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Impact of psychosocial determinants on sleep quality decreased during the COVID-19 lockdown: Evidence from an urban panel study

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ABSTRACT

Objectives: To explore the relationship between socioeconomic and health-related changes during the COVID-19 lockdown and sleep quality.
Methods: A panel study was conducted with 667 participants from the Argentine Social Debt Survey in 2019 (pre lockdown), 2020 (during lockdown), and 2021 (post lockdown). Generalized linear mixed-effects models were performed to explore the following predictors of self-reported sleep quality over time: age, educational level, living in poverty, employment status, place of residence, psychological distress, and health status.
Results: Reporting poor health and residing in Buenos Aires were associated with poor sleep quality, independent of the lockdown. Advanced age emerged as a significant predictor of poor sleep quality after the lockdown. Differences in sleep quality associated with living in poverty and psychological distress disappeared during lockdown and resumed post lockdown.
Conclusions: This work highlights the importance of the dynamic interplay between socioeconomic and health-related factors when assessing sleep quality. In this urban Argentine panel study, the COVID-19 lockdown appeared to mitigate poverty-related disparities in sleep quality, underscoring the need to refocus attention on these vulnerable subpopulations in the post-lockdown period, when such disparities re-emerged.

Introduction

Epidemiological studies consistently show that individuals of lower socioeconomic status (SES) are more likely to experience poorer sleep quality (SQ), more fragmented sleep, shorter sleep duration, and delayed onset.[1] Sleep disparities, defined as differences in sleep health due to social causes, may be partially driven by living in disadvantaged neighborhoods, which often have high rates of poverty, unemployment, and low rates of home ownership and university education.[2,3] Sleep disparities may be more severe in those lacking stable and secure places to sleep and may be reduced by simple housing improvements.[2,4]

COVID-19 lockdowns were associated with sleep problems like insomnia, sleep disruption, delayed sleep onset, increased sleep medication consumption, and sometimes longer sleep duration.[5,6] Overall, disturbed sleep was more prevalent in women and young adults. Higher levels of stress, anxiety, and depression symptoms were associated with increased sleep difficulties.[5,6] Other risk factors for sleep problems during COVID-19 lockdowns included a lower educational level,[7] lower SES,[8] and living in urban areas.[9]

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Early on, it was hypothesized that the COVID-19 crisis would exacerbate existing health disparities.[10] Lockdowns globally highlighted disparities in access to resources and opportunities, with lower-income individuals facing greater challenges in accessing healthcare,[11] education,[12] and employment opportunities[13] during the pandemic. Interestingly, lockdowns might have mitigated other disparities, such as less environmental pollution due to reduced industrial activity and transportation,[14] and improved work-life balance,[15] providing more opportunities to spend time with family and leisure activities. Although several studies identified mental health as a risk factor for poor SQ,[16,17] less studies evaluated factors related to SES.[8,18] Furthermore, studies addressing these risk factors were not panel studies or did not conduct live interviews, leaving them susceptible to potential biases. Finally, Argentina was characterized by strict and prolonged confinement measures, with strong state aid interventions, distinguishing it from other countries.[19] Given the above, the extent to which the COVID-19 lockdown modified sleep health disparities remains unclear.

In March 2020, Argentina implemented a strict and prolonged lockdown. This massive natural experiment might provide some insight into the mechanisms underlying the relationship between sleep health and SES. Thus, we sought to determine if changes associated with COVID-19 lockdown modified sleep health disparities using data from the Argentine Social Debt Survey 2019-2021.

Participants and methods

Experimental design

The present study is a panel design, utilizing three waves of data collection (2019, 2020, and 2021) of the Argentine Social Debt Survey (EDSA, for its acronym in Spanish). The EDSA is a multipurpose national survey carried out between July and October on an annual basis by the Observatory of Social Debt (ODSA) of the Pontifical Catholic University of Argentina (UCA). It collects socioeconomic information from households and their members living in urban areas with over 80,000 inhabitants, representing 60% of the total national population. The sample comprises about 5700 surveyed households. The household respondent was selected through a systematic quota allocation process based on age and sex distribution according to the population structure of each sample stratum and survey area. Due to lockdown restrictions during 2020, telephone interviews were carried out exclusively for data collection. In 2021, in-person surveys were reinstated, as lockdown restrictions were progressively relaxed since February 2021.

The EDSA is based on a probabilistic multistage sampling design, with nonproportional stratification and systematic selection of households at each sampling point. In the first stage, urban agglomerations were selected by geographic area and size. Second, stratified random sampling was used in conjunction with a variable radius plot, with probability proportional to the size of the population aged 18 years and older, and six strata based on a socioeconomic index. The last stage consisted of systematic random sampling of households within the radius plot. Trained interviewers visited households when possible or interviewed the participants via telephone. Individuals from each household were invited to participate, randomly selected through a quota system of age and sex corresponding to each residential radius.

