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Increased risk of depression and anxiety in patients with chronic back pain following COVID-19 infection based on a nationwide population-based study

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Using a nationwide database from the Korean National Health Insurance Service database, this retrospective cross-sectional study investigated how COVID-19 affects the onset of depression and anxiety in individuals with pre-existing back pain. Patients were enrolled between 2019 and 2020 using the International Classification of Diseases, Tenth Revision code. Ultimately, 28,593 and 24,777 eligible patients were classified into depression and anxiety groups, respectively. Further group subdivisions were made according to back pain and no back pain, established through a 1:3 ratio. The Cox proportional-hazards regression model was used to explore the risk of depression or anxiety developing in patients with back pain, adjusting for basic characteristics. Compared with individuals without back pain, those with back pain had higher crude hazard ratios (HRs) for depression (HR 1.877, 95% confidence interval [CI] 1.165–3.025, *P* = 0.01) and anxiety (HR 3.256, 95% CI 1.809–5.859, *P* < 0.001). Moreover, the back pain group had relatively high adjusted HRs for depression (HR 1.768, 95% CI 1.092–2.862, *P* = 0.02) and anxiety (HR 3.493, 95% CI 1.916–6.365, *P* < 0.001). COVID-19 is associated with a relatively high risk of developing depression and anxiety in patients with back pain than in those without.

Keywords COVID-19, Back pain, Depression, Anxiety, Mental health

Background

The coronavirus disease 2019 (COVID-19) pandemic outbreak has profoundly affected global societies since 2019, introducing multifaceted challenges, particularly in healthcare and mental well-being. Beyond its direct effects on respiratory health, the pandemic has unveiled a plethora of secondary ramifications, extending to mental health[1–3]. Mental disorders are among the primary causes of health-related burdens worldwide. According to the Global Burden of Diseases, Injuries, and Risk Factors Study 2019, depressive and anxiety disorders were the two most disabling mental disorders, ranked as the 25th largest cause of global burden in 2019[4,5]. Depression and anxiety, which were pervasive and debilitating conditions even before the pandemic, have surged to the forefront of public health concerns in the wake of COVID-19.

Studies conducted during the pandemic have consistently underscored the profound effect of COVID-19 on psychological well-being[6–8]. Several studies have reported increased rates of depression and anxiety resulting from the COVID-19 pandemic[9,10]. Risk factors for depression and anxiety associated with the COVID-19 pandemic include female sex, young age, the presence of chronic disease, pre-existing mental illness, and family relationships[10–12]. Heightened levels of stress, social isolation, economic instability, and fear of infection have contributed to a surge in mental health disorders globally. The confluence of these stressors has disproportionately affected vulnerable populations, including individuals grappling with chronic pain conditions such as back pain.

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Back pain, a prevalent and often debilitating musculoskeletal ailment, is intricately intertwined with psychological well-being[13]. Research spanning decades has elucidated the bidirectional relationship between back pain and mental health, demonstrating how one can exacerbate the other in a vicious cycle[9,14,15]. Individuals with chronic back pain frequently exhibit elevated rates of depression and anxiety, compounding the burden of their condition and impeding their overall well-being[16,17].

Rationale

Against the foregoing background, the intersection of COVID-19, back pain, and mental health warrants closer examination. While emerging evidence highlights the detrimental consequences of COVID-19 on mental health outcomes[18,19], relatively little is known about how it influences psychological distress in individuals with pre-existing back pain. Understanding the interplay between COVID-19 infection and the development of depression and anxiety in patients with back pain is imperative for optimizing clinical care, enhancing risk stratification, and devising targeted interventions to mitigate the psychosocial toll of the pandemic.

Therefore, this study aimed to elucidate the nexus between COVID-19, back pain, and mental health outcomes, drawing upon a robust dataset derived from the Korean National Health Insurance Service. We sought to determine the incidence of depression and anxiety in patients with COVID-19 with pre-existing back pain using multi-year comprehensive health records. Through rigorous statistical analysis and meticulous patient stratification, we could provide actionable insights that inform clinical practice, public health policy, and future research endeavors.

Methods

Study design and population

The study population was enrolled from the Korean National Health Insurance Service database between 2019 and 2020 using the International Classification of Diseases, Tenth Revision codes (ICD-10 code), comprising 118,438 patients with COVID-19. Exclusions were made for patients aged < 18 years; those with ICD-10 codes related to depression and anxiety from 2010 to 2018; and those with other neurological diseases, trauma, infection, cancer, or missing values. This resulted in 28,593 patients in the depression group and 24,777 in the anxiety group. Patients with back pain were identified as the back pain group. Thus, using propensity score matching (PSM), the no back pain group was established at a 1:3 ratio by matching variables such as basic characteristics, comorbidities, and socioeconomic status. The process of selecting case and control groups is illustrated in Fig. 1 (depression) and Fig. 2 (anxiety). This study was approved by the Institutional Review Board and Ethics Committee, which issued a waiver regarding the need for informed consent (CR323348). All studies were performed according to relevant guidelines and regulations.

COVID-19 was diagnosed using ICD-10 codes (B342, B972, J1288, U071, U07101, U072, U089, U099, Z29002). Depression was diagnosed using ICD-10 codes (F32.x, F33.x) and recorded more than twice in psychiatric outpatient or hospitalization visits. Anxiety was diagnosed using ICD-10 codes (F40.x, F41.x) and recorded more than twice in psychiatric outpatient or hospitalization visits. Back pain was diagnosed using ICD-10 codes (M54.4, M54.5) and recorded more than twice in outpatient or hospitalization visits in the year before the COVID-19 diagnosis. Additionally, cases with procedure codes (neuroplasty (SZ641, SZ634, S4594), block (LA251, LA253, LA352 ~ 9), radiofrequency ablation (S4825, S4826), epidural block (LA222 ~ 7, LA321, LA322), prolotherapy (MY143)), or drug codes (Tramadol, Acetaminophen + Tramadol, Acetaminophen, Acetaminophen + Hydrocodone, Celecoxib, Ibuprofen, Codeine + Ibuprofen + Paracetamol, Diclofenac, Meloxicam, Ketoprofen, Naproxen, Piroxicam, Ketorolac, Oxycodone, and Codeine related codes) were included. Patients diagnosed with other neurological diseases in ICD-10 codes (I64, I63.9, G46.3, G46.4, G37.3, G61.0, G35) after the COVID-19 code registration were excluded. Patients diagnosed with trauma in ICD-10 codes (S12, S13, S14, S22, S23, S24, S32, S33, S34, S38, T02.1, T03.8, T08.0, T08.1, T09.3) within the 2 weeks after the diagnosis of low back pain were excluded. Patients diagnosed with infection in ICD-10 codes (M46.2, M46.3, M46.4, M46.5, M46.8, M46.9, A18.00, G04.9, G06.1) within the 2 weeks after the diagnosis of low back pain were excluded. Patients diagnosed with cancer in ICD-10 codes (C41.2, C72.0, C72.1, C79.4, C79.5, D43.4, D48.0) within the 2 weeks after the diagnosis of low back pain were excluded. Basic characteristics (e.g., age, sex, alcohol consumption, smoking, physical exercise, body mass index [BMI]), comorbidities (e.g., hypertension, diabetes, and Charlson Comorbidity Index [CCI]), and socioeconomic status (e.g., region and income level) were retrieved. This study was approved by an appropriate institutional review board and ethics committee, which issued a waiver regarding the requirement for informed consent.

