

Anxiety and Depressive Symptoms Among Kidney Transplant Recipients in Post-COVID-19 China: Prevalence and Risk Factors

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Background: Anxiety and depression are highly prevalent and disabling mental disorders that often coexist. Kidney transplant recipients are at high risk of anxiety and depression, especially during the COVID-19 pandemic. However, studies focusing on depression and anxiety among kidney transplant recipients in the post-COVID-19 era are lacking.

Objective: The primary objective of this study was to analyze the prevalence of anxiety symptoms alone (ASA), depressive symptoms alone (DSA), and comorbid anxiety and depressive symptoms (CADS) in kidney transplant recipients after the COVID-19 pandemic. The secondary objective was to identify the risk factors associated with these symptoms.

Methods: A cross-sectional survey was conducted among kidney transplant recipients in a tertiary hospital in Hunan, China, from December 2022 to December 2023. A total of 520 recipients were invited to participate in the survey, and 517 valid questionnaires were obtained (response rate 99.4%). Anxiety and depressive symptoms were assessed using the Self-Rating Anxiety Scale (SAS) and Self-Rating Depression Scale (SDS), based on which participants were divided into four groups: normal (no anxiety or depressive symptoms), ASA, DSA, and CADS. Clinical characteristics were compared between the groups, and the risk factors associated with ASA, DSA, and CADS were analyzed using multiple logistic regression.

Results: Among the 517 kidney transplant recipients enrolled ASA was identified in 3.7% of recipients (n=19), DSA in 20.3% (n=105), and CADS in 13.9% (n=72). Multiple logistic regression showed that rejection was positively associated with ASA, and vaccination was negatively associated with DSA. Younger age, transplant nephritis/nephropathy, a history of postoperative pulmonary infection, and rejection were positively associated with CADS.

Conclusion: In the post-COVID-19 era, our study identifies a high prevalence of anxiety and depressive symptoms among kidney transplant recipients, with multiple associated factors. These findings highlight the urgent need for systematic mental health screening and the development of targeted psychological interventions in transplant care.

Keywords: post-COVID-19 era, kidney transplantation, anxiety, depression, comorbidity

Introduction

Anxiety and depression are widespread mental disorders with high prevalence and tremendous disease burden, ranking as the second and eighth leading causes of years lived with disability (YLDs) worldwide, respectively.¹ These disorders frequently co-occur, with comorbidity observed in over three-quarters of individuals diagnosed with either condition.² The traditional explanation of such high comorbidity is based on the common cause model, which assumes shared etiological factors and pathogenic pathways between anxiety and depression.³ However, recent psychological network models suggest that specific mental symptoms—whether overlapping or distinct—may serve as critical bridges in the development of comorbid anxiety and depression.⁴⁻⁶ Accumulating evidence has consistently demonstrated that comorbid anxiety and depression are associated with more psychosocial risk factors, greater functional impairments, increased illness severity,

and poorer health outcomes compared to either condition alone.^{2,7} Given the high prevalence and substantial disease burden of comorbid depression and anxiety, identifying modifiable risk factors for each condition and their co-occurrence is crucial and carries significant public health implications for guiding targeted intervention strategies.⁷

The global COVID-19 pandemic has resulted in significant psychological consequences across diverse populations due to rapid transmission, high mortality, social isolation, health-related stressors, and economic disruptions.^{8,9} Recent research has shown that during the COVID-19 pandemic, the global prevalence of anxiety disorders increased by 25.6% compared to pre-pandemic levels, while the prevalence of severe depressive disorders increased by 27.6%.¹⁰ In December 2022, the Chinese government transitioned from its “dynamic zero-COVID” policy to a complete reopening, making the beginning of China’s post-COVID-19 era.¹¹ Despite general control of transmission, emerging variants continue causing sporadic outbreaks with persistent mental health effects.¹² Recent Chinese studies show elevated psychological distress during this transition. Among college students, anxiety and depression prevalence were 25.0% and 29.7% respectively, higher than during the acute outbreak.¹³ Similarly, antenatal anxiety and depression affected 27.9% and 25.2% of pregnant women, representing increases from pre-pandemic levels.¹⁴ These findings indicate that psychological distress related to the COVID-19 pandemic persists beyond the acute phase of the pandemic.¹² It is thus crucial to continue screening and interventions for psychological symptoms among susceptible populations in the post-pandemic era.