A third of the households from the original probabilistic sample were interviewed multiple times allowing to obtain panel data. Respondents who remained in the household agreed to participate consecutively each year, and completed the full survey during each round, were included in the panel subgroup. The final sample size of the panel dataset consisted of 667 individuals aged 18 years and older residing in Argentinean urban areas. They were interviewed on an annual basis in 2019, 2020, and 2021 (pre lockdown, during lockdown, and post lockdown) during the third quarter of the year (July-October). Post-lockdown 2021 measures were more flexible, allowing activities with capacity limits and health protocols.[19] Using panel databases allows for successive follow-ups, making it possible to analyze changes over time and to establish cause-effect associations with greater reliability than cross-sectional studies. Panel studies help control time bias by removing variability due to differences in sample composition from one period to another. All the descriptions provided in this paper consider the variables for each year of the survey (2019-2020-2021).

Measurements

The present study analyzes the evolution of SQ before, during, and after the COVID-19 lockdown (2019-2020-2021) and evaluates factors that might explain poor SQ. This variable is self-reported in the EDSA with the following question taken from a Spanish version of the Pittsburgh Sleep Quality Index (PSQI): “How would you rate your sleep quality overall during the past 30 days?”.[20] Possible answers are rated on a four-point Likert scale ranging from “very bad” to “very good” sleep quality, which were then dichotomized as “good sleep quality” (“very good” and “quite good”) and “poor sleep quality” (“quite bad” and “very bad”).

Additionally, sociodemographic variables (SDVs) provided by the EDSA were included in our analyses as potential predictors (explanatory variables) of poor SQ. The variables considered in the following analysis were age, sex, educational level, place of residence, living in poverty, and employment status. Psychological distress and health status were also considered. Data about COVID-19 disease were obtained by self-report in 2021, referring to having had COVID either in 2020 or 2021. The survey year (2019, 2020, and 2021) was taken into consideration as a factor that might explain poor SQ, due to the COVID-19 lockdown.

Age was dichotomized into two categories: 18-59 vs. ≥60 years old. The selected age cutoff of 18 years is the standard used by EDSA for their analyses and reflects the age of majority in Argentina. Years of formal education was dichotomized in incomplete high school level vs. complete high school level or above. Place of residence was also divided into two categories: residing in Buenos Aires vs. residing in other urban areas. In addition, participants’ employment status was assessed by the EDSA, and classified as follows: unemployed (actively seeking work and available to work), precarious job, stable job, and inactive individuals (not seeking work—due to study, household duties, retirement, or discouragement).[21] The employment variable was then dichotomized into two categories: full employment (those with stable job) vs. unstable employment (including those with precarious jobs, unemployed, and inactive individuals).

Living in poverty was defined based on the poverty line method, which classifies households and their members as poor if their monthly income does not cover the market value of a consumer basket of goods and services necessary to meet basic subsistence and social functioning needs, based on household size and composition (approximately USD 600 in 2019 and 2020, and about USD 700 in 2021 for a household of two adults and two children). Individuals classified as poor did not meet or exceed this threshold. This method is used in Argentina as the official index to measure the deficit in the population’s current consumption capacity.[22]

Psychological distress was assessed by the EDSA through the Kessler Psychological Distress Scale (KPDS-10), a validated instrument with strong psychometric properties for screening psychological distress in the Argentine population.[23] It consists of 10 items that evaluate anxiety and depression symptoms during the last month. Participants were classified as experiencing psychological distress or not based on the KPDS-10 cutoff score of 24 points.

Health status measured self-reported health status, including biological and psychological dimensions. It identifies individuals without health problems, with some health problems or chronic or severe illnesses. For this study, respondents were classified into two categories as follows: those with no perceived health problems (good health) and those with some health problems or chronic illnesses (poor health).

Statistical analysis

All statistical analyses were conducted in RStudio (version 2023.09.1+494), ensuring reproducibility.

To assess whether the panel subsample was comparable to the larger EDSA sample, we examined differences in age, sex, living in poverty, and educational level between groups using chi-square tests. Values are presented as frequency and percentage.

Baseline SQ in 2019 was compared against baseline SDVs. To assess a possible relation between SQ and self-report COVID-19 disease in 2020 or 2021, we considered individuals with poor SQ in 2020 or 2021 and then compared the variables. These comparisons were conducted using chi-square tests and values are presented as frequency and percentage.

We employed generalized linear mixed-effects models (GLMMs) with a binary outcome variable representing poor SQ to analyze the effects of various predictors on SQ over time. In these models, SQ acted as the dependent variable, subject as a random factor, and each SDV as a fixed factor. Interactions between each SDV and time were also incorporated. The models were fit using the *glmer* function from the *lme4* package in RStudio.