Statistical analyses

The Cox proportional-hazards regression model was used to explore the risk of developing depression or anxiety in patients with COVID-19 with back pain, adjusting for basic characteristics, comorbidities, and socioeconomic status. The proportional hazards assumption was confirmed using Schoenfeld residuals. Patients were followed up for 1 year after COVID-19 infection until the development of depression or anxiety. The Kaplan–Meier curve and log-rank test ($P < 0.001$) were used to compare the survival of two groups (back pain vs. no back pain). PSM was conducted to reduce selection bias owing to the differences between the back pain and no back pain groups and to balance the distribution of confounders. In a data analysis room provided by the NHISS, statistical analyses were performed using the SAS enterprise guide, version 7.1 (SAS Inc., Cary, NC, USA), and R software, version 4.0.3 (The R Foundation for Statistical Computing, Vienna, Austria). All statistical tests were two-tailed, and P-values < 0.05 were considered significant.

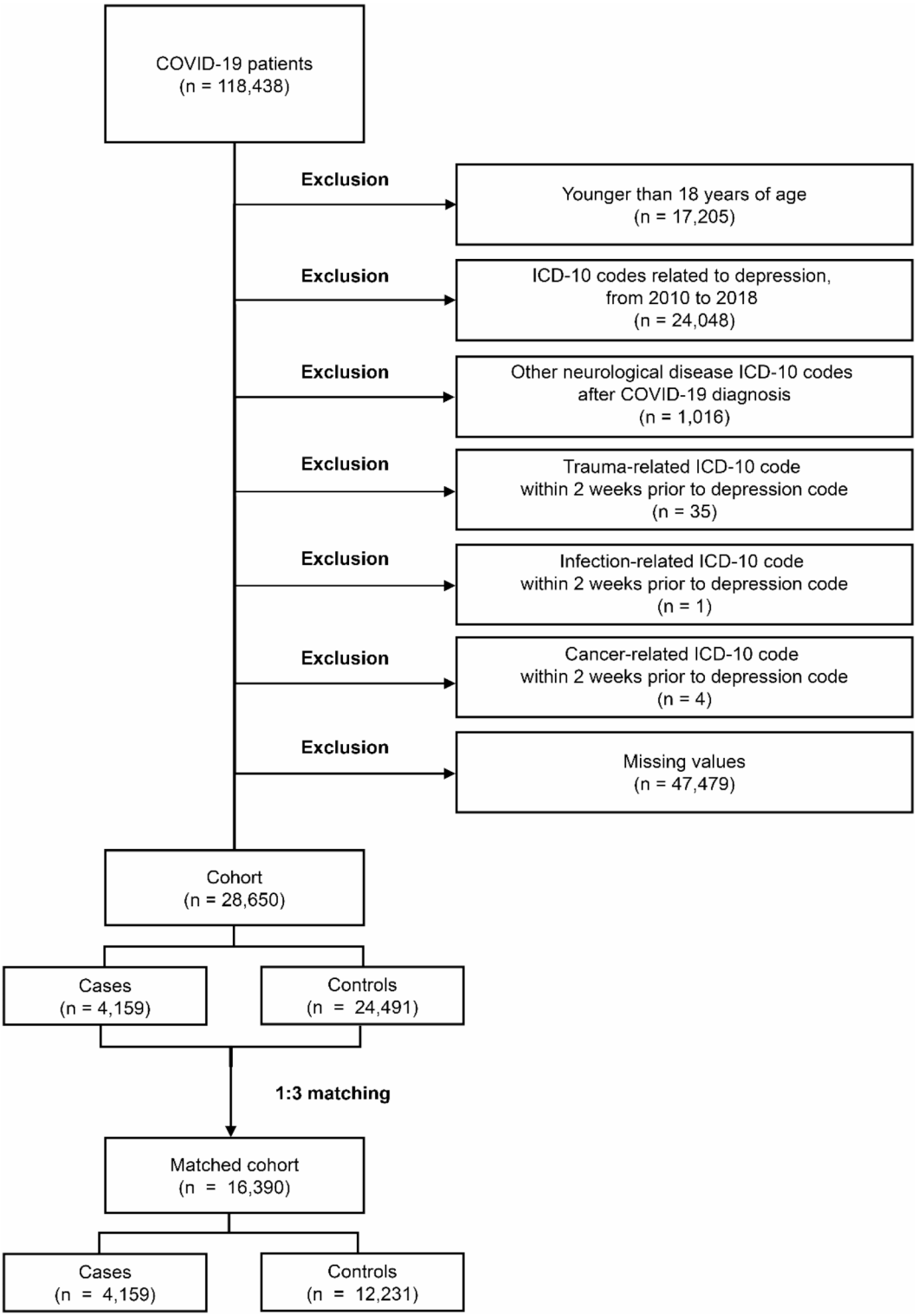

Fig. 1. Cohort selection process for studying depression in patients with COVID-19 with back pain.

Results

Demographic data analysis

The baseline characteristics of both groups were compared for both depression (Table 1) and anxiety (Table 2) before and after PSM to control for confounding variables. Before matching, significant differences were observed in several variables. In both tables, the sex distribution displayed no significant differences before or after matching ($P > 0.05$). The age distribution initially differed significantly, particularly in the younger age group (≤29 years), but these differences were minimized after matching, with slight imbalances remaining

