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Impact of the COVID-19 pandemic on incidence of psychiatric disorders using nationwide cohort data and ARIMA models

Jun Ho Seo[1,2], Myeongjee Lee[3], Sunghyuk Kang[4], Se Joo Kim[2,4], Inkyung Jung[5]✉ & Jee In Kang[2,4]✉

The present study aimed to investigate the impact of the COVID-19 pandemic on the incidence rates of psychiatric disorders using nationwide cohort data. A retrospective cohort study was conducted using South Korea's nationwide claims database, covering 1,598,540 patients with new psychiatric diagnoses from January 2017 to June 2021. We calculated incidence rate ratios pre- and during-pandemic and employed the autoregressive integrated moving average (ARIMA) model and interrupted time-series analysis to assess pandemic effects on incidence. Additionally, to determine the immediate impact of the pandemic on the observed incidence rates, we used level changes at the transition point by adopting a transfer function. The incidence rates for overall and most psychiatric disorders during the pandemic increased compared to the pre-pandemic period. However, the increases in incidence rates were due to the previous trend rather than the pandemic's impact. A notable exception was found in the diagnostic category of obsessive-compulsive disorders, which experienced a significant surge in incidence rates beyond what was predicted, indicating a direct pandemic impact. The study underscores that while the COVID-19 pandemic has influenced the incidence rates of psychiatric disorders, the effects vary significantly by disorder. The overall increase in psychiatric disorders aligns with pre-pandemic trends, except for obsessive-compulsive and substance-related disorders. Obsessive-compulsive disorders saw an actual increase in incidence rates, whereas substance-related disorders' decrease could reflect changes in healthcare-seeking behavior. The findings of this study provide valuable insights for public health planning and the development of mental health support systems in anticipation of future global health crises.

Keywords COVID-19 pandemic, Nationwide cohort study, Incidence study, Psychiatric disorders, Mental healthcare utilization

The aftermath of the COVID-19 pandemic is more than a historical note; the events and experiences, particularly in terms of global mental health during its height, remain to be fully unpacked, holding potential lessons and insights vital for future pandemics. Historically, pandemics have redefined cultures, politics, and healthcare systems[1]. The SARS epidemic, for example, revealed both immediate and lingering psychosocial effects on a significant fraction of the population[2,3]. COVID-19, however, with its pervasive reach in an interconnected era, brought forth unprecedented challenges. Sociopsychological stressors were exacerbated by not only the pervasive fear of the virus but also economic disruptions, limited service access, and soaring unemployment rates[4]. Moreover, stringent lockdown measures, while vital, transformed daily routines and amplified a collective sense of vulnerability[5].

This heightened susceptibility to stress is mirrored by the sharp rise in mental health complications during 2020, highlighting the pandemic's profound mental health implications[6,7]. Since then, numerous studies globally have reported similar findings, underscoring exacerbated anxiety, depression, and related symptoms across

[1]Department of Psychiatry, Yonsei University Wonju College of Medicine, Wonju, Korea. [2]Institute of Behavioral Science in Medicine, Yonsei University College of Medicine, Seoul, Korea. [3]Biostatistics Collaboration Unit, Department of Biomedical Systems Informatics, Yonsei University College of Medicine, Seoul, Korea. [4]Department of Psychiatry, Yonsei University College of Medicine, Yonsei-ro 50-1, Seodaemun-gu, Seoul 03722, Korea. [5]Division of Biostatistics, Department of Biomedical Systems Informatics, Yonsei University College of Medicine, Seoul, Korea. ✉email: ijung@yuhs.ac; jeeinkang@yuhs.ac

both developed and developing nations[8–13]. As many of these investigations rely on cross-sectional designs or before-and-after comparisons, which provide valuable snapshots of mental health during the pandemic but may not capture the full picture of the long-term trends, there have been concerns about whether the increased symptoms observed during the pandemic are indicative of transient stress responses or signal more entrenched psychiatric disorders[14,15]. In contrast, true trend studies that continuously monitor mental health indicators over an extended period have started to reveal patterns that suggest a more nuanced understanding of the pandemic's long-term effects. For instance, a longitudinal study in England found that mental health trends varied significantly over different phases of the pandemic, with some initial increases in anxiety and depression later stabilizing or even decreasing, demonstrating the dynamic nature of mental health impacts over time[16].

Recent meta-analyses and longitudinal studies provide a more nuanced view of the pandemic's mental health impacts. A meta-analysis of 134 cohorts identified minimal changes in general mental health and anxiety symptoms, with a slight increase in depression symptoms, varying significantly among subgroups such as women and those with pre-existing mental health conditions[17]. Similarly, Ahmed et al. (2023) synthesized data from 177 studies across high-income European countries, revealing that while the prevalence of certain mental health issues initially spiked, these increases generally subsided over time[18]. Concurrently, health records showed a significant reduction in new psychiatric diagnoses at the pandemic's onset, continuing through 2020, alongside a sharp decrease in mental health service utilization, which gradually rose in 2021. This dual impact—emerging mental health challenges and disruptions in care—highlights the need to consider both factors when assessing observed incidence rates. This pattern underscores the importance of shifting from prevalence studies, which provide only momentary glimpses, to an incidence-centric approach that better captures dynamic changes in mental health and healthcare utilization. Ultimately, a comprehensive longitudinal investigation covering the entire range of psychiatric disorders, assessing how incidence rates in each clinical diagnostic category have been affected by the pandemic, will offer invaluable insights into the pandemic's immediate and longer-term mental health impacts.

The Korean Health Insurance Review and Assessment Service (HIRA) offers an unparalleled opportunity to analyze incidence rates through its vast repository of real-world claim data. Managed by the Korean National Health Insurance Service (NHIS), a mandatory social insurance system, it ensures every medical care provider in the Republic of Korea is contracted. As a result, the HIRA database covers the entire population, encompassing comprehensive details from all NHIS claims. This includes demographic data, International Classification of Diseases, 10th Revision (ICD-10) diagnostic codes, healthcare types, associated costs, and prescribed medications and procedures for every healthcare service utilized by individuals[19]. The system's unique advantage lies in its ability to accurately identify patients with specific diagnoses, track all their medical comorbidities with date stamps, and minimize record overlap due to Korea's 13-digit resident registration number used uniformly across all medical establishments.

In this study, our primary objective is to elucidate the impact of the COVID-19 pandemic on the incidence rates within distinct diagnostic groups of psychiatric disorders, utilizing the comprehensive capabilities of South Korea's HIRA dataset. We aim to contrast the observed incidence rates during the pandemic with those predicted based on pre-pandemic trends by employing the autoregressive integrated moving average (ARIMA) model. In addition, to corroborate and supplement our ARIMA findings, we will undertake a time-series analysis, which provides insights into both acute changes and post-transition slope alterations. We assume that the acute changes in observed incidence rates at the onset of the pandemic are affected by healthcare utilization factors. Specifically, if a specific diagnostic group witnessed a significant reduction in its observed incidence rate during the pandemic's initial phase, it likely indicates an influence of healthcare utilization factors. Conversely, if there was no significant reduction, it remains uncertain whether healthcare utilization factors influenced the observed incidence rates. These assumptions help us differentiate between true changes in the incidence of psychiatric disorders and those due to shifts in healthcare utilization. This approach allows us to more accurately interpret the impact of the pandemic on mental health and provides valuable insights for policymakers and healthcare providers.

Methods

Data source

This study utilized the Health Insurance Review and Assessment Service (HIRA) database of Korean nationwide medical claims between January 2007 and June 2021. Because HIRA releases only claims that have completed insurance adjudication, producing a 6- to 12-month release lag, the latest month available was June 2021 when we requested the data in May 2022. Because it is mandatory for all citizens of Korea to be covered by either the National Health Insurance (NHI) system or the Medical Aid program, HIRA database covers the entire population of Korea. The database contains information for diagnostic codes by the ICD-10 and demographic characteristics on every healthcare utilization of the individuals. All methods were carried out in accordance with relevant guidelines and regulations. This study utilized big data held by a public institution, accessed after formal application and approval (HIRA, M20220112766). The need for obtaining informed consent from individual subjects was waived by the Institutional Review Board of Severance Hospital, Seoul, Republic of Korea due to the retrospective nature of the study and use of anonymized data (No: 4-2022-0245).

Study population and classification of diagnostic groups

First, we constructed cohort data of subjects who had any diagnostic code of psychiatric disorders as a primary diagnosis at least once between January 2007 and June 2021. Then, we set the washout period as the duration from January 2007 to December 2016. Subjects who had a primary or secondary diagnosis of any psychiatric disorders in these 10 years were excluded from the study population. Consequently, subjects with newly

diagnosed psychiatric disorders as a primary diagnosis between January 2017 and June 2021 were set as the study population.