First, simple models were conducted to explore the variations of SQ and time-varying SDVs along time. We reported the frequencies and percentages of occurrence for the comparison categories of each variable for each year. Estimates refer to the regression coefficients or parameters that quantify the relationship between the predictor variable (year) and the probability of the outcome, considering year 2020 as the reference category.

$$SQ \sim year + 1/subject$$

$$SDV \sim year + 1/subject$$

Models with one SDV predictor and its interaction with time were performed to explore individual effects of each predictor on SQ. When significant interactions were identified, we described the observed patterns to properly interpret data and determine whether main effects remained informative.

$$SQ \sim year + SDV + SDV^{*}year + 1/subject$$

Time-varying factors like living in poverty, employment status, psychological distress, and health condition are considered endogenous, as the value at time "t" depends on the previous value. While the model estimates describe the relationship between the predictor and the outcome, considering the random effects of the model, their exact values should be interpreted with caution.[24]

The *allEffects* function from the *effects* package was implemented to obtain the predicted log-odds of poor SQ for different levels of time and each SDV. These log-odds were then converted to probabilities and 95% confidence intervals were calculated. Pairwise contrasts of poor SQ log-odds between SDV conditions for each year were conducted using the *emmeans* package with p-values adjusted using Tukey's correction.

A comprehensive model was conducted, including all predictors and their interactions with time, in order to explore the independent influence of various demographic, socioeconomic, and health-related factors on SQ over time:

Table 1
Comparison of panel subsample and EDSA survey sociodemographic characteristics

	Group			p value
	Panel (n = 667)	EDSA (n = 5049)	Total (n = 5716)	
Sex				**> .001**
Female	395 (59.2%)	2641 (52.3%)	3036 (46.9%)	
Male	272 (40.8%)	2408 (47.7%)	2680 (53.1%)	
Age				**.001**
18-60 y	429 (64.3%)	3897 (77.2%)	4326 (75.7%)	
60+ y	238 (35.7%)	1152 (22.8%)	1390 (24.3%)	
Living in poverty				**.002**
Yes	162 (24.3%)	1527 (30.2%)	1689 (29.5%)	
No	505 (75.7%)	3522 (69.8%)	4027 (70.5%)	
Educational level				**.009**
Incomplete high school	247 (37%)	2142 (42.4%)	2389 (41.8%)	
Complete high school	420 (63%)	2907 (57.6%)	3327 (58.2%)	

Frequencies (percentages) are shown. Significant differences as assessed by a chi-square test, are marked in **bold**

$$SQ \sim year + SDV_1 + SDV_2 + [\ldots] + SDV_n + SDV_1{}^{*}year + SDV_2{}^{*}year + [\ldots] + SDV_n{}^{*}year + 1/subject$$

Finally, a sensitivity analysis was performed to assess the robustness and stability of our results by incorporating continuous variables when available and expanding categorical variables to multiple levels (see Supplementary Materials).

Ethical aspects

The EDSA was originally approved by the Institutional Review Board at UCA. The database is anonymized to ensure participants' confidentiality, who provided oral informed consent before starting the interview. As the present study only utilizes the anonymized EDSA database, compliance with the statistical confidentiality mandated by Argentine Law 17.622 is guaranteed, and no further ethical approval is required according to Ministry of Health Resolution 1480/11.

Results

Table 1 shows comparisons between the baseline (2019 survey) panel subsample and the overall baseline EDSA sample. The panel group differs significantly from the overall sample in sex, age, living in poverty, and educational level. However, the percentage differences between groups are generally below 10%.

Table 2 shows baseline (2019 survey) characteristics of the sample. Overall, the sample exhibited a high prevalence of individuals living in poverty, low educational level, and unstable employment. There was a higher percentage of participants with poor SQ among those living in poverty and individuals experiencing psychological distress. Other SDVs did not exhibit differences between groups (Table 2). A total of 18.7% of participants reported they had COVID-19, and almost a third of them (29.6%) reported poor SQ. Among those who did not report having COVID-19, 30.3% experienced poor SQ. No significant association was found between COVID-19 disease and poor SQ (X^2 = 0.001, p = .971).

Table 3 shows the binary logistic mixed-effects model assessing the COVID-19 lockdown effect on SQ and SDVs. Although the probability of having poor SQ decreased during 2021, this difference was not statistically significant. The probability of living in poverty and experiencing psychological distress was higher in 2020 than in 2021, while the probability of having poor health was lower in 2020 than