Kidney transplant recipients are a particularly vulnerable group to anxiety and depression.¹⁵ Statistics indicate that 13–40% of kidney transplant recipients develop depression, while 17–60% develop anxiety disorders.¹⁶ This population is also at high risk for COVID-19 infection due to the regular use of immunosuppressive drugs and comorbidities, such as cardiovascular disease and diabetes.¹⁷ Therefore, they experience more psychological distress due to fear of infection, limited medical resources, and financial burdens during the COVID-19 pandemic. A study of 106 kidney transplant recipients showed a high prevalence of anxiety (23.6%) and depression (44.3%), both of which were significantly elevated among those who had contracted the COVID-19 infection and those with rejection episodes.¹⁸ Moreover, previous research revealed that kidney transplant recipients taking antidepressants preoperatively had a 39% higher mortality rate than controls, whereas those initiating antidepressants in the first year post-transplantation exhibited twice the mortality rate of controls in the subsequent year.¹⁹ The situation in China may be particularly concerning, as a recent survey demonstrated that only approximately 9.5% of participants with 12-month depressive disorders received treatment from any healthcare providers, and merely 0.5% of participants with depressive disorders received adequate treatment.²⁰ These results indicate that anxiety and depression are highly prevalent and are associated with poor clinical outcomes among kidney transplant recipients, highlighting the urgent need to improve mental healthcare for this special population.

Despite the well-documented psychological distress among kidney transplant recipients, relatively less research attention has been paid to these problems in the post-COVID-19 era. In addition, to the best of our knowledge, no previous studies have directly compared the prevalence and associated factors between kidney transplant recipients with depression alone, anxiety alone, and comorbid depression and anxiety. Addressing these knowledge gaps is important due to the frequent transition and high comorbidity between anxiety and depression.² Therefore, we conducted the current study to assess anxiety and depression symptoms among kidney transplant recipients in a tertiary hospital in Hunan, China, after the COVID-19 pandemic. Specifically, we analyzed the prevalence and risk factors associated with anxiety alone, depression alone, and comorbid anxiety and depression in kidney transplant recipients. Our findings provide valuable insights into the psychological distress among kidney transplant recipients to guide further targeted and effective interventions to prevent these problems in the post-COVID-19 era.

Materials and Methods

Study Design and Participants

This single-center cross-sectional observational study used convenience sampling to collect data on kidney transplant recipients receiving treatment and regular follow-up at the Transplant Center at Xiangya Hospital, Central South University. The study was conducted from December 7, 2022, when the Chinese government announced a policy change, to December 31, 2023. The inclusion criteria of participants were as follows: 1) kidney transplant recipients (including both first transplants and re-transplants) undergoing regular follow-up at our clinic with functional kidney graft; 2) age \geq

18 years old; 3) being in a stable condition and able to complete the questionnaire survey. The exclusion criteria were as follows: 1) multi-organ transplant recipients; 2) recipients diagnosed with anxiety and depression before study initiation, requiring medication to control symptoms; 3) being unable to complete the study due to severe physical and mental illness. A total of 520 recipients were invited to participate in the survey, and 517 valid questionnaires were obtained, yielding an effective response rate of 99.4% (Figure 1).