All primary diagnoses by the ICD-10 (F0.x-F9.x) were categorized into clinically distinct diagnostic groups. The following nine diagnostic groups were selected as outcomes of interest among the most prevalent adult psychiatric diagnoses:

Substance-related disorders (F1.x)", "*Schizophrenia-spectrum disorders* (F2.x)," "*Bipolar mood disorders* (F30, F31, F34.0)," "*Unipolar mood disorders* (F32, F33, F34.1)," "*Anxiety disorders* (F40, F41)," "*Obsessive-compulsive disorders* (OCD) (F42)," "*Stress-related disorders* (F43)," "*Somatoform disorders* (F45)," and "*Sleep-related disorders* (F51, G47).

Because only groups with sufficient adult incidence can yield stable ARIMA estimates, eating disorders (F50.x) were excluded: adult-onset incidence in HIRA is fewer than 3 per 100,000 persons per year, and most new cases arise in adolescents, leaving monthly counts too sparse for reliable time-series modelling.

Variables and time definition

We collected diagnoses and the date of each healthcare use of individuals, age at the date of diagnosis, and the sex of all subjects. The primary diagnosis of psychiatric disorder at the first encounter was considered as the individual's psychiatric diagnosis and counted as one of nine diagnostic groups defined above. As the primary outcome variable, the incidence rate was calculated for overall and each diagnostic group of psychiatric disorders. The incidence rate was defined as the sum of new cases of overall or each diagnostic group of psychiatric disorders divided by the number of persons at risk for the disorder. We used the population size of Korea as the persons at risk, the midterm population size for the yearly incidence rate and the monthly population size for the monthly incidence rate (Korean statistical information service, https://kosis.kr/, accessed August 8, 2022). Both yearly and monthly incidence rates per 100,000 persons were calculated.

For the time definition, the period before the pandemic was set from January 2017 to January 2020 and the period during the pandemic was set from February 2020 to June 2021 because in Korea, the daily confirmed COVID-19 cases started to exceed 100 from February 22, 2020, with fears spreading.

Statistical analysis

Baseline characteristics of subjects diagnosed with psychiatric disorders as their primary diagnosis before and during the pandemic were summarized as frequencies with percentages and were compared using the Chi-squared test. We conducted three main analyses to determine the impact of the COVID-19 pandemic on the incidence of psychiatric disorders. First, to assess the incidence of psychiatric disorders during the pandemic compared to the period before the pandemic, we calculated the incidence rate ratio (IRR) using a Poisson regression model. We modeled the observed monthly number of new cases for each diagnostic group of psychiatric disorders as Poisson counts, incorporating the log of population size as an offset. Additionally, we adjusted for standard errors to account for overdispersion.

Next, we assessed the impact of the pandemic on the incidence of psychiatric disorders per 100,000 persons using an interrupted time series quasi-experimental design[20]. To address seasonality and autocorrelation in the rates of psychiatric disorders over time, we applied an ARIMA model to the data from the pre-pandemic period. We identified the optimal ARIMA parameters through an automated algorithm, specifically, *auto.arima( )* in the *forecast* package in R[21]. Using the optimal model selected for each outcome, we calculated the expected rates along with 95% prediction intervals (PIs) for each psychiatric disorder following the pandemic outbreak. We then compared these predicted values with the actual observed values. An 'unexpected' outcome was defined as an observed value that was outside the expected 95% PI.

Lastly, to determine the immediate impact of the pandemic on the observed incidence rates and to verify findings from the ARIMA model, we further estimated level changes at the transition point and slope changes after the transition by adopting a transfer function in the ARIMA model. All these analyses were stratified by gender to examine any differential effects. Statistical significance was determined using a two-sided P value < 0.05 and the Bonferroni-adjusted method was used for the multiple comparisons. Statistical analyses were conducted using the SAS Enterprise Guide version 7.1 (SAS Institute Inc., Cary, NC, USA) and R Statistical Software (version 4.1.2; R Core Team 2021).

Results

Demographics and baseline characteristics

From the HIRA database, we identified 11,692,028 patients who had any diagnostic code of psychiatric disorders of interest between January 2007 and June 2021. After applying the washout period of January 2007 to December 2016, we identified 1,606,041 patients aged over 19 who were newly diagnosed with a psychiatric disorder between January 2017 and June 2021. Among them, patients who newly received two or more primary diagnoses of different diagnostic groups were excluded because it would be arbitrary to select just one diagnosis for the analysis. After all, 1,598,540 patients aged over 19 with newly diagnosed psychiatric disorder between January 2017 and June 2021 were included. A detailed flow chart is presented in Fig. 1. Baseline characteristics of the study subjects are presented in Table 1.

Incidence rate ratio between the period before and during the pandemic

The Incidence rate of overall psychiatric disorders for the pandemic period increased by an IRR of 1.17 compared to the period before the pandemic (Table 2). Specifically, incidence rates for the pandemic period significantly increased over the period before the pandemic in diagnostic groups of bipolar mood disorders, unipolar mood disorders, anxiety disorders, OCD, stress-related disorders, and sleep-related disorders. Meanwhile, diagnostic groups of substance-related disorders and somatoform disorders showed decreases in incidence rate for the

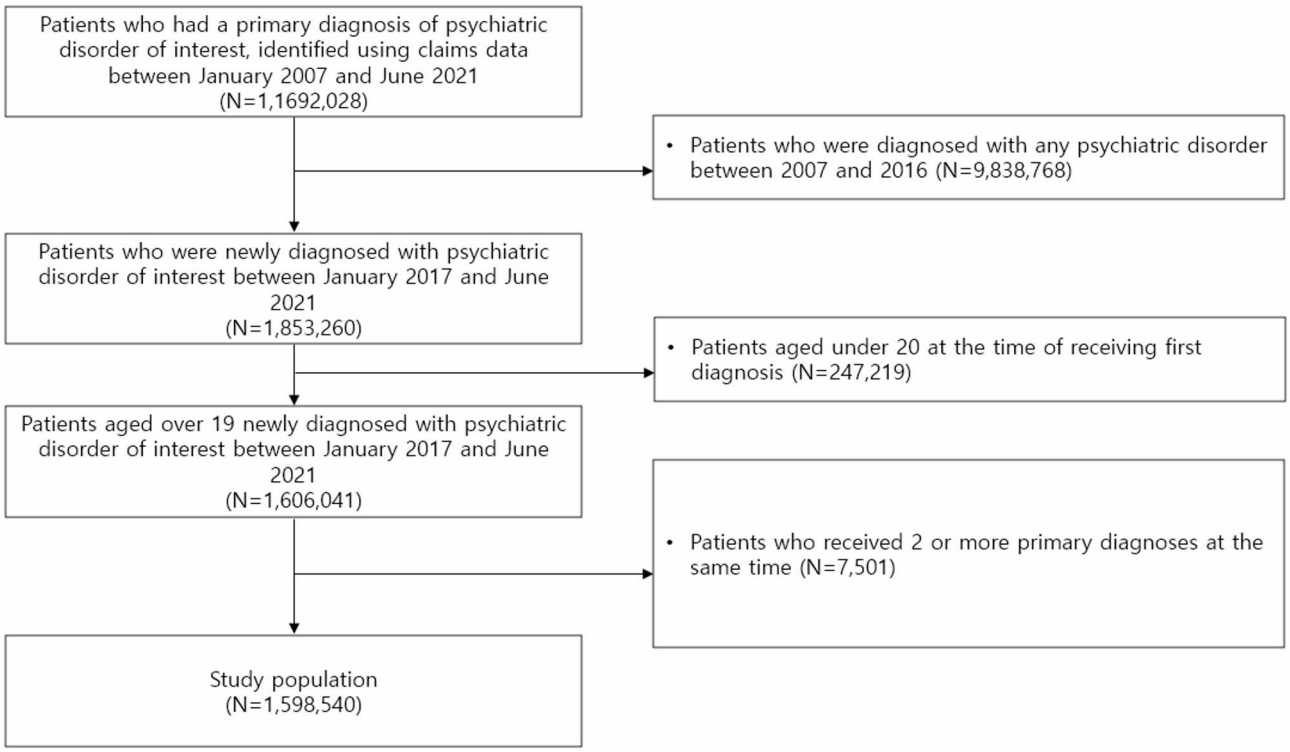

Fig. 1. Flow of study population selection.