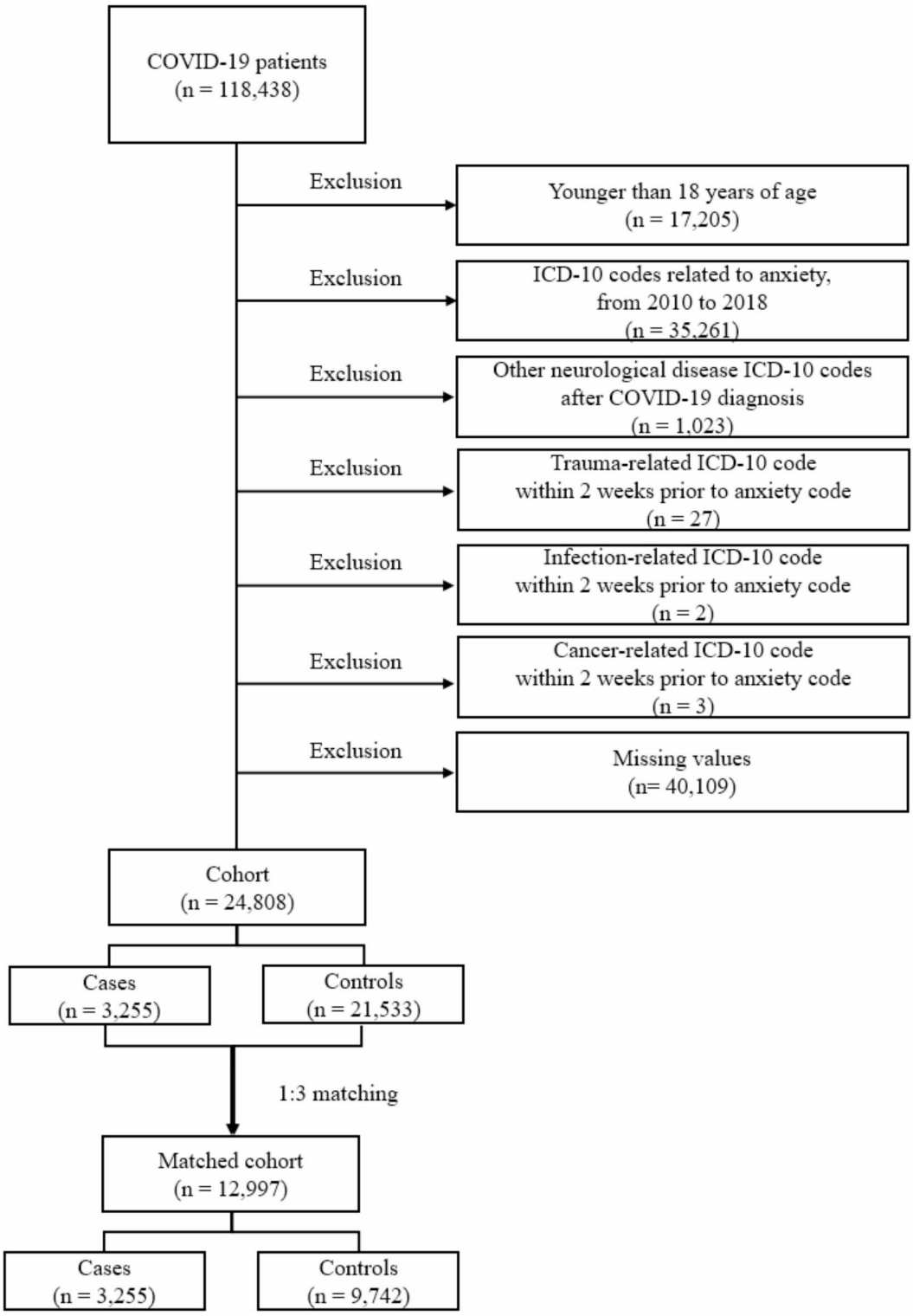

Fig. 2. Cohort selection process for studying anxiety in patients with COVID-19 with back pain.

in the depression cohort. Drinking habits exhibited significant differences before matching ($P = 0.001$ for depression, $P = 0.002$ for anxiety) because of minimal entries in the "none" category for patients with back pain, which balanced out after matching. Smoking status also differed significantly before matching ($P = 0.001$ for depression, $P = 0.003$ for anxiety) but was balanced out after matching in both cohorts. Physical activity levels exhibited initial significant differences ($P < 0.001$ for depression and anxiety), which were largely balanced out after matching. Additionally, BMI showed significant differences before matching ($P < 0.001$ for depression and anxiety), but these were no longer significant after matching. CCI scores, indicating the comorbidity burden,

Category	Before matching			After matching		
	Back pain ($n=4159$)	No back pain ($n=24491$)	*P*-value	Back pain ($n=4159$)	No back pain ($n=12231$)	*P*-value
Sex						
Women	2386 (57.37%)	14,077 (57.48%)	0.905	2386 (57.37%)	7034 (57.51%)	0.885
Men	1773 (42.63%)	10,414 (42.52%)		1773 (42.63%)	5197 (42.49%)	
Age (years)						
≤29	375 (9.02%)	4249 (17.36%)	< 0.001	375 (9.02%)	1189 (9.72%)	0.109
30–39	795 (19.11%)	6209 (25.35%)		795 (19.12%)	2252 (18.41%)	
40–49	898 (21.59%)	5593 (22.84%)		898 (21.59%)	2667 (21.81%)	
50–59	954 (22.94%)	4650 (18.99%)		954 (22.94%)	2971 (24.29%)	
≥60	1137 (27.34%)	3790 (15.48%)		1137 (27.34%)	3152 (25.77%)	
Drinking						
None	0 (0%)	7 (0.04%)	0.001	0 (0%)	3 (0.03%)	0.982
1–2/week	3399 (81.74%)	20,643 (84.29%)		3399 (81.73%)	9999 (81.75%)	
3–4/week	756 (18.18%)	3819 (15.59%)		756 (18.12%)	2216 (18.12%)	
≥5/week	4 (0.10%)	22 (0.09%)		4 (0.10%)	13 (0.11%)	
Smoking						
Non-smoker	2435 (58.55%)	14,924 (60.94%)	0.001	2435 (58.548%)	7123 (58.24%)	0.713
Former smoker	962 (23.13%)	5064 (20.68%)		962 (23.131%)	2906 (23.76%)	
Smoker	762 (18.32%)	4503 (18.39%)		762 (18.322%)	2202 (18.00%)	
Physical activity						
0/week	1033 (24.84%)	5705 (23.29%)	< 0.001	1033 (24.838%)	2903 (23.74%)	0.416
1–2/week	1179 (28.35%)	7668 (31.31%)		1179 (28.348%)	3590 (29.35%)	
3–4/week	1053 (25.32%)	6280 (25.64%)		1053 (25.319%)	3175 (25.96%)	
5–6/week	651 (15.65%)	3699 (15.10%)		651 (15.653%)	1893 (15.48%)	
7/week	243 (5.84%)	1139 (4.65%)		243 (5.843%)	670 (5.48%)	
BMI	24.731 (± 3.60)	24.251 (± 3.79)	< 0.001	24.731 (± 3.60)	24.689 (± 3.83)	0.535
Hypertension						
Non-hypertension	3042 (73.14%)	20,485 (83.64%)	< 0.001	3042 (73.14%)	9126 (74.61%)	0.062
Hypertension	1117 (26.86%)	4006 (16.36%)		1117 (26.86%)	3105 (25.39%)	
Diabetes						
Non-diabetic	3418 (82.18%)	21,898 (89.41%)	< 0.001	3418 (82.18%)	10,171 (83.16%)	0.153
Diabetic	741 (17.82%)	2593 (10.59%)		741 (17.817%)	2060 (16.84%)	
CCI score						
0	2442 (58.72%)	18,001 (73.50%)	< 0.001	2442 (58.716%)	7458 (60.98%)	0.046
1	983 (23.64%)	4258 (17.39%)		983 (23.635%)	2736 (22.37%)	
≥2	734 (17.65%)	2232 (9.11%)		734 (17.648%)	2037 (16.65%)	
Region						
Seoul	1315 (31.62%)	7971 (32.55%)	0.161	1315 (31.62%)	3812 (31.17%)	0.828
Metropolitan cities	1108 (26.64%)	6681 (27.28%)		1108 (26.64%)	3306 (27.03%)	
Non-metropolitan cities	1736 (41.74%)	9839 (40.17%)		1736 (41.74%)	5113 (41.80%)	
Income						
1/4	569 (13.681%)	2845 (11.62%)	0.001	569 (13.681%)	1639 (13.40%)	0.973
2/4	853 (20.51%)	4880 (19.93%)		853 (20.51%)	2504 (20.47%)	
3/4	1167 (28.06%)	7278 (29.72%)		1167 (28.06%)	3442 (28.14%)	
4/4	1570 (37.749%)	9488 (38.74%)		1570 (37.749%)	4646 (37.99%)	