Table 2
Baseline sociodemographic characteristics

	Sleep quality			p value
	Good (n = 509)	Poor (n = 158)	Total (n = 667)	
Sex				
Female	298 (58.5%)	97 (61.4%)	395 (59.2%)	.817
Male	211 (41.5%)	61 (38.6%)	272 (40.8%)	
Age				
60+ y	182 (35.8%)	56 (35.4%)	238 (35.7%)	.997
18-60 y	327 (64.2%)	102 (64.6%)	429 (64.3%)	
Living in poverty				
Yes	109 (21.4%)	56 (35.4%)	165 (24.7%)	**.002**
No	400 (78.6%)	102 (64.6%)	502 (75.3%)	
Educational level				
Incomplete high school	178 (35.0%)	69 (43.7%)	247 (37.0%)	.141
Complete high school	331 (65.0%)	89 (56.3%)	420 (63.0%)	
Unstable employment				
Yes	367 (72.1%)	124 (78.5%)	491 (73.6%)	.283
No	142 (27.9%)	34 (21.5%)	176 (26.4%)	
Place of residence				
Buenos Aires	153 (30.1%)	50 (31.6%)	203 (30.4%)	.931
Other urban areas	356 (69.9%)	108 (68.4%)	464 (69.6%)	
Psychological distress				
Yes	83 (16.3%)	73 (46.2%)	156 (23.4%)	**< .001**
No	426 (83.7%)	85 (53.8%)	511 (76.6%)	
Health status				
Poor	228 (44.8%)	107 (67.7%)	335 (50.2%)	**< .001**
Good	281 (55.2%)	51 (32.3%)	332 (49.8%)	
COVID-19*				
Yes	99 (19.5%)	26 (16.5%)	125 (18.7%)	.701
No	410 (80.5%)	132 (83.5%)	542 (81.3%)	

Frequencies (percentages) are shown. Significant differences as assessed by a chi-square test, are marked in **bold**
* COVID-19 refers to self-reported diagnosis in 2020 or 2021

2019. All the other SDVs showed no significant differences over time (Table 3).

Table 4 shows the binary logistic mixed-effects models individually assessing SDVs that modified the effect of COVID-19 lockdown on SQ. Fig. 1 shows the probability of having poor sleep over time categorized by SDVs. Being female was associated with a higher probability of having poor SQ, with no significant differences along time (Table 4 and Fig. 1A).

The presence of significant interactions suggests the probability of experiencing poor SQ over time changes differently depending on

Table 4
Binary logistic mixed-effects models individually assessing sociodemographic factors that modulate the effect of COVID-19 lockdown on sleep quality

	Estimate	SE	Z value	p value
Sex				
Time 2019	0.56	0.24	2.30	**.021**
Time 2021	−0.07	0.26	−0.26	.796
Female	0.66	0.24	2.72	**.007**
Time 2019: female	−0.50	0.30	−1.65	.100
Time 2021: female	−0.31	0.32	−0.96	.336
Age group				
Time 2019	0.19	0.18	1.07	.284
Time 2021	−0.52	0.20	−2.68	**.007**
60+ years	−0.15	0.24	−0.64	.522
Time 2019: 60+ years	0.14	0.30	0.45	.653
Time 2021: 60+ years	0.68	0.32	2.14	**.032**
Living in poverty*				
Time 2019	0.05	0.17	0.31	.753
Time 2021	−0.44	0.18	−2.43	**.015**
Yes	0.13	0.25	0.52	.602
Time 2019: yes	0.66	0.33	2.01	**.045**
Time 2021: yes	0.71	0.35	2.03	**.042**
Educational level*				
Time 2019	> 0.01	0.18	> 0.01	1.000
Time 2021	−0.59	0.20	−3.03	**.002**
Low educational level	−0.21	0.24	−0.88	.381
Time 2019: low ed. level	0.62	0.30	2.09	**.037**
Time 2021: low ed. level	0.92	0.32	2.84	**.005**
Employment status*				
Time 2019	0.25	0.32	0.78	.435
Time 2021	−1.15	0.41	−2.84	**.004**
Unstable employment	0.32	0.32	0.98	.324
Time 2019: unstable emp.	0.04	0.42	0.11	.915
Time 2021: unstable emp.	1.04	0.50	2.08	**.037**
Place of residence*				
Time 2019	0.41	0.18	2.29	**.022**
Time 2021	−0.07	0.19	−0.37	.708
Residing in Buenos Aires	0.60	0.24	2.5	**.012**
Time 2019: res. Buenos Aires	−0.50	0.31	−1.63	.102
Time 2021: res. Buenos Aires	−0.59	0.33	−1.81	.071
Psychological distress*				
Time 2019	0.02	0.19	0.11	.912
Time 2021	−0.48	0.20	−2.43	**.015**
Yes	0.93	0.24	3.90	**< .001**
Time 2019: yes	0.85	0.33	2.54	**.011**
Time 2021: yes	0.93	0.35	2.64	**.008**
Health status*				
Time 2019	0.10	0.23	0.43	.666
Time 2021	−0.81	0.25	−3.18	**.002**
Poor health	1.05	0.23	4.56	**< .001**
Time 2019: poor health	0.09	0.31	0.30	.766
Time 2021: poor health	0.91	0.34	2.70	**.007**

SE, standard error. Significant differences are marked in **bold**
* Time-varying endogenous factors (estimates should be interpreted with caution). See the text for details

Table 3
Binary logistic mixed-effects model assessing the effect of COVID-19 lockdown on sleep quality and sociodemographic variables