Number (%)		Overall	Pre-pandemic (2017.1 -2020.1)	Pandemic (2020.2-2021.6)	*p*-value
Sex	male	814,506 (50.95%)	533,948 (51.71%)	280,558 (49.57%)	< 0.001
	female	784,034 (49.05%)	498,580 (48.29%)	285,454 (50.43%)	
Age at diagnosis	20–29	400,467 (25.05%)	247,224 (23.94%)	153,243 (27.07%)	< 0.001
	30–39	321,769 (20.13%)	210,030 (20.34%)	111,739 (19.74%)	
	40–49	308,549 (19.30%)	205,819 (19.93%)	102,730 (18.15%)	
	50–59	276,819 (17.32%)	184,222 (17.84%)	92,597 (16.36%)	
	60–69	173,830 (10.87%)	110,530 (10.71%)	63,300 (11.18%)	
	70–79	83,290 (5.21%)	53,564 (5.19%)	29,726 (5.25%)	
	80-	33,816 (2.12%)	21,139 (2.05%)	12,677 (2.24%)	
Type of insurance	National Health Insurance	1,548,897 (96.89%)	1,000,022 (96.85%)	548,875 (96.97%)	< 0.001
	Medical aid	49,643 (3.11%)	32,506 (3.15%)	17,137 (3.03%)	
Total		1,598,540 (100%)	1,032,528 (100%)	566,012 (100%)	

Table 1. Baseline characteristics of the study subjects.

pandemic period over the period before the pandemic. In addition, the diagnostic group of schizophrenia-spectrum disorders showed no significant changes in incidence rates between two periods. These results were similar for both sexes. Incidence rates for both periods and the IRR of each diagnostic group are presented in Table 2. Incidence rates with the number of patients for each diagnostic group between January 2017 and June 2021 are presented in the supplementary material (Table S1).I.

Comparison of expected versus observed incidence rates during the pandemic using the ARIMA model

Forecast values of monthly incidence rates by the ARIMA model were compared with actual values during the pandemic. Figure 2 shows the expected versus the observed value of incidence rates from Jan 2017 to June 2021. 95% CIs for the predicted values of monthly incidence rates during the pandemic period based on the ARIMA model are also presented. For overall and most diagnostic groups of psychiatric disorders, observed values of incidence rates in the pandemic period were mostly within the range of 95% CI for the predicted values. However, overall incidence rates of OCD were significantly higher than the expected forecast values, showing observed values 24.4 ~ 53.5% higher than expected from May 2020 to June 2021. In addition, overall incidence

	All				Male				Female			
	IR of pre-pandemic	IR of the pandemic	IRR (95% CI)	P value	IR of pre-pandemic	IR of the pandemic	IRR (95% CI)	P value	IR of pre-pandemic	IR of the pandemic	IRR (95% CI)	P value
Overall	66.1 (63.6, 68.6)	77.5 (73.6, 81.5)	1.17 (1.10, 1.25)	<0.001*	69.0 (66.5, 71.5)	77.5 (73.7, 81.5)	1.12 (1.06, 1.20)	<0.001*	63.2 (60.7, 65.8)	77.4 (73.4, 81.6)	1.22 (1.15, 1.31)	<0.001*
Substance-related disorders	3.1 (3.1, 3.2)	2.4 (2.3, 2.6)	0.77 (0.73, 0.82)	<0.001*	5.1 (4.9, 5.2)	4.0 (3.8, 4.2)	0.78 (0.74, 0.83)	<0.001*	1.3 (1.2, 1.3)	0.94 (0.88, 1)	0.75 (0.69, 0.81)	<0.001*
Schizophrenia-spectrum disorders	0.78 (0.76, 0.81)	0.75 (0.72, 0.79)	0.96 (0.91, 1.02)	0.1917	0.75 (0.72, 0.78)	0.73 (0.69, 0.77)	0.97 (0.90, 1.04)	0.3422	0.81 (0.79, 0.84)	0.78 (0.74, 0.82)	0.96 (0.90, 1.02)	0.1871
Bipolar mood disorders	0.65 (0.62, 0.69)	0.84 (0.78, 0.89)	1.28 (1.18, 1.39)	<0.001*	0.67 (0.64, 0.71)	0.81 (0.76, 0.86)	1.20 (1.11, 1.30)	<0.001*	0.63 (0.6, 0.67)	0.86 (0.8, 0.93)	1.36 (1.24, 1.50)	<0.001*
Unipolar mood disorders	15.4 (14.6, 16.2)	20.1 (18.8, 21.5)	1.31 (1.20, 1.42)	<0.001*	13.6 (13.0, 14.2)	16.2 (15.3, 17.2)	1.19 (1.11, 1.28)	<0.001*	17.1 (16.2, 18.2)	23.9 (22.3, 25.7)	1.40 (1.27, 1.53)	<0.001*
Anxiety disorders	15.1 (14.5, 15.7)	17.9 (16.9, 18.9)	1.18 (1.10, 1.27)	<0.001*	14.6 (14.1, 15.2)	16.6 (15.8, 17.5)	1.14 (1.07, 1.22)	<0.001*	15.6 (14.9, 16.3)	19.1 (18.0, 20.2)	1.22 (1.14, 1.31)	<0.001*
Obsessive-compulsive disorders	0.38 (0.36, 0.39)	0.51 (0.48, 0.54)	1.36 (1.26. 1.47)	<0.001*	0.45 (0.42, 0.47)	0.55 (0.51, 0.59)	1.23 (1.13, 1.35)	<0.001*	0.3 (0.29, 0.32)	0.47 (0.44, 0.51)	1.55 (1.42, 1.70)	<0.001*
Stress-related disorders	5.8 (5.5, 6.1)	7.3 (6.8, 7.8)	1.25 (1.15, 1.36)	<0.001*	5.8 (5.5, 6.1)	7.1 (6.6, 7.6)	1.23 (1.13, 1.33)	<0.001*	5.9 (5.6, 6.2)	7.5 (7.0, 8.1)	1.27 (1.16, 1.40)	<0.001*
Somatoform disorders	2.7 (2.6, 2.8)	2.4 (2.2, 2.5)	0.87 (0.82, 0.93)	<0.001*	2.6 (2.5, 2.7)	2.3 (2.2, 2.4)	0.89 (0.83, 0.95)	<0.001*	2.8 (2.7, 2.9)	2.4 (2.3, 2.6)	0.86 (0.80, 0.92)	<0.001*
Sleep-related disorders	21.8 (20.9, 22.8)	25.0 (23.6, 26.5)	1.15 (1.07, 1.23)	<0.001*	25.4 (24.2, 26.6)	29.1 (27.3, 31.1)	1.15 (1.06, 1.25)	<0.001*	18.4 (17.7, 19.0)	21.0 (19.9, 22.1)	1.14 (1.07, 1.22)	<0.001*

Table 2. Incidence rate ratio before and during the COVID-19 pandemic. Pre-pandemic, January 2017 to January 2020; the pandemic, February 2020 to June 2021; IR, incidence rates per 100,000 persons; IRR, incidence rate ratio = incidence rate in the pandemic period /incidence rate in the pre-pandemic period. * p-value < 0.005.