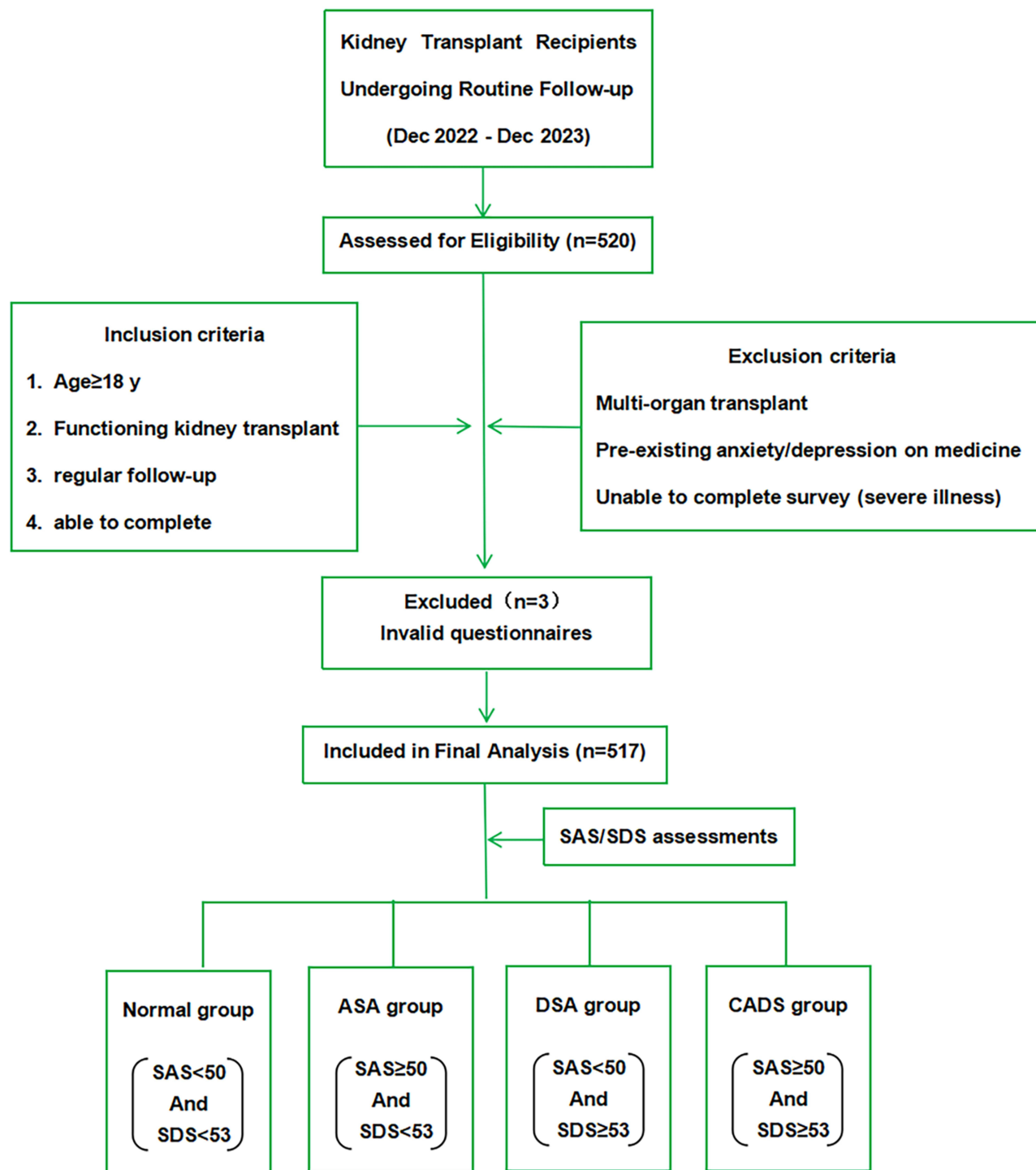


Figure 1 Participant flow diagram and symptom-based grouping.

Abbreviations: ASA, Anxiety symptoms alone; DSA, Depressive symptoms alone; CADS, Comorbid anxiety and depressive symptoms; SAS, Self-Rating Anxiety Scale; SDS, Self-Rating Depression Scale.

Sample Size Calculation

Based on current literature, the prevalence of anxiety among kidney transplant recipients is 23.6%,¹⁸ and the prevalence of depression is 44.3%. The sample size was calculated using the standard formula for estimating the required sample size for a population proportion: $\frac{u_{\alpha/2}^2 \pi(1-\pi)}{\delta^2}$ where π represents the prevalence rate, δ represents the allowable error, and α represents the significance level of the statistical test. We set $\delta=0.05$, $\pi=0.443$, $\alpha=0.05$, and $u_{0.05/2}=1.96$. Substituting it into the formula, the calculation is 379. Considering a 10% dropout rate, the minimum required sample size is 417 kidney transplant recipients.