	2019	2020	2021	Contrast	Model			
					Estimate	SE	Z value	p value
Poor sleep quality	158 (23.7%)	135 (20.2%)	112 (16.8%)	19v20	0.24	0.14	1.65	.984
				21v20	−0.27	0.15	−1.74	.081
Living in poverty	165 (24.7%)	178 (26.7%)	142 (21.3%)	19v20	−0.19	0.17	−1.12	.261
				21v20	−0.57	0.18	−2.15	**.001**
Unstable employment	491 (73.6%)	505 (75.7%)	501 (75.1%)	19v20	−0.43	0.25	−1.71	.087
				21v20	−0.13	0.25	−0.50	.617
Psychological distress	156 (23.4%)	183 (27.4%)	131 (19.6%)	19v20	−0.24	0.13	−1.79	.073
				21v20	−0.48	0.14	−3.51	**< .001**
Poor health	335 (50.2%)	276 (41.4%)	272 (40.8%)	19v20	0.62	0.15	4.23	**< .001**
				21v20	−0.04	0.15	−0.29	.771

Frequencies (percentages) are shown. SE, standard error. Significant differences are marked in **bold**

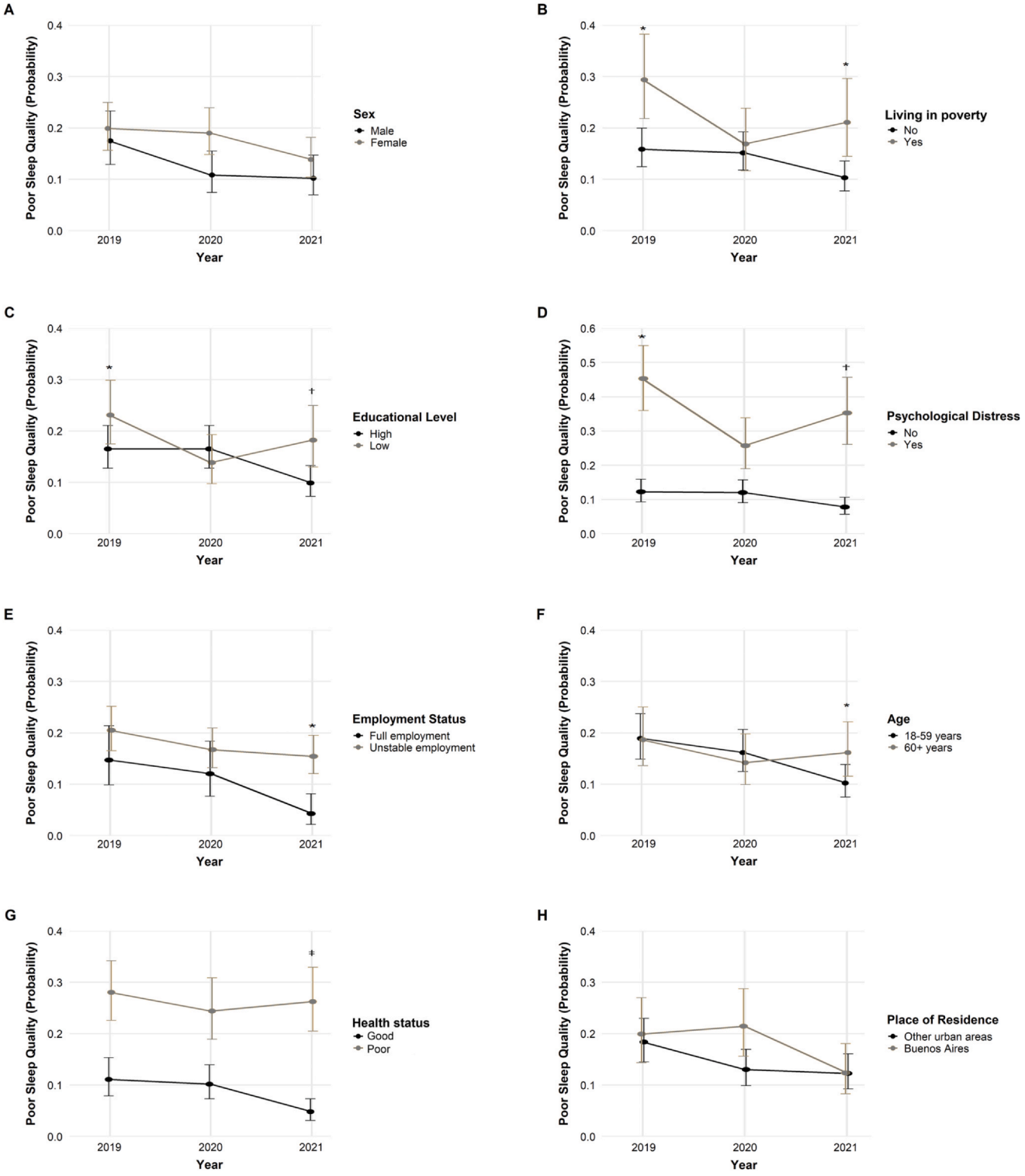

Fig. 1. Trends in poor sleep quality by socioeconomic factors that modulate the effect of COVID-19 lockdown. Being female was associated with a higher probability of having poor sleep quality, with no significant differences along time (A). Living in poverty (B), lower educational level (C), and presence of psychological distress (D) were associated with a higher probability of poor sleep quality both in 2019 and 2021, with these differences disappearing in 2020. Unstable employment (E) and age 60+ (F) were associated with a higher probability of poor sleep quality only in 2021. Poor health status (G) was associated with a higher probability of poor sleep quality in all years; however, a significant interaction term was observed, with statistical significance attained only in 2021. Although living in Buenos Aires (H) was associated with a nonsignificant trend toward poorer sleep quality in 2020, the association became significant only when living in Buenos Aires was considered as a main factor. Probabilities and 95% confidence intervals were derived from predicted log-odds of poor sleep quality for each year. * $p < .05$, † $p < .01$, ‡ $p < .001$. Note: (D) uses a different scale to avoid obscuring trends in the other graphs

age, living in poverty, educational level, employment status, psychological distress, and health status (Table 4). Living in poverty, lower educational level, and presence of psychological distress were associated with a higher probability of poor SQ both in 2019 and 2021, with these differences disappearing in 2020 (Figs. 1B, 1C and 1D, respectively). Unstable employment and age 60+ were associated with a higher probability of poor SQ only in 2021 (Figs. 1E and 1F, respectively). Poor health was associated with a higher

Table 5
Binary logistic mixed-effects model jointly assessing sociodemographic factors that modulate the effect of COVID-19 lockdown on sleep quality

	Estimate	SE	Z value	p value
2019	0.20	0.49	0.40	.689
2021	−1.31	0.60	−2.17	**.030**
Female	0.36	0.26	1.42	.157
60+ years	−0.84	0.32	−2.65	**.008**