Table 1. Baseline characteristics of patients with and without back pain related to depression before and after matching. *BMI* body mass index, *CCI* Charlson Comorbidity Index. Data are expressed as means ± standard deviations or total number (%).

Category	Before matching			After matching		
	Back pain (*n* = 3255)	No back pain (*n* = 21553)	*P*-value	Back pain (*n* = 3255)	No back pain (*n* = 9742)	*P*-value
Sex						
Women	1917 (58.89%)	12,675 (58.81%)	0.939	1917 (58.89%)	5766 (59.19%)	0.773
Men	1338 (41.11%)	8878 (41.19%)		1338 (41.11%)	3976 (40.81%)	
Age (years)						
≤29	329 (10.11%)	3939 (18.276%)	< 0.001	329 (10.11%)	1071 (10.99%)	0.316
30–39	691 (21.23%)	5618 (26.066%)		691 (21.23%)	1924 (19.75%)	
40–49	742 (22.80%)	4996 (23.18%)		742 (22.80%)	2222 (22.81%)	
50–59	739 (22.70%)	4003 (18.573%)		739 (22.70%)	2272 (23.32%)	
≥60	754 (23.16%)	2997 (13.905%)		754 (23.16%)	2253 (23.13%)	
Drinking						
None	1 (0.03%)	7 (0.032%)	0.002	1 (0.03%)	4 (0.04%)	0.925
1–2/week	2666 (81.91%)	18,111 (84.03%)		2666 (81.91%)	7991 (82.03%)	
3–4/week	585 (17.97%)	3416 (15.849%)		585 (17.97%)	1741 (17.87%)	
≥5/week	3 (0.09%)	19 (0.088%)		3 (0.09%)	6 (0.06%)	
Smoking						
Non-smoker	1874 (57.57%)	12,967 (60.16%)	0.003	1874 (57.57%)	5555 (57.02%)	0.847
Former smoker	753 (23.13%)	4458 (20.684%)		753 (23.13%)	2299 (23.60%)	
Smoker	628 (19.29%)	4128 (19.153%)		628 (19.29%)	1888 (19.38%)	
Physical activity						
0/week	789 (24.24%)	4951 (22.971%)	0.001	789 (24.24%)	2357 (24.19%)	0.375
1–2/week	925 (28.42%)	6867 (31.861%)		925 (28.42%)	2902 (29.79%)	
3–4/week	861 (26.45%)	5499 (25.514%)		861 (26.45%)	2419 (24.84%)	
5–6/week	511 (15.70%)	3287 (15.25%)		511 (15.70%)	1554 (15.95%)	
7/week	169 (5.19%)	949 (4.40%)		243 (5.84%)	670 (5.48%)	
BMI	24.767 (± 3.6)	24.268 (± 3.8)	< 0.001	24.767 (± 3.6)	24.77 (± 3.87)	0.970
Hypertension						
Non-hypertension	2481 (76.22%)	18,327 (85.03%)	< 0.001	2481 (76.221%)	7466 (76.64%)	0.633
Hypertension	774 (23.780%)	3226 (14.97%)		774 (23.779%)	2276 (23.36%)	
Diabetes						
Non-diabetic	2731 (83.90%)	19,445 (90.22%)	< 0.001	2731 (83.902%)	8191 (84.08%)	0.825
Diabetic	524 (16.10%)	2108 (9.78%)		524 (16.098%)	1551 (15.92%)	
CCI score						
0	2041 (62.70%)	16,173 (75.04%)	< 0.001	2041 (62.704%)	6196 (63.60%)	0.612
1	709 (21.78%)	3619 (16.79%)		709 (21.782%)	2050 (21.04%)	
≥2	505 (15.52%)	1761 (8.17%)		505 (15.515%)	1496 (15.36%)	
Region						
Seoul	1078 (33.12%)	7133 (33.10%)	0.490	1078 (33.118%)	3208 (32.93%)	0.929
Metropolitan cities	834 (25.62%)	5718 (26.53%)		834 (25.622%)	2529 (25.96%)	
Non-metropolitan cities	1343 (41.26%)	8702 (40.38%)		1343 (41.26%)	4005 (41.11%)	
Income						
1/4	407 (12.504%)	2493 (11.567%)	0.375	407 (12.504%)	1285 (13.19%)	0.416
2/4	651 (20%)	4212 (19.543%)		651 (20%)	1904 (19.54%)	
3/4	950 (29.186%)	6419 (29.782%)		950 (29.186%)	2732 (28.04%)	
4/4	1247 (38.31%)	8429 (39.108%)		1247 (38.31%)	3821 (39.22%)	

Table 2. Baseline characteristics of patients with and without back pain related to anxiety before and after matching. *BMI* body mass index, *CCI* Charlson Comorbidity Index. Data are expressed as means ± standard deviations or total number (%).

exhibited significant differences before matching, with slight imbalances remaining for depression but not for anxiety after matching ($P=0.046$ for depression, $P=0.612$ for anxiety). Regional and income differences were adjusted through matching, resulting in no significant differences after matching.

Prevalence of psychiatric disorders according to the presence or absence of back pain

Patients with back pain exhibited a significantly higher cumulative incidence of both depression and anxiety compared with those without back pain. The incidence of depression was notably higher in the back pain group ($P=0.009$; Fig. 3). Similarly, the incidence of anxiety was markedly elevated in this group, indicating a notably substantial difference ($P<0.001$; Fig. 4).