Procedure

Ethical approval was obtained from the Ethics Committee of Xiangya Hospital of Central South University (No.: 2,021,101,000). The research team members were one physician and four licensed nurses working in the Transplant Center of Xiangya Hospital. The research team received unified training prior to the formal investigation to ensure consistency and reliability of data collection. All kidney transplant recipients undergoing routine follow-up at our hospital were approached by our research team during their clinic visits. All participants were explained about the research's purpose, procedure, benefits, and risks. They were also informed that they could withdraw from the study at any time during the survey period, which would not affect their treatment at the hospital. After providing written informed consent, the participants were invited to complete a questionnaire survey online or on-site at their convenience. Most participants completed the questionnaire independently. For those who required assistance (eg, due to literacy issues or visual impairment), trained investigators provided standardized support by reading questions aloud and recording participants' verbal responses verbatim, without offering interpretation or influencing their answers. All investigators received training on neutral questioning techniques to minimize potential bias. The total questionnaire took 20–35 minutes to complete.

Clinical Data Collection

Clinical data were collected from medical records for all patients. Where records were incomplete or data appeared inconsistent, face-to-face or telephone interviews were conducted to ensure data integrity. The general variables collected included sex, age, body mass index (BMI), donor type, transplant duration, posttransplant complications and adverse events, current maintenance immunosuppressant regimen, COVID-19 vaccination status, and latest serum creatinine level at the time of the investigation. Previously laboratory-confirmed COVID-19 cases were diagnosed through nucleic acid or antigen testing according to the “Diagnosis and Treatment Protocol for Novel Coronavirus Infection” published by the National Health Commission of the People's Republic of China.²¹ The CKD-EPI formula was used to estimate the glomerular filtration rate (eGFR),²² and the Charlson Comorbidity Index (CCI) was used to evaluate comorbidity.²³

Measurement of Anxiety and Depressive Symptoms

Participants' anxiety and depressive symptoms were assessed using standard scales embedded within the composite questionnaire: the Self-Rating Anxiety Scale (SAS)²⁴ and the Self-Rating Depression Scale (SDS),²⁵ developed by Zung et al. Both scales include 20-item self-rated items that assess participants' anxiety/depressive symptoms over the past week.^{24,25} Items are rated on a 4-point Likert scale ranging from 1 to 4. Total score ranges from 20 to 80, with higher score indicating greater symptoms severity. The Chinese versions of both scales have been previously validated and widely used in Chinese populations.^{26,27} In our study, they demonstrated good internal consistency, with Cronbach's alpha coefficient of 0.78 for the SAS and 0.85 for the SDS.

According to the guidelines, a SAS score ≥ 50 indicates anxiety symptoms, and an SDS score ≥ 53 indicates depressive symptoms.^{28–30} Based on these cutoffs, the participants were classified into four groups: 1) normal (no symptoms of anxiety or depression): SAS < 50 and SDS < 53 ; 2) anxiety symptoms alone (ASA): SAS ≥ 50 and SDS < 53 ; 3) depressive symptoms alone (DSA): SDS ≥ 53 and SAS < 50 ; and 4) comorbidity of anxiety and depressive symptoms (CADS): SAS ≥ 50 and SDS ≥ 53 .^{31,32}

Statistical Analysis

Data analysis was performed using IBM SPSS Statistics for Windows version 26.0. Continuous variables were described as means \pm standard deviations or medians (first quartile, third quartile). If the data satisfied the homogeneity of variance assumption, a one-way analysis of variance was used to compare the differences between the groups. If the data violated the homogeneity of variance assumption, the Kruskal–Wallis *H*-test was used. Categorical variables were presented as frequencies (percentages), and differences between groups were compared using the chi-square test. The Kruskal–Wallis *H*-test was used to compare ordinal data across multiple groups. The LSD-*t* test or chi-square test was used for pairwise comparisons of statistically significant variables. Multiple logistic regression models were established for ASA, DSA, and CADs, with the normal group as the reference and variables with $p < 0.05$ in univariate analysis, along with clinically relevant variables identified from previous literature as potential confounders or predictors of depression in transplant recipients, regardless of their statistical significance in our univariate analysis. Statistical significance was set at $P < 0.05$.

Results

Comparison of Sample Characteristics Across Four Groups

Table 1 shows the characteristics of the 517 kidney transplant recipients. The participants were predominantly male (60.0%), with a mean age of 44.75 ± 11.01 years and a median transplant duration of 4.67 (2.38, 8.08) years. Most participants had cadaveric donors (82.2%), had a BMI of 18.5–23.9 kg/m² (63.8%), had hypertension as a major post-transplant complication (62.7%), and had an Immunosuppressive regime of CNI+MPA+Pred (82.6%). Most participants did not receive COVID-19 vaccination (71.6%) and had laboratory-confirmed COVID-19 infection (74.1%) during the survey period.