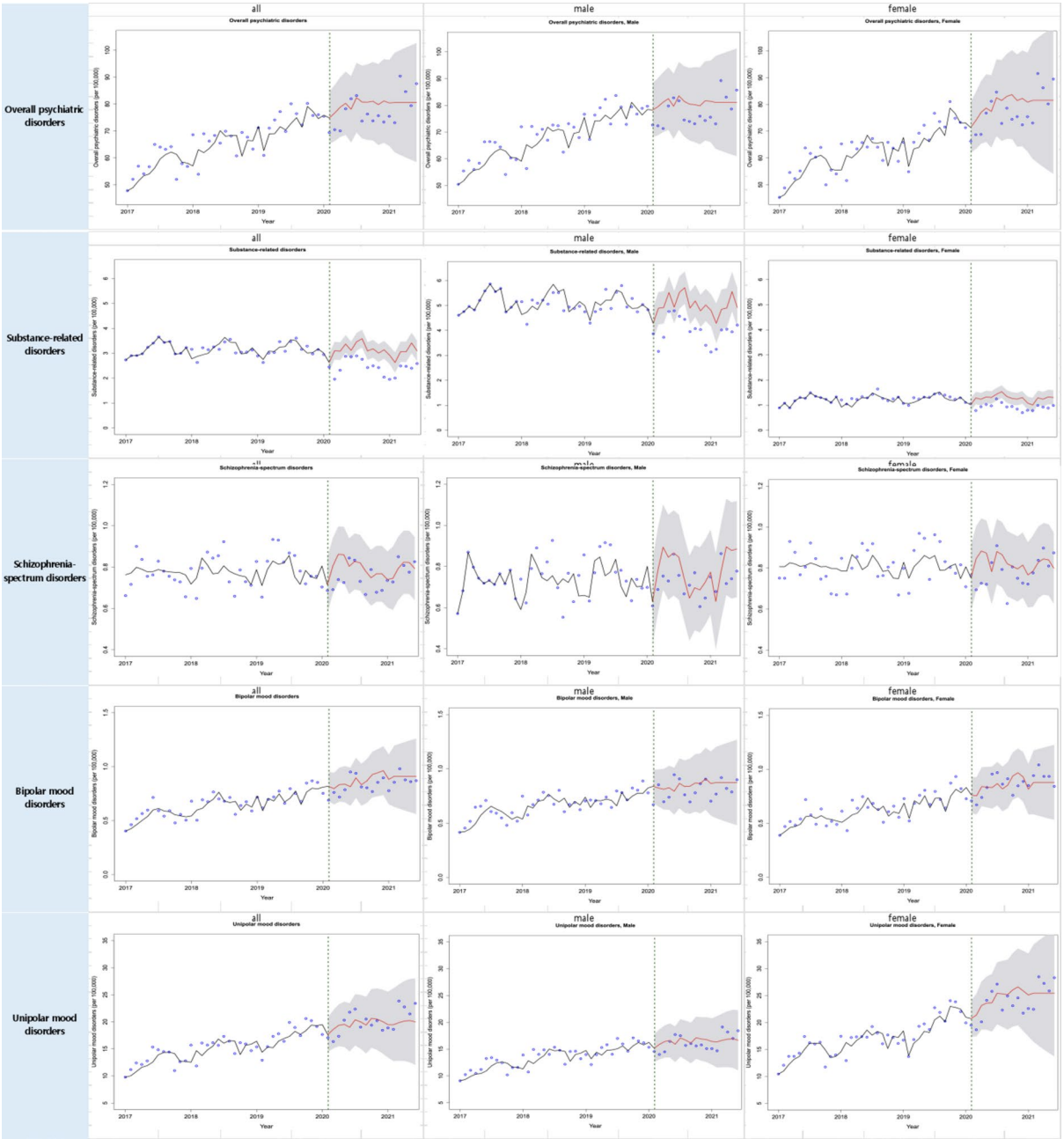

Fig. 2. Observed and expected monthly trend of incidence rates (per 100,000 persons) from Jan 2017 to June 2021. Red lines mean expected values of incidence rate during the pandemic based on ARIMA model. Blue circles mean observed values. 95% prediction intervals for the expected values in the pandemic period are colored in gray. Vertical dashed-line denotes transition time to the COVID-19 pandemic, February 2020.

rates of substance-related disorders were significantly lower than the expected values, showing observed values 15.8 ~ 45.1% lower than expected during the pandemic period. Monthly differences between expected and observed incidence rates of overall and each diagnostic group of psychiatric disorders were estimated as percent differences and are presented in the supplementary material (Table S2).

Changes of monthly incidence rates right after the break of the pandemic

During the transition to the pandemic period, significant level decreases of incidence rates were observed in diagnostic groups of substance-related disorders, schizophrenia spectrum disorders, and somatoform disorders. Meanwhile, incidence rate levels of bipolar mood disorders, unipolar mood disorders, anxiety disorders, OCD, stress-related disorders, and sleep-related disorders were not significantly changed at the transition to the pandemic period. (Table 3, 'level change at transition').

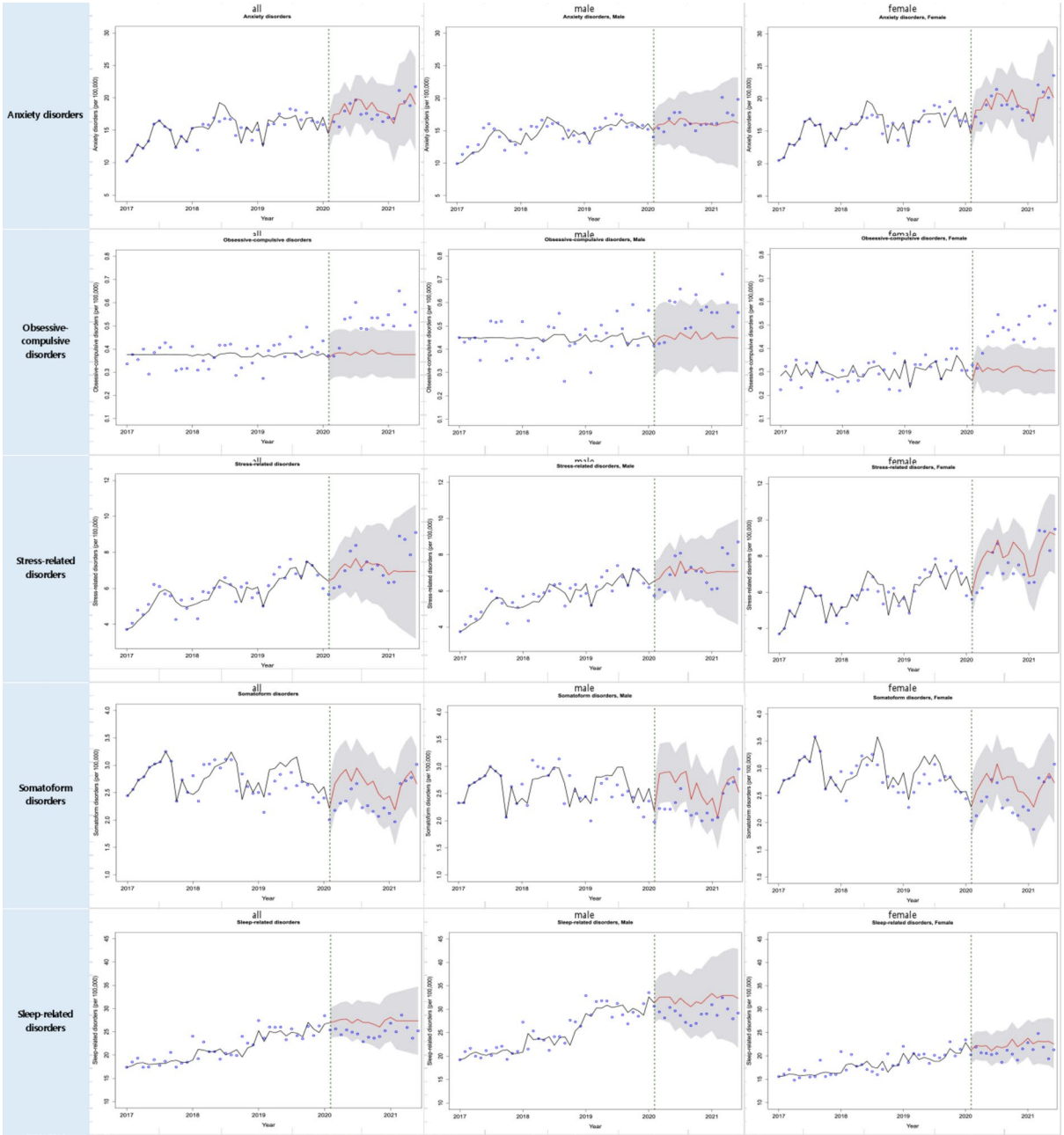

Fig. 2. (continued)

Analysis of trendline slope variations before and during the pandemic

The trendline slope of monthly incidence rates were compared between periods before and during the pandemic. Among diagnostic groups that showed no significant level decreases in incidence rates during the transition to the pandemic (bipolar mood disorders, unipolar mood disorders, anxiety disorders, OCD, stress-related disorders, and sleep-related disorders), significant slope changes of incidence rates between periods before and during the pandemic were observed only in OCD. Meanwhile, slope changes among diagnostic groups with significant level decreases at the transition to the pandemic were disregarded because incidence rates of the groups, measured by treatment visits, were presumably affected by healthcare utilization factors and because the base effect of level decrease at transition can confound the trendline slope of incidence rates of the pandemic period. (Table 3, 'Post-transition slope change')

Discussion

The present study analyzed the longitudinal impact of the COVID-19 pandemic on psychiatric disorder incidence rates using an ARIMA model and an interrupted time-series analysis, based on nationwide cohort data covering almost the entire population of the Republic of Korea. While our analysis via the ARIMA model demonstrated

