: a systematic review and meta-analysis. Int J Environ Res Public Health. 2024;21(5):583. http://doi.org/10.3390/ijerph21050583.
31. Gupta N, Dhar R, Swarnakar R, Bedi R, Chawla R. Impact of COVID-19 on (Non-COVID) chronic respiratory disease outcome survey in India (CCROS study). Lung India. 2021;38(5):454-9. http://doi.org/10.4103/lungindia.lungindia_965_20.
32. Baugh A, Buhr RG, Quibrera P, Barjaktarevic I, Barr RG, Bowler R, et al. Risk of COPD exacerbation is increased by poor sleep quality and modified by social adversity. Sleep (Basel). 2022;45(8):45. http://doi.org/10.1093/sleep/zsac107.
33. Mikolasch TA, Garthwaite HS, Porter JC. Update in diagnosis and management of interstitial lung disease. Clin Med (Lond). 2017;17(2):146-53. http://doi.org/10.7861/clinmedicine.17-2-146.
34. Gabrovska M, Herpeux A, Bruyneel AV, Bruyneel M. Pulmonary rehabilitation improves sleep efficiency measured by actigraphy in poorly sleeping COPD patients. Sci Rep. 2023;13:11333. http://doi.org/10.1038/s41598-023-38546-3.
35. Cox NS, Pepin V, Burge AT, Hill CJ, Lee AL, Bondarenko J, et al. Pulmonary rehabilitation does not improve objective measures of sleep quality in people with chronic obstructive pulmonary disease. COPD. 2019;16(1):25-9. http://doi.org/10.1080/15412555.2019.1567701.

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