

Health and Treatment-Related Anxiety among Kidney Transplant Recipients in Kazakhstan

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Abstract

Background: Kidney transplantation (KTx) is a life-saving intervention, but post-transplant psychological well-being and treatment adherence remain critical challenges. This study aimed to (1) develop and validate a Health and Treatment-Related Anxiety Scale in Kazakh and Russian languages, (2) identify predictors of such anxiety, and (3) examine its impact on adherence to treatment and well-being among kidney transplant recipients in Kazakhstan.

Methods: A cross-sectional study was conducted among 223 adult kidney transplant recipients. The newly developed anxiety scale was tested for psychometric validity using exploratory and confirmatory factor analyses. Internal consistency and criterion-related validity were assessed through item-rest correlations and correlation with related outcomes. Multiple linear regression and mediation models were used to identify predictors of health and treatment-related anxiety and psychological mechanisms affecting treatment adherence and well-being.

Results: The scale demonstrated strong psychometric properties with a one-factor structure and high internal consistency (Cronbach's $\alpha=0.893$). Anxiety negatively correlated with both treatment adherence ($p<0.001$). Regression analysis identified employment under disability status and perceived availability of post-KTx monitoring as protective factors. Emotional support and anxiety levels significantly predicted treatment adherence. Mediation analyses revealed that anxiety partially mediated the relationship between perceived post-KTx monitoring and both adherence and well-being ($p<0.05$).

Conclusion: The validated anxiety scale is a reliable tool for assessing psychological vulnerability in kidney transplant recipients. Addressing treatment-related anxiety may enhance post-transplant care by improving both adherence and emotional well-being.

Keywords: kidney transplantation, anxiety, validation, adherence, well-being.

Introduction

Kidney transplantation is the preferred treatment option for patients with end-stage renal disease, offering significantly improved survival rates and quality of life. However, despite these clinical benefits, the psychological impact of transplantation remains an important and often underexplored issue. In Kazakhstan, much of the existing literature has focused on the clinical and immunological outcomes of kidney transplantation such as graft rejection,

biomarkers, and pathophysiology [1–4]. In contrast, fewer studies have addressed the psychological consequences that follow transplantation, even though mental health plays a crucial role in patient recovery and long-term outcomes.

Anxiety and depression are common psychological disorders among transplant recipients [5]. Studies show that depression affects 13% to 40% of transplant patients and doubles the risk of mortality [6]. Anxiety, reported in up to 35% of

kidney transplant recipients [7], is similarly linked to poorer outcomes, including lower quality of life (QOL), higher rates of hospitalization, and increased complications such as rejection and graft dysfunction [8]. What is more, depression has been linked to significantly lower adherence to post-transplant medical regimens, with affected patients being up to three times more likely to be non-adherent [9].

Understanding the factors contributing to psychological distress, particularly anxiety, among kidney transplant recipients is therefore essential. Research indicates that several things, such as stress, depression, long-term medication treatment, dread of the unknown, and uncertainty about the future, may cause such anxiety in transplant recipients [10]. A recent study conducted in Kazakhstan further highlights the importance of contextual and demographic factors in shaping psychological outcomes. It identified key determinants of psychological well-being among kidney transplant recipients, including educational level, access to healthcare services, and anxiety related to post-transplant treatment [11]. Notably, patients residing in rural areas faced greater barriers to care and reported higher levels of psychological distress, with anxiety emerging as a strong negative predictor of overall well-being.

In this regard, it is essential to assess anxiety in kidney transplant recipients using validated psychological tools to address psychological challenges. These tools usually provide a standardized and reliable method for identifying patients at risk of developing anxiety-related complications. For instance, the Hospital Anxiety and Depression Scale is an effective screening tool for anxiety and depression among kidney transplant recipients, with high sensitivity and specificity [8]. Similarly, the Spielberger State-Trait Anxiety Inventory (STAI) has been widely used to assess both state and trait anxiety in transplant populations [12]. Implementing such assessments can guide the development of targeted psychological interventions and inform healthcare policies aimed at improving both mental health and clinical outcomes.

Despite growing awareness, there is limited understanding of the specific mechanisms through which anxiety influences treatment adherence and psychological well-being among kidney transplant recipients in Kazakhstan. Thus, this study aims to (1) develop and validate a Health and Treatment-Related Anxiety Scale (HTRAS) in Kazakh and Russian languages, (2) identify predictors of such anxiety, and (3) examine its impact on adherence to treatment and well-being among kidney transplant recipients in Kazakhstan.