		All			Male			Female		
		Estimate	s.e.	p-value	Estimate	s.e.	p-value	Estimate	s.e.	p-value
Overall psychiatric disorders	Level change at transition	-7.630	3.728	0.041	-8.024	3.522	0.023	-7.157	4.117	0.082
	Post-transition slope change	0.465	0.585	0.427	0.384	0.476	0.419	0.56	0.777	0.471
Substance-related disorders	Level change at transition	-0.603	0.096	< 0.001*	-0.922	0.163	< 0.001*	-0.358	0.036	< 0.001*
	Post-transition slope change	-0.011	0.009	0.233	-0.016	0.015	0.279	-0.006	0.003	0.045
Schizophrenia-spectrum disorders	Level change at transition	-0.092	0.030	0.002*	-0.063	0.04	0.110	-0.11	0.038	0.003*
	Post-transition slope change	0.006	0.003	0.031	0.004	0.004	0.307	0.007	0.003	0.025
Bipolar mood disorders	Level change at transition	-0.091	0.064	0.155	-0.073	0.07	0.296	-0.066	0.082	0.420
	Post-transition slope change	0.005	0.010	0.583	0.002	0.009	0.798	0.012	0.009	0.190
Unipolar mood disorders	Level change at transition	-1.900	1.626	0.242	-1.546	1.039	0.137	-2.185	2.053	0.287
	Post-transition slope change	0.378	0.253	0.136	0.11	0.181	0.544	0.53	0.334	0.113
Anxiety disorders	Level change at transition	-1.437	0.700	0.040	-1.53	0.947	0.106	-1.244	0.766	0.105
	Post-transition slope change	0.054	0.123	0.663	0.162	0.156	0.301	0.034	0.138	0.805
Obsessive-compulsive disorders	Level change at transition	0.050	0.028	0.076	0.038	0.039	0.336	0.065	0.028	0.018
	Post-transition slope change	0.010	0.003	< 0.001*	0.007	0.004	0.042	0.011	0.003	< 0.001*
Stress-related disorders	Level change at transition	-0.765	0.479	0.110	-0.654	0.457	0.152	-1.205	0.334	< 0.001*
	Post-transition slope change	0.098	0.060	0.104	0.079	0.057	0.160	0.072	0.041	0.078
Somatoform disorders	Level change at transition	-0.518	0.107	< 0.001*	-0.601	0.124	< 0.001*	-0.475	0.109	< 0.001*
	Post-transition slope change	0.042	0.010	< 0.001*	0.049	0.011	< 0.001*	0.037	0.01	< 0.001*
Sleep-related disorders	Level change at transition	-2.488	0.977	0.011	-2.334	1.452	0.108	-1.377	0.806	0.088
	Post-transition slope change	0.031	0.159	0.847	-0.291	0.22	0.186	-0.034	0.113	0.763

Table 3. Level change at transition to the pandemic and post-transition slope change between periods before and during the COVID-19 pandemic for monthly incidence rates. * p-value < 0.005.

that the incidence rates for the majority of psychiatric disorders during the pandemic period largely followed the pre-existing trends, suggesting a lack of direct pandemic impact, distinct exceptions were also noted. Specifically, OCD exhibited a significant increase in incidence rates beyond predicted values, suggesting a direct pandemic effect on these disorders. In contrast, substance-related disorders presented lower than expected incidence rates, a phenomenon potentially attributable to alterations in mental healthcare utilization during the pandemic. These divergent patterns underscore the complexity of the pandemic's impact on mental health, suggesting that while broad trends indicate stability, certain disorders experienced specific pandemic-related shifts.

The current study showed that incidence rates during the pandemic period over the period before the COVID-19 pandemic increased in overall and most diagnostic groups including unipolar mood disorders and anxiety disorders. However, aside from specific conditions like OCD and substance-related disorders, the ARIMA model's analysis, showing no significant difference between the predicted and observed values, suggests that the pandemic's impact on the incidence of psychiatric disorders was minimal, reflecting the resilience observed in broader trends. While early reports during the onset of the pandemic indicated an increase in psychological symptoms like depression and anxiety[22,23], and there was an overall rise in stress throughout the pandemic period[12], the prolonged impact of the pandemic appears to have had a limited influence on the new onset of mental disorders overall. While there are few large-scale longitudinal studies for incidence of mental disorders during COVID-19 pandemic, a probability-based large national UK cohort study reported that the prevalence of common mental disorders during the COVID-19 pandemic initially elevated significantly compared to pre-pandemic waves[24] but then decreased to the pre-pandemic level in September 2020[25]. Similarly, a systematic meta-analysis of longitudinal studies for mental health problems during COVID-19 pandemic reported that depression and anxiety decreased over time during the pandemic with their peaks in April to May 2020 even though psychological distress persisted[26]. Another previous systematic review estimated the actual relative risk of prevalence for anxiety or depression during the pandemic period until July 2021 over the period before the pandemic as 1.3 to 1.5 from three large-scale United States of America (USA) government trend Surveys[27]. Although determining prevalence as the product of incidence rate and disorder duration can be complex in real-world scenarios, under specific assumptions, the relative risk of prevalence between two periods might resemble the incidence rate ratio. Based on this assumption, our study showed slightly smaller but similar IRR of anxiety disorders (1.10–1.27) or unipolar mood disorders (1.20–1.42) than IRR estimated from the three USA Surveys (1.3–1.5). All of the values are very much lower than expected from studies having focused on the initial period of the pandemic[9,11–13]. These previous studies of quality above support the current results suggesting that the pandemic is likely to have little impact on the incidence rate of common mental disorders when viewed over a period of more than a year, even if the pandemic has not ended, especially for depressive and anxiety disorders. This suggests that the immediate reactions and symptoms displayed at the beginning of the pandemic may not have translated into long-term psychiatric morbidity, or other mitigating factors could have been at play over the extended period. A potential explanation for these findings could be the notion of collective resilience, which showcases the innate ability of groups to cope, drawing upon shared resources and social support in times of adversity[28]. Despite the initial surge in symptoms like depression and anxiety due to

abrupt pandemic-induced changes, individuals and communities might have exhibited this resilience, adjusting to the new norm as the pandemic persisted. While circumstances vary across countries, examining the factors that contributed to collective resilience in contexts like South Korea, with its high healthcare accessibility, robust public health infrastructure, and effective government response, could be illuminating. Future research into the elements that reinforced such collective resilience during the pandemic may provide crucial insights for nations globally, aiding in preparations for potential future pandemics.

On the other hand, the observed incidence rates of OCD consistently remained higher than the expected estimates from three months after the onset of the pandemic, suggesting that the pandemic influenced the onset of new cases of OCD. In previous studies for the pandemic's initial phase, the rate of OC symptoms outpaced its pre-pandemic prevalence in general population[29,30]. Although studies on the longer-term phase of the pandemic are limited, the severity of OC symptoms generally intensified during the COVID-19 era for both individuals previously diagnosed and those who were not[31]. A multicenter Italian study reported significant worsening in more than one-third of OCD patients during the pandemic, characterized by the emergence of new obsessions and compulsions[32]. Furthermore, follow-up studies revealed that OCD symptom exacerbation persisted into subsequent waves of COVID-19, demonstrating even greater recurrence rates of past OC symptoms and additional psychiatric comorbidities[33]. From an evolutionary perspective, OCD symptoms such as fear of contamination and compulsive handwashing might have emerged to shield our ancestors from infectious diseases[34]. Roughly 50% of individuals with OCD globally manifest symptoms like fear of contamination and compulsive handwashing[35]. Based on WHO's COVID-19 recommendations with emphasis on hand sanitation, individuals may have experienced an increased fear of contamination and therefore result in OCD symptoms worsening[30]. The fear of getting contaminated and the fear of being affected by the disease may be responsible for the increase in new onset OCD during the pandemic. Meanwhile, while previous studies indicated an increase in OC symptoms during the initial stages of pandemics, our research found that the onset of new OCD at the start of the pandemic did not exceed projected estimates (**Table S2**). This discrepancy might be attributed to the latency period required for the onset of clinical OCD in the vulnerable population. Alternatively, due to factors related to healthcare utilization, the actual rise in OCD incidence rate might have been masked by a dip in the treatment incidence rate during the pandemic's onset, thus aligning with our projections. An analysis of extensive electronic health records from the UK indicated a decline in OCD-related consultations during the pandemic compared to preceding years although their findings can be different from ours given that they included pre-existing OCD patients[36]. It's also conceivable that after the first three months of the pandemic, measures like social distancing and other infection control protocols might have made it more comfortable for OCD patients to visit hospitals compared to times when infection prevention wasn't emphasized. Nevertheless, we've confirmed that the onset rates of OCD have increased during the COVID-19 pandemic period using nationwide longitudinal data. This finding emphasizes the need for clinical and policy interventions towards the onset of OCD in such scenarios. Historical precedents from pandemics such as Severe Acute Respiratory Syndrome (SARS), Middle Eastern Respiratory Syndrome (MERS), and influenza indicate that exacerbation of OCD symptoms persisted for 6–12 months after the outbreak's conclusion[37]. While further studies are essential to ascertain if the COVID-19 pandemic will mirror these patterns, it's imperative to provide dedicated care and management for those diagnosed with OCD during the pandemic as we navigate the challenges of the post-pandemic era.