Table 1 Sample Characteristics Across Different Normal, ASA, DSA, and CADs Groups

Clinical Demographics	Total (n=517)	Normal (n=321,62.1%)	ASA (n=19,3.7%)	DSA (n=105,20.3%)	CADs (n=72,13.9%)	$\chi^2 / H / F$	P
Sex, n(%)						4.980	0.173
Male	310(60.0)	193(60.1%)	11(57.9)	70(66.7)	36(50.0)		
Female	207(40.0)	128(39.9)	8(42.1)	35(33.3)	36(50.0)		
Age, n(%)						10.633	0.014
<40 years	175(33.8)	97(30.2)	3(15.8)	43(41.0) ^{a,b}	32(44.4) ^{a,b}		
≥40 years	342(66.2)	224(69.8)	16(84.2)	62(59.0) ^{a,b}	40(55.6) ^{a,b}		
BMI, n(%)						1.259	0.739
18.5–23.9 kg/m ²	330(63.8)	211(65.7)	11(57.9)	64(61.0)	44(61.1)		
<18.5 kg/m ²	57(11.0)	33(10.3)	5(26.3)	10(9.5)	9(12.5)		
24–27.9 kg/m ²	108(20.9)	64(19.9)	2(10.5)	25(23.8)	17(23.6)		
≥28 kg/m ²	22(4.3)	13(4.0)	1(5.3)	6(5.7)	2(2.8)		
Donor type, (%)						4.714	0.194
Deceased	425(82.2)	267(83.2)	17(89.5)	88(83.8)	53(73.6)		
Living	92(17.8)	54(16.8)	2(10.5)	17(16.2)	19(26.4)		
Transplant duration, (%)						1.544	0.672
<1 year	35(6.8)	24(7.5)	1(5.3)	7(6.7)	3(4.2)		
1–5 years	246(47.6)	154(48.0)	9(47.4)	51(48.6)	32(44.4)		
>5 years	236(45.6)	143(44.5)	9(47.4)	47(44.8)	37(51.4)		
Post-transplant comorbidities							
CCI, mean(SD)	0.52±0.71	0.45±0.68	0.89±0.66 ^a	0.48±0.65 ^b	0.79±0.86 ^{a,c}	19.760	0.000
Hypertension, n(%)	324(62.7)	200(62.3)	16(84.2)	63(61.0)	45(62.5)	4.107	0.250
Diabetes, n(%)	97(18.8)	58(18.1)	5(26.3)	19(18.1)	15(20.8)	1.046	0.790

(Continued)

Table 1 (Continued).

Clinical Demographics	Total (n=517)	Normal (n=321,62.1%)	ASA (n=19,3.7%)	DSA (n=105,20.3%)	CADS (n=72,13.9%)	$\chi^2 / H / F$	P
Post-transplant complications							
Transplant nephritis or Transplant nephropathy, n(%)	44(8.5)	19(5.9)	4(21.1) ^a	9(8.6)	12(16.7) ^a	12.759	0.005
Post-transplant pneumonia	62(12.0)	30(9.3)	4(21.1)	11(10.5)	17(23.6) ^{a,c}	13.046	0.005
Rejection	22(4.3)	9(2.8)	3(15.8) ^a	3(2.9) ^b	7(9.7) ^a		0.005
Cardiovascular and cerebrovascular events	17(3.3)	10(3.1)	1(5.3)	3(2.9)	3(4.2)		0.712
Immunosuppressive regime, n(%)						6.673	0.352
CNI+MPA+Pred	427(82.6)	261(81.3)	15(78.9)	92(87.6)	59(81.9)		
CNI+MPA	47(9.1)	28(8.7)	3(15.8)	10(9.5)	6(8.3)		
Other	43(8.3)	32(10.0)	1(5.3)	3(2.9)	7(9.7)		
Vaccination, n(%)						18.650	0.000
No	370(71.6)	210(65.4)	15(78.9)	91(86.7) ^a	54(75.0) ^c		
Yes	147(28.4)	111(34.6)	4(21.1)	14(13.3) ^a	18(25.0) ^c		
Lab-confirmed COVID-19, n(%)						3.129	0.372
No	134(25.9)	89(27.7)	4(21.1)	28(26.7)	13(18.1)		
Yes	383(74.1)	232(72.3)	15(78.9)	77(73.3)	59(81.9)		
eGFR*, mean(SD)	61.81±23.92	64.40±23.40	50.65±20.21 ^a	59.47±23.41	56.62±26.19 ^a	4.177	0.006