The baseline characteristics of both groups were compared for both depression (Table 3) and anxiety (Table 4) using hazard ratios (HRs) to assess risk. For depression, the crude HR for patients with back pain was 1.877 (95% CI: 1.165–3.025, $P=0.01$), indicating a significantly higher risk compared with those without back pain. After adjusting for variables such as sex, age, height, weight, BMI, smoking status, drinking habits, physical activity, region, CCI score, and income, the adjusted HR was 1.768 (95% CI: 1.092–2.862, $P=0.02$), confirming the increased risk. For anxiety, the crude HR for patients with back pain was 3.256 (95% CI: 1.809–5.859, $P<0.001$), indicating a markedly higher risk compared with those without back pain. The adjusted HR, accounting for the same variables as in the depression analysis, was even higher, at 3.493 (95% CI: 1.916–6.365, $P<0.001$), indicating a significant link between back pain and a heightened likelihood of anxiety during the COVID-19 pandemic.

Discussion

This study holds significant merit as it analyzes the period of rigorous national and societal measures against COVID-19 and ensures high diagnostic accuracy according to ICD-10 codes. The robust diagnostic practices during this era provided reliable data, which is crucial for epidemiological studies. Further, this study meticulously controlled for environmental and past disease factors that could influence mental health outcomes through matching, allowing for a clear temporal analysis of the prevalence of psychiatric disorders. The distinction between anxiety and depression is paramount, particularly in understanding their interaction with chronic back pain and COVID-19 infection.

Anxiety, characterized by a heightened state of alertness and unease regarding future events, often manifests as an acute response to stress[20,21]. In the context of COVID-19, the fear of infection, isolation, and uncertainty likely exacerbated anxiety in individuals with chronic back pain. The immediate stress response can increase

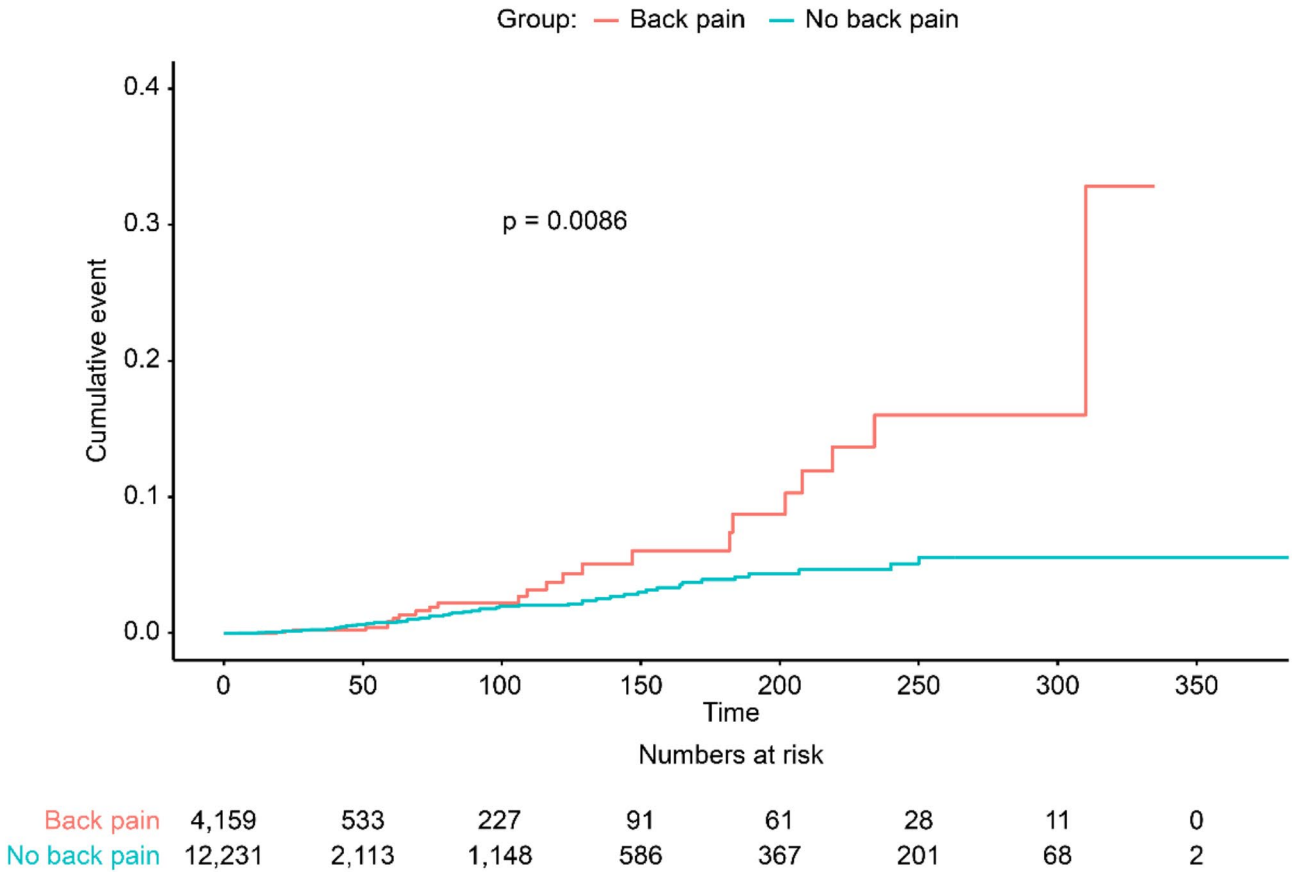

Fig. 3. Cumulative incidence of depression in patients with and without back pain.