High educational level	0.25	0.26	0.95	.343
Living in poverty	−0.22	0.31	−0.72	.472
Unstable employment	0.15	0.34	0.44	.663
Residing in Buenos Aires	0.58	0.25	2.30	**.022**
Psychological distress	0.79	0.25	3.16	**.002**
Poor health	1.22	0.28	4.42	**< .001**
Time 2019: female	−0.53	0.33	−1.59	.112
Time 2021: female	−0.40	0.36	−1.11	.268
Time 2019: 60+ years	0.67	0.40	1.68	.093
Time 2021: 60+ years	0.88	0.44	2.00	**.045**
Time 2019: high educational level	−0.19	0.34	−0.55	.584
Time 2021: high educational level	−0.21	0.37	−0.57	.571
Time 2019: living in poverty	0.84	0.41	2.05	**.040**
Time 2021: living in poverty	1.21	0.45	2.68	**.007**
Time 2019: unstable employment	−0.15	0.44	−0.34	.737
Time 2021: unstable employment	0.42	0.54	0.78	.433
Time 2019: residing in Buenos Aires	−0.50	0.33	−1.51	.130
Time 2021: residing in Buenos Aires	−0.50	0.36	−1.39	.165
Time 2019: psychological distress	0.86	0.35	2.43	**.015**
Time 2021: psychological distress	0.81	0.38	2.12	**.034**
Time 2019: poor health	−0.05	0.36	−0.14	.890
Time 2021: poor health	0.64	0.41	1.58	.114

Estimates should be interpreted with caution. See the text for details. SE, standard error. Significant differences are marked in **bold**

probability of poor SQ in all years; however, a significant interaction term was observed, with statistical significance attained only in 2021 (Fig. 1G). Although residing in Buenos Aires was associated with a nonsignificant trend toward poorer SQ in 2020, the association became significant only when residing in Buenos Aires was considered as a main factor (Fig. 1H).

Table 5 presents the comprehensive binary logistic mixed-effects model for jointly assessing SDVs that modulate the effect of COVID-19 lockdown on SQ. Regarding sociodemographic predictors, having poor health and residing in Buenos Aires remained significant only as main factors, both showing a general positive effect on poor SQ. In the interaction analyses, only living in poverty and psychological distress remained significant, maintaining the same previous trends (Table 5), while being 60+ years old exhibited a significant positive effect on poor SQ only in 2021.

Sensitivity analysis results are in line with these findings (see Supplementary Materials).

Discussion

In this study, we examined key factors associated with sleep quality before, during, and after the COVID-19 lockdown. Our main finding is that COVID-19 lockdown impacted sleep disparities by changing the dynamics and social factors associated with SQ during lockdown. The COVID-19 lockdown disrupted associations during lockdown that were present pre lockdown and resumed in post lockdown. Also, as previously reported in the literature, reporting poor health and residing in Buenos Aires were associated with poor sleep quality, independent of the lockdown, while advanced age emerged as a significant predictor of poor sleep quality after the lockdown.