Notes: ^a significantly different from the normal group. ^b significantly different from the anxiety symptoms alone group. ^c significantly different from the depressive symptoms alone group. * P-value derived from one-way ANOVA for continuous variables.

Abbreviations: ASA, Anxiety symptoms alone; DSA, Depressive symptoms alone; CADs, Comorbid anxiety and depressive symptoms; BMI, body mass index; CCI, Charlson Comorbidity Index; CNI, calcineurin inhibitor; MPA, mycophenolic acid; Pred, prednisone; eGFR, estimated glomerular filtration rate.

Among the 517 recipients, 19 (3.7%) had ASA, 105 (20.3%) had DSA, and 72 (13.9%) had CADs. The DSA and CADs groups were younger than the normal group and ASA group. The ASA (0.89 ± 0.66) and CADs (0.79 ± 0.86) groups had significantly higher CCI scores than both of the normal (0.45 ± 0.68) and DSA (0.48 ± 0.65) groups (all pairwise comparisons $P < 0.05$). The CADs group had more postoperative pulmonary infections (23.6%) than the normal group (9.3%, $P < 0.05$) and the DSA group (10.5%, $P < 0.05$). The ASA (15.8%) and CADs (9.7%) group experienced more rejection episodes than the normal group (2.8%, $P < 0.05$), and the ASA group also had more rejection episodes than the DSA group (2.9%, $P < 0.05$). The ASA (50.65 ± 20.21 mL/min/1.73 m²) and CADs group (56.62 ± 26.19 mL/min/1.73 m²) had lower mean eGFR than the normal group (64.40 ± 23.40 mL/min/1.73 m², $P < 0.05$). The DSA group had a lower vaccination rate than the normal group (13.3% vs 34.6%, $P < 0.001$) and the CADs group (13.3% vs 25%, $P < 0.001$). No significant differences were observed among the four groups in terms of sex, BMI, donor type, transplant duration, current maintenance immunosuppressant regimen, or COVID-19 infection ($P > 0.05$).

Factors Independently Associated with ASA, DSA, CADs Based on Logistic Regression

Table 2 shows the results of the multivariable logistic regressions of factors associated with ASA, DSA, and CADs, respectively. Rejection was associated with an increased risk of ASA (odds ratio (OR): 6.216; 95% CI: 1.432, 26.991, $P = 0.015$). Vaccination was associated with a decreased risk of DSA (OR: 0.300; 95% CI: 0.163, 0.553, $P < 0.001$). Additionally, age < 40 years (OR: 2.198; 95% CI: 1.259, 3.846, $P = 0.006$). Transplant nephritis/nephropathy (OR = 2.668, $P = 0.018$), history of posttransplant pulmonary infection (OR = 3.688, $P < 0.001$), and rejection (OR = 3.539, $P = 0.022$) were independent risk factors for CADs.

Table 2 Multiple Logistic Regression Analysis of Determinants for ASA, DSA, and CADS

Dependent Variable	Independent Variable	β	P	OR(95% CI)
ASA	Constant	-4.439	<0.001	
	Age < 40 years	-0.781	0.232	0.458(0.127,1.650)
	Transplant nephritis/nephropathy	1.169	0.069	3.219(0.915,11.325)
	History of posttransplant pneumonia	0.791	0.202	2.205(0.654,7.431)
	Rejection	1.827	0.015	6.216(1.432,26.991)
	Vaccination	-0.599	0.309	0.549(0.173,1.741)
DSA	Constant	-0.130	0.751	
	Age < 40 years	0.456	0.059	1.577(0.983,2.532)
	Transplant nephritis/nephropathy	0.260	0.544	1.297(0.559,3.008)
	History of posttransplant pneumonia	0.175	0.648	1.192(0.561,2.531)
	Rejection	-0.007	0.992	0.993(0.257,3.831)
	Vaccination	-1.203	<0.001	0.300(0.163,0.553)
CADS	Constant	-0.494	0.292	
	Age < 40 years	0.788	0.006	2.198(1.259,3.846)
	Transplant nephritis/nephropathy	0.981	0.018	2.668(1.185,6.008)
	History of posttransplant pneumonia	1.305	<0.001	3.688(1.818,7.482)
	Rejection	1.264	0.022	3.539(1.204,10.400)
	Vaccination	-0.323	0.293	0.724(0.397,1.322)