Conversely, throughout the pandemic, we observed a discernible decline in the incidence rates of substance-related disorders, with rates persistently lower than projected across virtually all periods of observation. This reduction, particularly evident at the onset of the pandemic, appears to be driven by a shift in healthcare utilization factors (See Results 3.4.). However, the sustained observation of rates being consistently lower than predicted throughout the pandemic suggests genuine reductions in incidence rates of substance-use disorders beyond just the initial phase of the pandemic. Given Korea's strict prohibition on drug use, it can be inferred that a large portion of these results pertains mainly to alcohol. Previous studies in other countries have presented a heterogeneous landscape for this issue. For instance, observational studies highlighted an increase in alcohol consumption during the pandemic in the United Kingdom (UK) and USA, suggesting that pandemic-induced stressors and COVID-19 related anxiety might elevate alcohol intake[38,39]. In contrast, there were reports of diminished alcohol and cannabis use in Greece during the early stages of lockdown, likely influenced by pandemic-related policies, notably social distancing[40,41]. A comprehensive cross-sectional study covering 21 European countries from April to July 2020 noted a decline in alcohol consumption, largely attributed to a reduction in heavy episodic drinking (HED). This trend was counterbalanced by an increase in alcohol use among individuals with severe alcohol dependencies[42]. When extending the observation period from January 2020 to September 2021, it was further corroborated that a larger proportion of individuals in Europe reported a reduction rather than an escalation in their alcohol consumption during the pandemic[43]. These findings from Europe align with our observations in the Republic of Korea. Yet, a comprehensive review study emphasized the variability across countries[44]: while Australia showed a consistent drop in consumption, the USA experienced an uptick in frequency, and while both Australia and Spain saw reductions in HED frequency, the UK noted a rise in problematic alcohol use. Considering the Republic of Korea implemented rigorous social distancing policies shortly after the onset of COVID-19, our findings, compared to the existing body of research, suggest that the incidence of substance-related disorders during the pandemic is profoundly shaped by the socio-cultural dynamics and specific policies of each nation during the crisis. In alignment with this, data from the European Monitoring Center for Drugs and Drug Addiction (EMCDDA) underscored that during strict social distancing measures, there was a noticeable reduction or even cessation in drug consumption. However, as these distancing protocols began to ease, there was a corresponding resurgence in drug use[45,46].

Furthermore, our research suggests that there was a considerable decline in treatment accessibility for patients with substance-related disorders during the pandemic. This trend is mirrored in Europe, where the early stages

of the pandemic witnessed a sharp 60% drop in the availability of detoxification services[47]. Individuals with alcohol use disorders during the pandemic encountered heightened vulnerabilities, facing challenges amplified by socio-economic shifts and disruptions in mental health services. The pronounced influence of social isolation, a critical factor for alcohol misuse[48], demands attention especially during the pandemic. Given these findings, it's crucial to prioritize healthcare access for substance-related disorders in preparation for future pandemics.

Parallel to our observations with substance-related disorders, we noted that the observed incidence rates for schizophrenia-spectrum and somatoform disorders also exhibited a marked decrease during the initial phase of the pandemic, as indicated by the immediate level changes observed in the interrupted time-series analysis using weekly data (Table 3). Conversely, ARIMA model comparisons in Fig. 2 using monthly data show trends within the 95% confidence interval, potentially smoothing out immediate impacts. Even, distinct from other diagnostic categories, incidence rates of substance-related disorders, schizophrenia-spectrum disorders, and somatoform disorders consistently remained below 10% of the predicted values for three consecutive months following the onset of the pandemic (Table S2). This abrupt drop from the anticipated values, immediately following the outbreak of the pandemic, hints at a potential underreporting or underdiagnosing due to pandemic-related healthcare challenges in these groups. Patients within these diagnostic groups, or their caregivers, might have reduced their medical access due to heightened COVID-19 related anxieties or disruptions from nationwide travel restrictions, quarantine measures, and changes in health-care services delivery[49,50]. Specifically, for patients with schizophrenia-spectrum disorders, our previous study indicated that the reduction in visits to mental healthcare services after the COVID-19 outbreak might not be directly attributed to fears of the viral spread[51]. Instead, the unique circumstances introduced by the pandemic might have intensified social isolation for these patients. The diminished social support and significant shifts in routine could make it more challenging for existing patients to engage with treatments[52,53]. We anticipate similar effects on those newly developing schizophrenia-spectrum disorders.

On the other hand, individuals with newly developing somatoform disorders might have been especially hesitant to seek medical care throughout the pandemic, not just in its early days. Elevated health anxieties and fears of infection, more pronounced in this group than in others, might have driven this hesitance[54]. These individuals often undergo various medical evaluations and treatments before seeking psychiatric care, thereby prolonging their time to diagnosis[55,56]. Moreover, the unique backdrop of the pandemic might have normalized certain degrees of health anxiety, potentially leading to delays in diagnoses of somatoform disorders. Our data revealed that, over a year after the pandemic's onset, the observed incidence rates for somatoform disorders, consistently lower, eventually caught up with the predicted rates, reflecting the unique characteristics of this group mentioned above (Fig. 2 & Table S2). Therefore, interpreting the results for this group requires caution. It's plausible that, for an extended period - possibly throughout the pandemic's duration - the actual incidence rates for somatoform disorders may have been much higher than observed.

Given the patterns observed specifically for substance-related disorders, schizophrenia-spectrum, and somatoform disorders, we discern the considerable impact of underreporting and its consequent effects on patient care within these categories. Multiple factors likely contributed to these observed trends, with differential impacts across disorder types. First, diagnostic overshadowing during the pandemic may have significantly influenced diagnostic patterns. Rather than complete underdiagnosis, emerging complex psychiatric symptoms may have been coded as more "acceptable" pandemic-related conditions. For instance, affective or psychotic presentations could have been initially classified as situational anxiety or insomnia amid pervasive pandemic distress. This phenomenon likely had particular impact on somatoform disorders, where complex somatic presentations may have been misclassified as simple anxiety or stress responses rather than receiving appropriate psychiatric evaluation. Second, reduced outpatient visits during the pandemic contributed to differential underreporting across diagnostic categories. Substance-related disorders experienced the most pronounced declines (15.8 ~ 45.1% below expected values), likely reflecting both social stigma that made patients particularly reluctant to seek care during a health crisis and the tendency to defer addiction treatment as "non-urgent." As previously discussed in this paper, schizophrenia-spectrum disorders also showed significant underreporting due to disrupted caregiver support systems and the inherent challenges this population faces in adapting to healthcare changes during crises. These findings highlight the vulnerabilities of our mental healthcare system, particularly in identifying and treating emerging mental disorders. The pandemic-induced changes in healthcare-seeking behavior, especially in individuals developing new mental health symptoms, necessitate innovative strategies to ensure early detection and intervention for enhanced responsiveness in future pandemics. Adaptations may include strengthening telehealth services, expanding outreach programs, and intensifying public awareness campaigns to emphasize the importance of mental health during global adversities.

Expanding upon specific implications related to mental healthcare utilization factors, the broader findings of our study have significant implications for both policy and clinical practices in the face of global crises like the COVID-19 pandemic. Notably, the differential impact of the pandemic on various psychiatric disorders underscores the need for a tailored approach in mental healthcare. The relative stability in the incidence rates of many psychiatric disorders during this period may hint at inherent resilience within populations, facing such challenges. While our findings do not directly provide evidence, it is tempting to contemplate whether these patterns suggest a form of collective resilience, where communities might be drawing upon inherent coping mechanisms, shared resources, and mutual support to navigate collective adversities from the pandemic. This perspective certainly warrants further exploration in subsequent research. In addition, while the increased incidence of OCD during the pandemic calls for targeted interventions, the findings on substance-related disorders emphasize how socio-cultural dynamics and nation-specific policies significantly impact mental health utilizations. In South Korea, strict social distancing measures and cultural responses particularly affected trends in substance-related disorders, which are sensitive to social isolation and reduced access to healthcare services. This highlights the need for policies that prioritize healthcare access for individuals with substance-

related disorders and mitigate the negative impacts of social isolation. Our study also emphasizes the need for ongoing mental health research to understand the lasting effects of the pandemic and to prepare for similar future challenges. As nations globally chart their post-pandemic recovery, the mental health impacts of such crises cannot be overlooked, and our study provides helpful reference for shaping responsive and effective mental healthcare strategies.

The current study possesses several strengths. First, by utilizing nationwide cohort data from the database of claims in the Republic of Korea, it provides a comprehensive view of the situation, encapsulating almost the entire population. This broad scope ensures the reliability of our findings, reducing potential biases that smaller samples might introduce. Secondly, the longitudinal nature of our analysis, spanning both pre- and post-COVID-19 periods, allows for a more detailed examination of trends and their evolution over time. Moreover, the employment of advanced statistical techniques like ARIMA modeling and interrupted time-series analysis enhances the precision of our results, ensuring they are robust and grounded in solid methodological frameworks. Furthermore, the categorization and detailed analysis of individual psychiatric disorders offer a nuanced understanding of the differential impacts of the COVID-19 pandemic, shedding light on specific areas of concern.