An ever-growing body of evidence has described the consequences of the COVID-19 lockdown on SQ. For example, two large Italian studies revealed increased sleep latency, decreased sleep efficiency, increased use of sleep medication, increased sleep duration, and better daytime functioning,[25] as well as impaired SQ and disrupted sleep habits as a result of heightened psychological distress.[16] A US study reported poor sleep was present in one-fifth of participants with one or more chronic conditions. Being over 70 years old and having received the COVID-19 vaccine were protective factors against poor sleep. Conversely, the study identified experiencing poor physical function and mental health as risk factors.[17]

Findings from Latin America were largely consistent with those described above. A Brazilian study reported an increase in sleep duration and sleep efficiency, with a decline in SQ and a rise in insomnia-related symptoms.[26] An online cross-sectional study in the same country showed that over 40% of individuals developed sleep disturbances during the pandemic and 48% reported exacerbation of their pre-existing sleep problems.[27] Research from Chile and Uruguay reported similar results.[28,29] Notably, another investigation from Brazil challenged these results. It included data from two population-based cross-sectional studies conducted in 2019 and 2020, based on interviews with approximately 800 adults conducted by trained personnel. The findings of this study showed a decrease in the prevalence of poor or very poor SQ during COVID lockdown.[30]

An Argentine study of a sample of 1021 subjects that completed online questionnaires before and during the pandemic reported that participants slept longer and later during lockdown weekdays, and exhibited lower levels of social jetlag.[31] Regarding SQ, in a sample of 5760 interviewed participants from the EDSA survey in 2020, experiencing poor SQ in the previous month remained stable compared with previous years, with one-fifth of responders reporting poor SQ. Specifically, in 2019, 22% of adults rated their SQ as quite poor or very poor, while in 2020, this figure decreased to 19%.[32]

In our subsample, taken from the same EDSA survey, 24% of adults reported quite poor or very poor SQ, which decreased to 20% in 2020, and further declined to 17% in 2021. Although the likelihood of having poor SQ decreased during the lockdown, this difference was not statistically significant. These results mirror Schäfer et al.'s findings,[30] who implemented a similar sampling method (though not a panel) and data collection technique, differing from the online questionnaires used in most studies that usually involve biased methods such as social media ads or mailing lists. The authors attributed these results to weak mitigation measures to contain COVID-19, possibly resulting in part of the population not perceiving significant changes in their lives brought about by the pandemic. Conversely, in Argentina, mitigation measures were robust, leading us to attribute the observed results to a reduction in job-related stress variables, which may have persisted into 2021 when considering the sample as a whole, but not when divided by other variables, as discussed below.

Studying the associations between SQ and other variables can provide additional insight into the interpretation of our findings. Being female was associated with a higher probability of having poor SQ over time, which may be explained by higher prevalence of insomnia, differences in childcare and elderly care, or income differences.[33] However, sex differences vanished when controlling for other variables. Being over 60 years old was associated with a higher likelihood of reporting poor SQ only in 2021. Sleep problems associated with increasing age may not be evident in epidemiological studies, as seen in a previous study by our group.[3] Although age is linked to less robust circadian rhythms and sleep homeostasis,[34] younger adults report higher daily stressors that can decrease SQ,[35] thus compensating for these differences. The relative weight of these factors during the study years may partially explain results during and after the lockdown. The increased likelihood of reporting poor SQ in 2021 may be linked to the rise in sleep disorders among individuals over 60 following the lockdown, attributed to a slower recovery from its psychological impact with increasing age.[36] Conversely, it was reported that younger individuals might have been more susceptible to psychological distress, while older individuals, less concerned about job loss threats, may have continued engaging

in similar activities as before the lockdown.[37] The predominance of this factor over the dampening of circadian rhythms typically associated with aging might explain why older age emerged as a significant main protective factor in the comprehensive model.

Residing in Buenos Aires was associated with a higher likelihood of reporting poor SQ during 2020, but not in 2019 or 2021. However, these differences disappeared in the comprehensive model. Unstable employment was associated with a higher probability of poor SQ only in 2021. Similarly, SQ differences related to unstable unemployment disappeared in the comprehensive model, while the increased probability of poor SQ associated with residing in Buenos Aires remained as a main factor. This finding is consistent with other studies that describe living in megacities as associated with stressful situations, which may contribute to sleep problems development.[38]

Even if having poor health modified SQ, having COVID-19 by itself was not associated with differences in the probability of reporting poor SQ. This likely reflects that the majority of COVID-19 cases, estimated at 90%, were mild and did not require hospital admission in Argentina,[39] and that the usual symptom duration was around 15 days in outpatients.[40] As revealed by the comprehensive model, having poor health was a main factor that determined poor SQ, independently of COVID lockdown. Along these lines, other studies observed insomnia was associated with depression or anxiety or pre-existing chronic conditions.[41]

In our research, living in poverty, educational level, and psychological distress were associated with a higher likelihood of reporting poor SQ both in 2019 and 2021, with these disparities disappearing in 2020. These results contrast with previous published research. A large study of 14,676 US residents reported that higher socioeconomic deprivation was associated with shorter sleep duration and poorer mental health after adjusting for age, sex, race, education, income, and body mass index.[18] In Brazil, the chance of sleep disorders exacerbation was 34%, and it was higher in people who lost their jobs or experienced a significant income decrease.[8] The authors attributed these findings to the disproportionate impact of COVID-19 on disadvantaged areas, highlighting the additional deleterious effects of structural inequities.[8,18]