Methods

Study Design and Participants

A cross-sectional study was conducted among adult kidney transplant (KTx) recipients in Kazakhstan between February and March 2025. Participants were recruited through outpatient nephrology and transplant clinics affiliated with major urban hospitals, as well as via patient WhatsApp chat groups moderated by transplant coordinators or peer volunteers. Eligible individuals were aged ≥ 18 years, had received a kidney transplant at least three months prior, and were fluent in either Kazakh or Russian.

Participants were recruited through outpatient nephrology and transplant clinics affiliated with major urban

hospitals, as well as through patient WhatsApp support group chats moderated by transplant coordinators or peer volunteers. The online survey link (Google Forms) was distributed via these support chats, while additional participants were contacted and invited by phone. All participants received comprehensive information about the study's objectives, procedures, and their rights as participants. Informed consent was obtained electronically or verbally for phone interviews. Anonymity and confidentiality were rigorously upheld: no personal identifiers were collected, and all responses were securely stored and accessed only by the research team. Participation was entirely voluntary and involved no physical or psychological risk. Participants could withdraw at any stage without consequence.

A total of 223 recipients participated, with 96 completing the Kazakh-language version and 127 completing the Russian-language version of the survey. The final sample was linguistically and socio-demographically diverse, including rural and urban residents and individuals with varying education and occupational statuses.

Instrument Development and Translation

Patients' concerns regarding post-transplant (post-KTx) health and treatment were assessed using a newly developed 7-item scale (HTRAS), with each item rated on a 5-point Likert scale (1 = never to 5 = always), adapted from the framework of Rhu et al. (2019) [13]. The items addressed specific anxiety-provoking domains, including: (1) risk of infection due to immunosuppressive therapy, (2) concerns about maintaining kidney function, (3) anxiety over unfavorable laboratory results, (4) long-term health stability, (5) financial burden of treatment, (6) emotional distress such as depression or low mood, and (7) side effects of immunosuppressive medications. Higher cumulative scores indicated greater health and treatment-related anxiety [9].

The item pool and wording were refined through expert consultation with professionals fluent in English, Kazakh, and Russian. The expert panel included clinical nephrologists, health psychologists, and researchers with experience in psychometric validation. Their input ensured that the scale was both culturally appropriate and clinically relevant for the multiethnic transplant recipient population in Kazakhstan.

Measures

In addition to the HTRAS, the questionnaire included several validated and self-developed measures:

- Subjective well-being was assessed using the WHO-5 Well-Being Index, a widely used and validated tool for measuring psychological well-being [14]. The scale consists of five positively worded items, each rated on a 6-point scale from 0 ("At no time") to 5 ("All of the time"), with total raw scores ranging from 0 to 25. To standardize results, the raw score was multiplied by four to yield a percentage score ranging from 0 to 100, where higher scores indicate greater well-being.

- Self-reported adherence to the post-transplant treatment regimen was assessed with a single item: "How do you assess your ability to follow your post-transplant treatment regimen (including taking immunosuppressive medication)?" Participants responded on a 5-point scale ranging from "Very easy to follow" to "I do not follow."

- Perceived emotional care after kidney transplantation was evaluated using a single item asking whether participants

received emotional support from family, friends, or healthcare providers. Response options were categorized as “All of the time,” “Sometimes,” or “Never.”

- Perceived availability of follow-up care was assessed using a 5-point Likert scale ranging from 1 (“Very unavailable”) to 5 (“Very available”).

- Sociodemographic and clinical data were also collected, including age, gender, marital status, number of children, place of residence (urban vs. rural), education level, occupation, and receipt of disability benefits. Clinical variables included the presence of comorbid conditions.

Psychometric Validation

Internal consistency was assessed using Cronbach’s alpha and item-rest correlations (IRC). Criterion validity was tested by examining Spearman correlations between HTRAS scores and well-being, adherence, and perceived monitoring availability.

Exploratory Factor Analysis (EFA) was conducted separately for each language version and the full sample to assess the dimensionality of the HTRAS. Suitability for factor analysis was evaluated using the Kaiser-Meyer-Olkin (KMO) measure and Bartlett’s test of sphericity. Confirmatory Factor Analysis (CFA) was then employed to test the model fit of the one-factor solution. Model fit was evaluated using the Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA).

Statistical Analysis

Descriptive statistics were used to characterize the sample. Group comparisons were performed using Chi-square and independent-sample t-tests. To identify predictors of anxiety and adherence, multiple linear regression models were fitted, controlling for sociodemographic, clinical, and psychosocial variables. Two mediation analyses were conducted to examine whether HTRAS scores mediated the relationship between perceived monitoring availability and: (1) treatment adherence, and (2) psychological well-being. All statistical analyses were performed using Jamovi software (version 2.6.17), and results were considered statistically significant at $p < 0.05$.