However, several limitations should be acknowledged. First, as our analysis was based on claims databases, individuals not seeking treatment or those undiagnosed would not be captured, potentially leading to underestimation in certain diagnostic groups. We anticipated this limitation during the research design phase. To address this, we interpreted the significant decrease in incidence rates right after the pandemic transition not as true incidence rates but as results confounded by healthcare utilization factors. Consequently, this approach provided insights into healthcare utilization patterns. Second, while our findings are representative of the Republic of Korea, their generalizability to other countries or regions may be limited. Factors such as cultural, social, and policy differences across nations can significantly influence the incidence and reporting of psychiatric disorders. Therefore, caution is needed when applying our findings to different contexts. A specific limitation to note is that our study did not factor in the potential shift to telehealth or online counseling services during the pandemic. However, the reason we did not delve into telehealth is due to its limited introduction in Korea[57]. Despite this regional constraint, it's important to acknowledge that such shifts in healthcare modalities could have influenced healthcare utilization patterns elsewhere, potentially affecting the observed incidence rates, especially given the swift global adoption of telehealth services in response to the pandemic[45]. Third, our analyses focused on diagnostic groups, potentially masking the variations within subcategories of disorders, or the interplay of comorbidities, which could provide a nuanced understanding of the pandemic's impact. Eating disorders (F50.x) were also excluded. Although they represent a clinically important group, adult incidence is fewer than 3 per 100,000 per year in Korea and most new cases arise in adolescents, leaving counts too sparse for reliable ARIMA modelling. Fourth, we excluded individuals with two or more primary psychiatric diagnoses. Although this affects a relatively small number of cases ($n = 7{,}501$) compared to the total population ($n = 1{,}598{,}540$), it may introduce a bias by underestimating incidence rates of disorders with common comorbidities. The exclusion applied only to those with multiple primary diagnoses, while cases with secondary diagnoses were still included. Fifth, because our observation window ends in June 2021, the study does not capture the Delta and Omicron waves (July 2021–2023); results should therefore be interpreted cautiously for later phases, and future analyses using newer HIRA releases will be needed to confirm whether the patterns persist. Lastly, as with all observational studies, our findings provide associations and trends but do not conclusively attribute changes solely to the COVID-19 pandemic. To complement our incidence-focused findings, future research should partition the psychosocial stressors of the pandemic from the direct pathophysiological consequences of SARS-CoV-2 by linking laboratory-confirmed infection with incident psychiatric diagnoses. Such designs would help clarify how long-COVID neuroinflammatory mechanisms translate into new-onset disorders[58]. Parallel surveillance of suicide deaths and hospital admission data has already shown phase-specific fluctuations in psychiatric presentations and heterogeneous suicide patterns across countries[59,60]. Incorporating these dimensions into interrupted-time-series designs will yield a more complete picture of the pandemic's mental-health burden.

In summary, this nationwide cohort study evaluated the longitudinal impact of the COVID-19 pandemic on the incidence of psychiatric disorders using ARIMA modeling and interrupted time-series analysis. While the overall increase in diagnoses largely followed pre-pandemic trends, certain disorders—most notably OCD—exhibited significant deviations indicative of a direct pandemic effect. In contrast, substance-related disorders showed a decline, potentially due to reduced healthcare utilization. These findings underscore the heterogeneous impact of the pandemic on mental health and highlight the need for disorder-specific surveillance and targeted intervention. The study provides valuable insights to inform future mental health policy and preparedness for global health crises.

Data availability

The datasets generated during and/or analysed during the current study are not publicly available due to Data Protection Laws and Regulations in Korea, but final analyzing results are available from the corresponding authors on reasonable request.

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References

1. LePan, N. *History of Pandemics*. https://www.visualcapitalist.com/history-of-pandemics-deadliest/ (2020).
2. Nickell, L. A. et al. Psychosocial effects of Sars on hospital staff: survey of a large tertiary care institution. *CMAJ: Can. Med. Association J. = J. De l'Association Medicale Canadienne.* **170** (5), 793–798 (2004).

3. Delanerolle, G. et al. Mental health impact of the middle East respiratory syndrome, sars, and covid-19: A comparative systematic review and meta-analysis. *World J. Psychiatry*. **12** (5), 739–765 (2022).
4. Asper, M. et al. Effects of the covid-19 pandemic and previous pandemics, epidemics and economic crises on mental health: systematic review. *BJPsych Open*. **8** (6), e181 (2022).
5. Markiewicz-Gospodarek, A. et al. The relationship between mental disorders and the covid-19 pandemic-course, risk factors, and potential consequences. *Int. J. Environ. Res. Public Health* **19**(15), 9573 (2022).
6. Zhang, Y. & Lange, K. W. Coronavirus disease 2019 (covid-19) and global mental health. *Global Health J. (Amsterdam Netherlands)*. **5** (1), 31–36 (2021).
7. Daly, M., Sutin, A. R. & Robinson, E. Longitudinal changes in mental health and the covid-19 pandemic: evidence from the Uk household longitudinal study. *Psychol. Med.* **52** (13), 2549–2558 (2022).
8. Vindegaard, N. & Benros, M. E. Covid-19 pandemic and mental health consequences: systematic review of the current evidence. *Brain. Behav. Immun.* **89**, 531–542 (2020).
9. Xiong, J. et al. Impact of covid-19 pandemic on mental health in the general population: A systematic review. *J. Affect. Disord.* **277**, 55–64 (2020).
10. Leung, C. M. C. et al. Mental disorders following covid-19 and other epidemics: A systematic review and meta-analysis. *Translational Psychiatry*. **12** (1), 205 (2022).
11. Chen, J., Zhang, S. X., Yin, A. & Yáñez, J. A. Mental health symptoms during the covid-19 pandemic in developing countries: A systematic review and meta-analysis. *J. Global Health*. **12**, 05011 (2022).
12. Zhang, S. X. et al. Mental disorder symptoms during the covid-19 pandemic in Latin america - a systematic review and meta-analysis. *Epidemiol. Psychiatric Sci.* **31**, e23 (2022).
13. Yuan, K. et al. A systematic review and meta-analysis on prevalence of and risk factors associated with depression, anxiety and insomnia in infectious diseases, including covid-19: A call to action. *Mol. Psychiatry*. **27** (8), 3214–3222 (2022).
14. Delpino, F. M. et al. Prevalence of anxiety during the covid-19 pandemic: A systematic review and meta-analysis of over 2 million people. *J. Affect. Disord.* **318**, 272–282 (2022).
15. Cavieres, Á. & Arancibia, M. A non-systematic, descriptive literature review of observational research on anxiety during the first covid-19 pandemic phase. *Medwave* **22** (11), e2637 (2022).
16. Fancourt, D., Steptoe, A. & Bu, F. Trajectories of anxiety and depressive symptoms during enforced isolation due to covid-19 in england: A longitudinal observational study. *Lancet Psychiatry*. **8** (2), 141–149 (2021).
17. Sun, Y. et al. Comparison of mental health symptoms before and during the covid-19 pandemic: evidence from a systematic review and meta-analysis of 134 cohorts. *BMJ (Clinical Res. ed)*. **380**, e074224 (2023).
18. Ahmed, N. et al. Mental health in Europe during the covid-19 pandemic: A systematic review. *Lancet Psychiatry*. **10** (7), 537–556 (2023).
19. Kwon, S. Thirty years of National health insurance in South korea: lessons for achieving universal health care coverage. *Health Policy Plann.* **24** (1), 63–71 (2009).
20. Bernal, J. L., Cummins, S. & Gasparrini, A. Interrupted time series regression for the evaluation of public health interventions: A tutorial. *Int. J. Epidemiol.* **46**(1), 348–355 (2017) .
21. Hyndman, R. J. & Khandakar, Y. Automatic time series forecasting: the forecast package for r. *J. Stat. Softw.* **27**, 1–22 (2008).
22. Zhu, C., Zhang, T., Li, Q., Chen, X. & Wang, K. Depression and anxiety during the covid-19 pandemic: Epidemiology, mechanism, and treatment. *Neurosci. Bull.* **2022**, 1–10 (2022).
23. Deng, J. et al. The prevalence of depression, anxiety, and sleep disturbances in covid-19 patients: A meta-analysis. *Ann. N. Y. Acad. Sci.* **1486** (1), 90–111 (2021).
24. Pierce, M. et al. Mental health before and during the covid-19 pandemic: A longitudinal probability sample survey of the Uk population. *Lancet Psychiatry*. **7** (10), 883–892 (2020).
25. Daly, M. & Robinson, E. Longitudinal changes in psychological distress in the Uk from 2019 to September 2020 during the covid-19 pandemic: evidence from a large nationally representative study. *Psychiatry Res.* **300**, 113920 (2021).
26. Cénat, J. M. et al. The global evolution of mental health problems during the covid-19 pandemic: A systematic review and meta-analysis of longitudinal studies. *J. Affect. Disord.* **315**, 70–95 (2022).
27. Kessler, R. C. et al. Changes in prevalence of mental illness among Us adults during compared with before the covid-19 pandemic. *Psychiatr. Clin. North Am.* **45** (1), 1–28 (2022).
28. Norris, F. H., Stevens, S. P., Pfefferbaum, B., Wyche, K. F. & Pfefferbaum, R. L. Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness. *Am. J. Community Psychol.* **41** (1–2), 127–150 (2008).
29. Munk, A. J. L., Schmidt, N. M., Alexander, N., Henkel, K. & Hennig, J. Covid-19-beyond virology: potentials for maintaining mental health during lockdown. *PloS One*. **15** (8), e0236688 (2020).
30. Abba-Aji, A. et al. Covid-19 pandemic and mental health: prevalence and correlates of new-onset obsessive-compulsive symptoms in a Canadian Province. *Int. J. Environ. Res. Public Health* **17**(19). (2020).
31. Linde, E. S., Varga, T. V. & Clotworthy, A. Obsessive-compulsive disorder during the covid-19 pandemic-a systematic review. *Front. Psychiatry*. **13**, 806872 (2022).
32. Benatti, B. et al. What happened to patients with obsessive compulsive disorder during the covid-19 pandemic? A multicentre report from tertiary clinics in Northern Italy. *Front. Psychiatry*. **11**, 720 (2020).
33. Benatti, B. et al. First vs second wave of covid-19 pandemic in patients with obsessive compulsive disorder: A multicentre report from tertiary clinics in Northern Italy. *J. Psychiatr Res.* **154**, 293–299 (2022).
34. Rajkumar, R. P. Contamination and infection: what the coronavirus pandemic could reveal about the evolutionary origins of obsessive-compulsive disorder. *Psychiatry Res.* **289**, 113062 (2020).
35. Brady, R. E., Adams, T. G. & Lohr, J. M. Disgust in contamination-based obsessive-compulsive disorder: A review and model. *Expert Rev. Neurother.* **10** (8), 1295–1305 (2010).
36. Mansfield, K. E. et al. Indirect acute effects of the covid-19 pandemic on physical and mental health in the uk: A population-based study. *Lancet Digit. Health*. **3** (4), e217–e230 (2021).
37. Banerjee, D. D. The other side of covid-19: impact on obsessive compulsive disorder (ocd) and hoarding. *Psychiatry Res.* **288**, 112966 (2020).
38. Jacob, L. et al. Alcohol use and mental health during covid-19 lockdown: A cross-sectional study in a sample of Uk adults. *Drug Alcohol Depend.* **219**, 108488 (2021).
39. Rodriguez, L. M., Litt, D. M. & Stewart, S. H. Drinking to Cope with the pandemic: the unique associations of covid-19-related perceived threat and psychological distress to drinking behaviors in American men and women. *Addict. Behav.* **110**, 106532 (2020).
40. Rantis, K. et al. Substance use during the covid-19 pandemic in Greece. *J. Subst. Use*. **27** (3), 231–238 (2022).
41. Panagiotidis, P., Rantis, K., Holeva, V., Parlapani, E. & Diakogiannis, I. Changes in alcohol use habits in the general population, during the covid-19 lockdown in Greece. *Alcohol Alcohol. (Oxf. Oxfs.)*. **55** (6), 702–704 (2020).
42. Manthey, J. et al. Use of alcohol, tobacco, cannabis, and other substances during the first wave of the sars-cov-2 pandemic in europe: A survey on 36,000 European substance users. *Subst. Abuse Treat. Prev. Policy*. **16** (1), 36 (2021).
43. Kilian, C. et al. Changes in alcohol use during the covid-19 pandemic in europe: A meta-analysis of observational studies. *Drug Alcohol Rev.* **41** (4), 918–931 (2022).