When jointly assessing sociodemographic factors that modulate the effect of COVID-19 lockdown on SQ in a single model, apart from the already discussed interaction between age and time, only two interactions remained as significant predictors: living in poverty and time, and psychological distress and time. Conversely, the interactions between educational level, poor health, or residing in Buenos Aires, and time, disappeared. Thus, living in poverty and psychological distress may act as confounders of the relationship between SQ and those variables.[38,42]

The effect of living in poverty and psychological distress on SQ during lockdown warrants a comprehensive discussion. In Argentina, salaries in both the public and private sectors were not interrupted. A governmental regulation (Executive order 332/2020) mandated that employers continue paying part of the salaries, while the State covered the rest. Additionally, employee dismissal was penalized, with severance costs doubling.[43,44] We believe this explains the lack of observed changes in employment, psychological distress, and poverty during the lockdown, with the latter two even decreasing after it. Similarly, a study from Belgium observed unemployed individuals experienced fewer restrictions due to a robust and redistributive welfare system focused on minimum income protection, and on social risks such as financial aid for long-term unemployment.[33]

Living in poverty and psychological distress showed a lower likelihood of poor SQ during the lockdown, disrupting associations that were present pre lockdown and resumed post lockdown. Since most workers continued receiving their salaries during lockdown, other factors become more important for explaining sleep quality disparities than poverty and distress that were important drivers in 2019 and 2021. Among the factors that may have changed and could account for these differences, commuting deserves attention. Commuting and commuting time decreased after the lockdown began.[45,46] Additionally, low-income individuals often face significant challenges to commute because their neighborhoods are not well-connected to areas where their job is located.[47] Commuting is a main factor associated with sleep disruption, being associated with sleep loss, increased sleep duration variability, lower sleep or wake schedule regularity, increased everyday stress, lower vitality, and perceived poor SQ.[42,48]

This result may appear contradictory to the observation that unstable employment was associated with a higher probability of poor SQ only in 2021. However, “unstable employment” does not necessarily imply “staying at home”; individuals with precarious jobs or unemployed and actively seeking work also fall into this category. Even if we assume those with unstable employment do not commute, the stressful situation of being unemployed can have a greater negative impact on SQ than commuting. In any case, the associations between employment status and SQ disappeared in the comprehensive model.

An important strength of our study is that data collection was through personal interviews with participants selected by random sampling, involving the same individuals in 2019, 2020, and 2021. This allowed us to discard selection bias (often associated with online studies or convenience samples) and attribute results to factors associated with the COVID-19 lockdown. Additionally, inquiring about current SQ rather than changes compared to the past helped us discard recall bias.

The main limitation of this research is the reliance on self-reported sleep data through a single question, which may introduce measurement bias and inaccuracies, compared with sleep measurements obtained through more extensive questionnaires or objective instruments. Another limitation is the attribution of the observed changes solely to the “lockdown effect.” While our data show annual percentage variations, these trends could be influenced by other evolving factors, such as economic, political, and social fluctuations. Finally, SDV exhibited significant differences between the panel subsample and the overall EDSA sample, that may have implications for the generalizability of the findings, especially as some of the differences involve interactions.

Conclusion

Our study showed that in this Argentine urban panel study, COVID-19 lockdown mitigated poverty-associated disparities in SQ. These findings suggest the importance of refocusing attention on these subpopulations in the post-lockdown context, when disparities in sleep quality re-emerged. Overall, our results offer valuable insights into the broader determinants of health and underscore the potential effectiveness of such interventions in promoting health equity.

Author contributions

Carolina Abulafia: Conceptualization, formal analysis, methodology, writing—original draft, and writing—review and editing. **María Agustina Paternó Manavella:** Conceptualization, data curation, investigation, methodology, writing—original draft, and writing—review and editing. **Solange Rodríguez Espínola:** Conceptualization, data curation, investigation, methodology, and writing—review and editing. **Mauro Brangold:** Writing—review and editing. **Guido Simonelli:** Funding acquisition, writing—review and

editing. **Agustín Salvia:** Conceptualization, data curation, funding acquisition, investigation, methodology, supervision, and writing—review and editing. **Daniel Eduardo Vigo:** Conceptualization, formal analysis, methodology, supervision, writing—original draft, and writing—review and editing.

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Data availability

The EDSA EQUIDAD 2019-2022 can be provided by Observatorio de la Deuda Social Argentina pending scientific review and a completed material transfer agreement. Requests for the EDSA EQUIDAD 2019-2022 should be submitted to: observatorio_deudasocial@uca.edu.ar. More information at: https://uca.edu.ar/es/observatorio-de-la-deuda-social-argentina/estadisticas-edsa/bases-edsa-agencia-pisac-covid-19.

Declaration of conflicts of interest

The authors have declared no conflicts of interest.

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NA.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.sleh.2025.06.009.

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