Notes: The normal group served as the reference category for all comparisons. All odds ratios (OR) are calculated relative to the normal group.

Abbreviations: ASA, Anxiety symptoms alone; DSA, Depressive symptoms alone; CADS, Comorbid anxiety and depressive symptoms.

Discussion

Anxiety and depression are closely interrelated mental disorders. Compared to either disorder occurring alone, individuals with comorbid anxiety and depression have a significantly increased risk of developing chronic diseases,⁷ more treatment resistance and poorer outcomes.^{33–35} Previous studies have predominantly focused on describing anxiety alone or depression alone among kidney transplant recipients,^{15,18,36} with limited attention paid to comorbid anxiety and depression. Our study showed that in the post-COVID-19 era, anxiety and depressive symptoms were still common among kidney transplant recipients, with the prevalence ranging from 3.7% for ASA to 20.3% for DSA. In addition, various factors were associated with various groups. Rejection was positively associated with ASA, and vaccination was negatively associated with DSA. Younger age, transplant nephritis/nephropathy, a history of postoperative pulmonary infection, and rejection were positively associated with CADS.

Our study found that after the COVID-19 pandemic, the prevalence of ASA among kidney transplant recipients was 3.7%, which is comparable to the prevalence of anxiety in the general population before the pandemic.³⁷ The prevalence of DSA and CADS were 20.3% and 13.9%, respectively, which were substantially higher than that in the general population before and during the COVID-19 pandemic.³⁸ This indicates that in the post-COVID-19 era, kidney transplant recipients are more likely to develop depressive symptoms or comorbid anxiety and depressive symptoms. This may be explained by the long-lasting fear of a potential recurrent COVID-19 outbreak after the pandemic, as well as other concerns specific to kidney transplant recipients, such as posttransplant complications, rejection episodes, comorbidities, and financial burden.^{13,15} These findings highlight that psychological distress is a common phenomenon among kidney transplant recipients in the post-COVID-19 era that requires consistent clinical attention and continuous monitoring, with psychological support provided when necessary. Previous research shows that anxiety and depression can influence each other, with over 66% of patients with depressive disorders having anxiety, and 61% of anxious patients having depression.^{39,40} In our study, 79% of recipients with anxiety symptoms concurrently had depressive symptoms, while only 41% of those with depressive symptoms concurrently had anxiety symptoms. This suggests that the psychological stress caused by emergent public health events, such as the COVID-19 outbreak, may more readily lead to the

development of depressive symptoms in anxious recipients but has a relatively smaller impact on the development of anxiety symptoms in depressed kidney transplant recipients.

Our study found that the DSA and CADS groups were younger than the normal and ASA groups, with more patients aged < 40 years. This is consistent with previous findings that during the pandemic, the prevalence of anxiety and depression was higher among young adults aged 21–40 years.^{41,42} These findings suggest that young patients are more susceptible to mental health harm than other age groups. Younger kidney transplant recipients may have higher social and family pressures, as they are often the primary workforce in their families and have to work to support household income and their medication costs. The pandemic-induced economic downturn may affect the employment of some recipients, leading to reduced income, increased stress, and decreased psychological well-being.⁴³ Younger kidney transplant recipients are more adversely affected by the aftermath of COVID-19, resulting in more depressive symptoms. Therefore, more attention should be paid to the psychological health of younger kidney transplant recipients, and necessary assessments and interventions should be implemented to prevent depression.