44. Sohi, I. et al. Changes in alcohol use during the covid-19 pandemic and previous pandemics: A systematic review. *Alcohol. Clin. Exp. Res.* **46** (4), 498–513 (2022).
45. Hatami, H. et al. Tele-medicine and improvement of mental health problems in covid-19 pandemic: A systematic review. *Int. J. Methods Psychiatr. Res.* **31** (3), e1924 (2022).
46. Mellos, E. (ed Paparrigopoulos, T.) Substance use during the covid-19 pandemic: what is really happening? *Psychiatrike = Psychiatriki* **33** 1 17–20 (2022).
47. Emcdda Trendspotter Briefing. Impact of Covid-19 on Drug Services and Help-Seeking in Europe. (European Monitoring Centre for Drugs and Drug Addiction, 2020).
48. Sarfraz, A. et al. The incidence of alcohol use disorders during the covid-19 pandemic. *Psychiatria Danubina*. **34** (3), 535–543 (2022).
49. Moreno, C. et al. How mental health care should change as a consequence of the covid-19 pandemic. *Lancet Psychiatry*. **7** (9), 813–824 (2020).
50. Yao, H., Chen, J. H. & Xu, Y. F. Patients with mental health disorders in the covid-19 epidemic. *Lancet Psychiatry*. **7** (4), e21 (2020).
51. Seo, J. H., Kim, S. J., Lee, M. & Kang, J. I. Impact of the covid-19 pandemic on mental health service use among psychiatric outpatients in a tertiary hospital. *J. Affect. Disord.* **290**, 279–283 (2021).
52. Kozloff, N., Mulsant, B. H., Stergiopoulos, V. & Voineskos, A. N. The covid-19 global pandemic: implications for people with schizophrenia and related disorders. *Schizophr. Bull.* **46** (4), 752–757 (2020).
53. Fonseca, L. et al. Schizophrenia and covid-19: risks and recommendations. *Revista Brasileira De Psiquiatria (Sao Paulo Brazil: 1999)*. **42** (3), 236–238 (2020).
54. Sauer, K. S., Schmidt, A., Jungmann, S. M., Bailer, J. & Witthöft, M. Do patients with pathological health anxiety fear covid-19? A time-course analysis of 12 single cases during the first wave of the covid-19 pandemic in Germany. *J. Psychosom. Res.* **152**, 110687 (2021).
55. Schneider, A., Donnachie, E., Zipfel, S. & Enck, P. Patients with somatoform disorders are prone to expensive and potentially harmful medical procedures—results of a retrospective cohort study over 15 years. *Deutsches Arzteblatt Int.* **118** (25), 425–431 (2021).
56. Smith, G. R. Jr. The course of somatization and its effects on utilization of health care resources. *Psychosomatics* **35** (3), 263–267 (1994).
57. Kim, H. S., Kim, B., Lee, S. G., Jang, S. Y. & Kim, T. H. Covid-19 case surge and telemedicine utilization in a tertiary hospital in Korea. *Telemedicine J. e-health: Official J. Am. Telemedicine Association*. **28** (5), 666–674 (2022).
58. Barlattani, T. et al. Neuropsychiatric manifestations of Covid-19 disease and post Covid syndrome: the role of n-acetylcysteine and acetyl-l-carnitine. *Curr. Neuropharmacol.* **23** (6), 686–704 (2025).
59. Barlattani, T. et al. Patterns of psychiatric admissions across two major health crises: L' aquila earthquake and covid-19 pandemic lockdown. *BMC Psychiatry*. **24** (1), 658 (2024).
60. Barlattani, T. et al. Suicide and covid-19: A rapid scoping review. *Ann. Gen. Psychiatry*. **22** (1), 10 (2023).

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Author contributions

Authors J.I. Kang, J.H. Seo, I Jung, and M Lee designed the study. J.H. Seo and M Lee facilitated the acquisition of data by coordinating with the Health Insurance Review and Assessment Service (HIRA). M Lee and I Jung performed the statistical analyses. J.H Seo, S Kang, S.J. Kim, and J.I. Kang interpreted the findings. J.H. Seo, M Lee, and J.I Kang prepared the main manuscript. All authors have contributed to and approved the final manuscript. J.H.Seo and M Lee contributed equally as co-first authors, and co-corresponding authors are J.I.Kang and I Jung.

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Declarations

Competing interests

The authors declare no competing interests.

Ethics approval

This is an observational study. Approval was granted by HIRA (research data: M20220112766) and the IRB of Severance Hospital, Seoul, Republic of Korea (No: 4-2022-0245).

Additional information

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Correspondence and requests for materials should be addressed to I.J. or J.I.K.