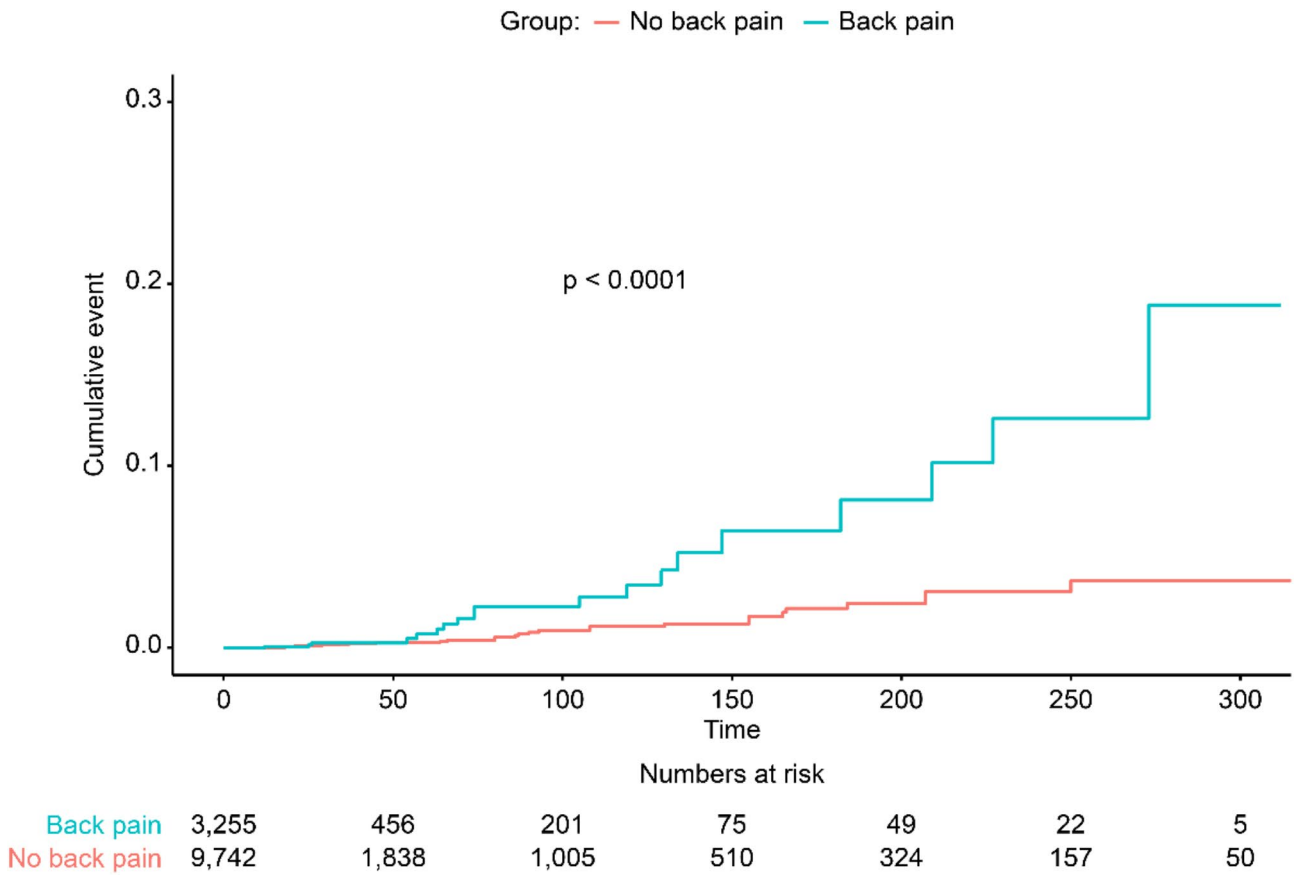

Fig. 4. Cumulative incidence of anxiety in patients with and without back pain.

	Back pain (*n* = 4,159)	No back pain (*n* = 12,231)	*P*-value
Model 1 (crude)			
Hazard ratio (95% CI)*	1.877 (1.165–3.025)	1 (Ref.)	*0.01
Model 2 (sex + age + height + weight + bmi + smk_yn + drink + physical + region + cci_categ + income)			
Hazard ratio (95% CI)*	1.768 (1.092–2.862)	1 (Ref.)	*0.02

Table 3. Hazard ratios for depression in patients with and without back pain. Model 2 is adjusted for demographic, lifestyle, and socioeconomic factors, including sex, age, height, weight, body mass index (BMI), smoking status (smk_yn), alcohol consumption (drink), physical activity (physical), residential region (region), Charlson Comorbidity Index (CCI), and income level (income). BMI refers to body mass index, smk_yn indicates smoking status (yes/no), drink represents alcohol consumption, physical refers to physical activity, region denotes residential area, CCI reflects comorbidity burden, and income represents socioeconomic status based on income level. *Indicates significance.

muscle tension and pain perception, creating a vicious cycle that amplifies both physical pain and psychological distress. Contrarily, depression is a prolonged state of low mood and disinterest, often stemming from past events or chronic conditions[22]. It is also typically a long-term response to ongoing stressors and can significantly impair daily functioning. For individuals with chronic back pain, the enduring nature of both physical pain and depression can lead to a profound decrease in the quality of life[23–28]. The COVID-19 pandemic, with its extended period of social isolation and disruption of normal routines, likely contributed to an increase in depressive symptoms in this population[29,30]. The chronic stress and lack of access to regular medical care during the lockdowns have likely further compounded these issues[31].

The findings highlight the temporal progression of these conditions, with anxiety potentially being an initial acute response to the pandemic, subsequently leading to longer-term depressive states. The data indicate that the incidence of both anxiety and depression increased over time in those experiencing chronic back pain, underscoring the importance of temporal factors in the management of these conditions. The significant HRs

	Back pain ($n = 3,255$)	No back pain ($n = 9,742$)	*P*-value
Model 1 (crude)			
Hazard ratio (95% CI)*	3.256 (1.809–5.859)	1 (Ref.)	< 0.001
Model 2 (sex + age + height + weight + bmi + smk_yn + drink + physical + region + cci_categ + income)			
Hazard ratio (95% CI)*	3.493 (1.916–6.365)	1 (Ref.)	< 0.001

Table 4. Hazard ratios for anxiety in patients with and without back pain. Model 2 is adjusted for the same demographic, lifestyle, and socioeconomic factors as in Table 3. *Indicates significance.

for both anxiety and depression in the back pain cohort compared with those without back pain demonstrate the compounded burden of these conditions. The adjusted HR for anxiety (HR 3.493; 95% CI: 1.916–6.365) was notably higher than that for depression (HR 1.768; 95% CI: 1.092–2.862), suggesting that anxiety might be a more immediate response exacerbated by the pandemic's acute stressors. This aligns with the literature indicating that acute stress and anxiety can significantly worsen chronic pain conditions[32,33]. Moreover, our approach of using a national database and rigorous matching procedures ensures that confounding factors are minimized, providing a clearer picture of the true relationship between COVID-19, back pain, and mental health outcomes. Sociodemographic and socioeconomic factors significantly influence mental health outcomes[34,35]. Specifically, a lower socioeconomic status often correlates with limited access to healthcare, increased job insecurity, and a higher likelihood of experiencing significant psychological distress. Our PSM balanced these variables; yet, a higher incidence of mental health issues in the back pain group persisted, underscoring the profound impact of chronic pain on mental health during the pandemic[36,37].

The implications for healthcare policy and practice are substantial. Integrating mental health support with chronic pain management is imperative, particularly during public health crises. Telehealth options can mitigate the barriers to care, while routine mental health screenings can help identify and address issues early[38]. Developing comprehensive care models that combine physical rehabilitation with psychological support is essential for improving patient outcomes. To comprehend the long-term effect of the COVID-19 pandemic on mental health in individuals with chronic pain, future research should concentrate on longitudinal studies. Randomized controlled trials investigating integrated care models can provide valuable insights into optimal strategies for managing both physical and psychological distress. The persistence of mental health issues beyond the acute phase of the pandemic highlights the need for sustained support for this vulnerable population.