Vaccination is an effective method for preventing COVID-19. However, only 28.4% of kidney transplant recipients in our study received the COVID-19 vaccine, which is much lower than that in the general population⁴⁴ but similar to that in the liver transplant recipients.⁴⁵ One explanation may be the lack of knowledge and awareness about the COVID-19 vaccine, leading to concerns about its effectiveness and safety. Additionally, immunosuppressive drugs significantly suppress the immune response to COVID-19 vaccines, making it difficult for kidney transplant recipients to produce protective antibodies.⁴⁶ Thus, physicians may be less likely to recommend vaccination. However, we observed a significant negative association between receiving the COVID-19 vaccine and experiencing depressive symptoms among kidney transplant recipients, consistent with observations in patients with chronic kidney disease and the general population.^{47,48} This association between COVID-19 vaccination and lower depressive symptoms may reflect a bidirectional relationship. On one hand, vaccinated kidney transplant recipients may experience greater sense of security and reduced worry about infection, leading to lower anxiety and depressive symptoms. Conversely, patients with existing depressive symptoms may be more socially withdrawn and hesitant to seek medical care, including vaccination, thereby showing lower vaccination rates. It is recommended that, when facing similar public health emergencies in the future, proactive measures are needed to improve the sense of security among kidney transplant recipients to prevent adverse psychological outcomes and improve mental health.

Our study also showed that complications and comorbidities were associated with ASA and CADS. The ASA and CADS groups had higher CCI scores and more complications and comorbidities than the normal and DSA groups. History of posttransplant pulmonary infection, rejection, and transplant kidney nephritis/nephropathy were independent risk factors for CADS. Moreover, rejection was the only significant risk factor for ASA. Pulmonary infection is a common complication and a major cause of recipient death after kidney transplantation.⁴⁹ Recipients with severe post-transplant pneumonia may suffer life-threatening respiratory failure, making them more fearful of COVID-19 pneumonia and leading to an increased risk of CADS. Rejection and transplant nephritis/nephropathy are the main causes of long-term allograft dysfunction, accounting for approximately 80% of the long-term dysfunction of the transplanted kidney.⁵⁰ Therefore, recipients who experience rejection and transplant nephropathy may develop anxiety owing to worsening graft function and worry about graft loss. These findings suggest that accurate assessment of donor kidney quality and efforts to prevent rejection, infections, and other complications are essential to reducing anxiety and depressive symptoms and improving the mental health of kidney transplant recipients.

This study has some limitations. First, participants were recruited from a single center and may not represent kidney transplant recipients in other centers and other regions. Future multicenter studies are needed to get a more representative sample and test our findings. Second, the cross-sectional study design prevents definitive determination of causality between COVID-19-related factors and psychological symptoms. Third, anxiety and depression were measured based on recipients' self-reported surveys, which are subject to bias. Future studies should consider conducting standard psychological assessments to get a more objective and accurate result. Fourth, the cross-sectional design limits our ability to establish temporal relationships between recent health events and psychological symptoms. Fifth, detailed treatment parameters including specific medications, ICU admissions, immunosuppression modifications, and concurrent infections were inconsistently documented across different care settings, precluding their inclusion in multivariate analyses.

Conclusion

In summary, our study demonstrated that anxiety and depressive symptoms were prevalent mental disorders that often coexisted among kidney transplant recipients in the post-COVID-19 era in China. We identified that kidney recipients under 40 years of age, without vaccination, and with complications such as pulmonary infections and rejection episodes were particularly vulnerable to ASA, DSA, and CADs. These findings offer practical clinical guidance for developing varied and personalized mental health interventions based on patients' specific psychological profiles. Additionally, our findings highlight the substantial burden of anxiety and depressive symptoms in this population and underscore the need for systematic mental health screening protocols in transplant follow-up care and integration of psychiatric services such as multidisciplinary teams comprising psychiatrists and transplant specialists within transplant care systems.

Data Sharing Statement

The data analyzed in this study is subject to the following licenses/restrictions: All the data were supplied by our single-central follow-up study. Requests to access these datasets should be directed to the corresponding author.

Ethical Approval and Consent to Participate

This study was approved by the Institutional Review Board of Xiangya Hospital, Central South University (registration number: 2021101000). All kidneys were donated voluntarily with written informed consent, and that this was conducted in accordance with the Declaration of Istanbul I.⁵¹ All the procedures were followed in accordance with the Declaration of Helsinki.⁵² Each participant was informed of the purpose of the study and signed a written informed consent.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors report no conflicts of interest in this work.

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