The COVID-19 pandemic has undoubtedly left an indelible mark on global health, emphasizing the critical interplay between physical and mental health. While the acute phase of the pandemic may have passed, this study provides valuable insights that remain relevant for future public health crises. Chronic back pain, a prevalent and often debilitating condition, has been demonstrated to markedly elevate the risk of depression and anxiety, particularly during health emergencies such as the COVID-19 pandemic. A major takeaway from this study is the heightened vulnerability of patients with chronic back pain to psychiatric disorders in the context of a pandemic. The findings highlight that during the COVID-19 pandemic, patients with chronic back pain experienced considerably elevated rates of depression and anxiety in contrast to those without back pain. This suggests that the compounded stress of managing chronic pain and navigating the uncertainties of a pandemic can severely affect mental health. Therefore, although the immediate threat of COVID-19 has subsided, the insights gained from this study underscore the need for preparedness in addressing mental health during future pandemics. Future infectious disease outbreaks are likely; thus, understanding the specific needs of patients with chronic conditions during such times is crucial. Additionally, public health policies should emphasize the importance of mental healthcare for individuals with chronic conditions during pandemics. This could involve regular mental health screenings for patients with chronic pain, increasing awareness about the potential psychological impacts of chronic pain during stressful times, and ensuring that mental health resources are readily available and accessible. By addressing these mental health challenges proactively, healthcare systems can better support patients with chronic pain in case of future pandemics, ultimately improving their overall well-being and resilience.

Limitations

This study has several limitations that must be acknowledged. First, back pain was defined based on diagnoses made at least twice a year in outpatient or inpatient settings. This broad definition did not subclassify back pain into specific diagnoses, such as herniated disc, spinal stenosis, or vertebral fracture; this could have provided more detailed insights into the different types of back pain and their specific associations with psychiatric conditions. Second, this study did not specify the degree of back pain or track detailed treatment histories. This lack of granularity means that variations in the intensity of back pain and the types of treatments received (e.g., pharmacological vs. non-pharmacological interventions) were not accounted for, which could have influenced the psychological outcomes. Third, having relied on ICD-10 codes for identifying cases of depression and anxiety might not have captured all instances of these conditions, especially if patients did not seek medical help or were not formally diagnosed. Moreover, the study period overlapped with the peak of the COVID-19 pandemic, which introduced various external stressors that could independently affect mental health, making it challenging to isolate the impact of back pain. Fourth, the exclusion of certain patients, such as those with other neurological diseases, trauma, infections, or cancer, and those with missing data, could have introduced

selection bias. This affects the "extent to which the findings can be applied to the wider population" of those with back pain. Fifth, the current retrospective design relies on existing medical records, which can be subject to inaccuracies or incomplete data. Prospective studies with more detailed data collection and longitudinal follow-up would be beneficial to validate and expand upon these findings.

Conclusion

Our study highlights the increased risk for depression and anxiety in patients with back pain during the COVID-19 pandemic. These findings emphasize the critical need for integrated healthcare frameworks that address both physical and mental health, particularly during public health crises. Ongoing research and targeted interventions are essential for improving the well-being of and reducing the healthcare burden on individuals with chronic pain. The lessons learned from this pandemic should inform future healthcare strategies to better support the mental and physical health of patients with chronic conditions.

Data availability

The data that support the findings of this study are available from the corresponding author, upon reasonable request.

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References

1. Daly, M. & Robinson, E. Depression and anxiety during COVID-19. *Lancet* **399**, 518. https://doi.org/10.1016/s0140-6736(22)00187-8 (2022).
2. Singh, S. P. & Khokhar, A. Prevalence of posttraumatic stress disorder and depression in general population in India during COVID-19 pandemic home quarantine. *Asia Pac. J. Public. Health*. **33**, 154–156. https://doi.org/10.1177/1010539520968455 (2021).
3. Tang, F. et al. COVID-19 related depression and anxiety among quarantined respondents. *Psychol. Health*. **36**, 164–178. https://doi.org/10.1080/08870446.2020.1782410 (2021).
4. Addisu, A. et al. Common mental disorder and associated factors among women attending antenatal care follow-up in North Wollo Public Health Facilities, Amhara Region, Northeast Ethiopia: A cross-sectional study. *Depress Res Treat* 8828975. https://doi.org/10.1155/2024/8828975 (2024).
5. Batista, P. et al. Anxiety and coping stress strategies in researchers during COVID-19 pandemic. *Front. Public. Health*. **10**, 850376. https://doi.org/10.3389/fpubh.2022.850376 (2022).
6. Bäckryd, E. & Alföldi, P. Chronic pain and its relationship with anxiety and depression. *Lakartidningen* **120** (2023).
7. Li, Y., Scherer, N., Felix, L. & Kuper, H. Prevalence of depression, anxiety and post-traumatic stress disorder in health care workers during the COVID-19 pandemic: A systematic review and meta-analysis. *PLoS One*. **16**, e0246454. https://doi.org/10.1371/journal.pone.0246454 (2021).
8. Parker, C. et al. Depression, anxiety, and acute stress disorder among patients hospitalized with COVID-19: A prospective cohort study. *J. Acad. Consult Liaison Psychiatry*. **62**, 211–219. https://doi.org/10.1016/j.psym.2020.10.001 (2021).
9. Global prevalence and burden of depressive and anxiety disorders. In 204 countries and territories in 2020 due to the COVID-19 pandemic. *Lancet* **398**, 1700–1712. https://doi.org/10.1016/s0140-6736(21)02143-7 (2021).
10. 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. https://doi.org/10.1016/j.jad.2020.08.001 (2020).
11. Global burden of 369. diseases and injuries in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet* 396, 1204–1222. (2020). https://doi.org/10.1016/s0140-6736(20)30925-9
12. Dehn, L. B. & Beblo, T. [Depressed, biased, forgetful: the interaction of emotional and cognitive dysfunctions in depression]. *Neuropsychiatr* **33**, 123–130. https://doi.org/10.1007/s40211-019-0307-4 (2019).
13. Tanishima, S., Hagino, H., Matsumoto, H., Tanimura, C. & Nagashima, H. Relationship among osteoporosis, sarcopenia, locomotive syndrome, and spinal kyphosis in older individuals living in a local mountain area. *Asian Spine J.* **17**, 1074–1081. https://doi.org/10.31616/asj.2023.0001 (2023).
14. Linton, S. J. A review of psychological risk factors in back and neck pain. *Spine (Phila Pa. 1976)*. **25**, 1148–1156. https://doi.org/10.1097/00007632-200005010-00017 (2000).
15. Stoecklein, V. M. et al. Strong association of depression and anxiety with the presence of back pain while impact of spinal imaging findings is limited: analysis of an MRI cohort study. *J. Pain*. **25**, 497–507. https://doi.org/10.1016/j.jpain.2023.09.009 (2024).
16. Huang, L. T. & McMillan, S. C. Mutual effects of depression on quality of life in patients and family caregivers. *Oncol. Nurs. Forum*. **46**, 208–216. https://doi.org/10.1188/19.Onf.208-216 (2019).
17. Parkerson, G. R. Jr., Broadhead, W. E. & Tse, C. K. Quality of life and functional health of primary care patients. *J. Clin. Epidemiol.* **45**, 1303–1313. https://doi.org/10.1016/0895-4356(92)90171-i (1992).
18. Gadermann, A. C. et al. Examining the impacts of the COVID-19 pandemic on family mental health in Canada: findings from a National cross-sectional study. *BMJ Open*. **11**, e042871. https://doi.org/10.1136/bmjopen-2020-042871 (2021).
19. Mohammadkhanizadeh, A. & Nikbakht, F. Investigating the potential mechanisms of depression induced-by COVID-19 infection in patients. *J. Clin. Neurosci.* **91**, 283–287. https://doi.org/10.1016/j.jocn.2021.07.023 (2021).
20. da Silva Lopes, L. et al. Is there a common pathophysiological mechanism between COVID-19 and depression? *Acta Neurol. Belg.* **121**, 1117–1122. https://doi.org/10.1007/s13760-021-01748-5 (2021).
21. Golla, A., Østby, H. & Kermen, F. Chronic unpredictable stress induces anxiety-like behaviors in young zebrafish. *Sci. Rep.* **10**, 10339. https://doi.org/10.1038/s41598-020-67182-4 (2020).
22. Garfan, S. et al. Telehealth utilization during the Covid-19 pandemic: A systematic review. *Comput. Biol. Med.* **138**, 104878. https://doi.org/10.1016/j.compbiomed.2021.104878 (2021).
23. Kao, Y. C., Chen, J. Y., Chen, H. H., Liao, K. W. & Huang, S. S. The association between depression and chronic lower back pain from disc degeneration and herniation of the lumbar spine. *Int. J. Psychiatry Med.* **57**, 165–177. https://doi.org/10.1177/00912174211003760 (2022).
24. Krishnan, R. R. K. et al. Chronic pain and depression. I. Classification of depression in chronic low back pain patients. *Pain* **22**, 279–287. https://doi.org/10.1016/0304-3959(85)90028-4 (1985).
25. Martini, L. & Hoffmann, F. Comorbidity of chronic back pain and depression in Germany: results from the GEDA study, 2009 and 2010. *Z. Evid. Fortbild. Qual. Gesundhwes.* **137–138**, 62–68. https://doi.org/10.1016/j.zefq.2018.10.003 (2018).
26. Rush, A. J., Polatin, P. & Gatchel, R. J. Depression and chronic low back pain: Establishing priorities in treatment. *Spine (Phila Pa. 1976)*. **25**, 2566–2571. https://doi.org/10.1097/00007632-200010150-00004 (2000).

27. Sullivan, M. J. L., Reesor, K., Mikail, S. & Fisher, R. The treatment of depression in chronic low back pain: review and recommendations. *Pain* **50**, 5–13. https://doi.org/10.1016/0304-3959(92)90107-m (1992).
28. Yoo, J. I. et al. Orthopedic patients with mental disorder: literature review on preoperative and postoperative precautions. *Clin. Orthop. Surg.* **14**, 155–161. https://doi.org/10.4055/cios21156 (2022).
29. Gallagher, R. M., Moore, P. & Chernoff, I. The reliability of depression diagnosis in chronic low back pain. A pilot study. *Gen. Hosp. Psychiatry*. **17**, 399–413. https://doi.org/10.1016/0163-8343(95)00088-7 (1995).
30. Riepenhausen, A. et al. Coping with COVID: risk and resilience factors for mental health in a German representative panel study. *Psychol. Med.* **53**, 3897–3907. https://doi.org/10.1017/s0033291722000563 (2023).
31. Kobayashi, K., Sato, K., Ando, T., Ando, K. & Imura, S. Impact of the COVID-19 pandemic on adherence to denosumab therapy: A single center study. *Asian Spine J.* **17**, 842–850. https://doi.org/10.31616/asj.2022.0417 (2023).
32. Calvano, C. et al. Correction to: families in the COVID–19 pandemic: parental stress, parent mental health and the occurrence of adverse childhood experiences-results of a representative survey in Germany. *Eur. Child. Adolesc. Psychiatry*. **31**, 2013–2016. https://doi.org/10.1007/s00787-021-01816-4 (2022).
33. Mullins, P. M., Yong, R. J. & Bhattacharyya, N. Associations between chronic pain, anxiety, and depression among adults in the united States. *Pain Pract.* **23**, 589–594. https://doi.org/10.1111/papr.13220 (2023).
34. Brooks, S. K. et al. The psychological impact of quarantine and how to reduce it: rapid review of the evidence. *Lancet* **395**, 912–920. https://doi.org/10.1016/s0140-6736(20)30460-8 (2020).
35. Stewart-Brown, S., Samaraweera, P. C., Taggart, F., Kandala, N. B. & Stranges, S. Socioeconomic gradients and mental health: implications for public health. *Br. J. Psychiatry*. **206**, 461–465. https://doi.org/10.1192/bjp.bp.114.147280 (2015).
36. Hochheim, M., Ramm, P., Wunderlich, M. & Amelung, V. Association between chronic low back pain and regular exercise, sedentary behaviour and mental health before and during COVID-19 pandemic: insights from a large-scale cross-sectional study in Germany. *BMC Musculoskelet. Disord.* **23**, 860. https://doi.org/10.1186/s12891-022-05806-8 (2022).
37. Soltani, S. et al. Pain, mental health and healthcare utilization: impact of the COVID-19 pandemic on youth with chronic pain, parents and siblings. *Eur. J. Pain*. **27**, 1249–1265. https://doi.org/10.1002/ejp.2157 (2023).
38. Global and national burden of bone fractures in 204 countries and territories, 1990–2019: A systematic analysis from the Global Burden of Disease Study 2019. *Lancet Healthy Longev.* **2**, e580–e592. https://doi.org/10.1016/s2666-7568(21)00172-0 (2021).

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Joonoh Seo: Conceptualization, formal analysis methodology, writing - original draftNamhoo Kim: Validation, visualizationKyung-Soo Suk: Supervision, writing - review and editingByung Ho Lee: Writing - review and editingYoonjong Bae: Data curation, formal analysis, investigation, methodologyMinae Park: Data curation, formal analysis, investigation, methodologyHyung Joon Ahn: Writing - original draftSi-Young Park: Writing - review and editingHak-Sun Kim: Writing - review and editingSeoung-Hwan Moon: Writing - review and editingJae-Won Shin: Writing - review and editingJi-Won Kwon: Conceptualization, methodology, project administration, resources.

Declarations

Competing interests

The authors declare no competing interests.

Ethical approval

This study was approved by our Institutional Review Board and Ethics Committee, which issued a waiver regarding the need for informed consent. And all studies were performed in accordance with relevant guidelines and regulations.

Additional information

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