Results

A total of 223 kidney transplant recipients participated in the study, with 96 individuals in the Kazakh-language group and 127 in the Russian-language group. The mean age was 37.7 ± 10.2 years in the Kazakh-language group and 39.5 ± 10.5 years in the Russian-language group. The median duration since kidney transplantation was 47.5 months (IQR: 72.5) in the Kazakh-language group and 36 months (IQR: 79.0) in the Russian-language group, with no statistically significant difference between the groups.

The gender distribution was similar between groups, with 44.8% males in the Kazakh-language group and 43.3% in the Russian-language group ($p=0.825$, Table 1). Participants aged 18–39 years constituted 57.3% of the Kazakh group and 49.6% of the Russian group ($p=0.255$).

Educational attainment differed marginally between groups ($p=0.052$), with a higher proportion of college-educated individuals in the Kazakh group (34.4%) compared to the Russian group (19.7%). Notably, a significant difference was

Table 1 Study participants (N=223)

Variable	Kazakh-language group (n=96)		Russian-language group (n=127)		χ^2 , p
	n	%	n	%	
Gender					
Male	43	44.8	55	43.3	0.05, $p=0.825$
Female	53	55.2	72	56.7	
Age group					
18-39 years	55	57.3	63	49.6	1.30, $p=0.255$
40-64 years	41	42.7	64	50.4	
Education					
Middle-school	6	6.3	5	3.9	9.37, $p=0.052$
High-school	11	11.5	11	8.7	
College	33	34.4	25	19.7	
Undergraduate	45	46.9	85	66.9	
Post-graduate	1	1.0	1	0.8	
Residence					
Rural	22	22.9	11	8.7	8.81, $p=0.003$
Urban	74	77.1	116	91.3	
Occupation					
Student	6	6.3	13	10.2	6.13, $p=0.294$
Employed	39	40.6	43	33.9	
Self-employed	11	11.5	15	11.8	
Unemployed	11	11.5	7	5.5	
On disability benefits	27	28.1	42	33.1	
Pensioner	2	2.1	7	5.5	
Marital status					
Single	24	25.0	42	33.1	3.12, $p=0.374$
Married	63	65.6	72	56.7	
Divorced	8	8.3	9	7.1	
Widow	1	1.0	4	3.1	
Children					
No	32	33.3	47	37.0	0.323, $p=0.570$
Yes	64	66.7	80	63.0	
Comorbidities					
No	34	35.4	49	38.6	0.235, $p=0.628$
Yes	62	64.6	78	61.4	

found in place of residence, with 22.9% of Kazakh-speaking participants residing in rural areas compared to only 8.7% in the Russian-speaking group ($p = 0.003$).

Occupational status, marital status, parenthood, and presence of comorbidities did not differ significantly between groups. However, a relatively high proportion of participants in both groups reported being on disability benefits (28.1% in the Kazakh group vs. 33.1% in the Russian group).

Validity of the Health and Treatment-Related Anxiety Scale

Descriptive statistics and IRC for the newly developed Health and Treatment-Related Anxiety Scale (HTRAS) are presented in Table 2. Across both language versions, the most frequently endorsed item was concern about the financial costs associated with prescribed post-transplant treatment, with a mean score of 4.18 (SD=1.21) in the Kazakh-language group and 3.65 (SD=1.28) in the Russian-language group. The least endorsed item was the experience of depression or low mood after transplantation, with mean scores of 3.22 (SD=1.52) and 2.77 (SD=1.28) in the Kazakh- and Russian-language groups, respectively. Most items showed strong item-rest correlations, indicating good internal consistency. In the Kazakh-language

Table 2

Post-KTx health and treatment-related anxiety scale items descriptive statistics and item-rest correlations

Item	Kazakh-language			Russian-language		
	M	SD	IRC	M	SD	IRC
Concern about the risk of infection due to taking immunosuppressants after transplantation	3.97	1.33	0.712	3.50	1.20	0.770
Concern about how well the function of the transplanted kidney will be maintained	4.11	1.19	0.633	3.67	1.24	0.790
Concern about poor laboratory test results during clinic visits	3.81	1.24	0.708	3.83	1.13	0.774
Concern about how long health will remain stable after transplantation	4.04	1.26	0.705	3.73	1.24	0.833
Concern about financial costs associated with prescribed post-transplant treatment	4.18	1.21	0.394	3.65	1.28	0.601
Experience of depression or low mood after transplantation	3.22	1.52	0.538	2.77	1.28	0.671
Concern about potential problems with the transplanted kidney and overall health due to taking immunosuppressive medications	3.57	1.43	0.643	3.43	1.31	0.808

version, IRC values ranged from 0.394 to 0.712, while in the Russian-language version they ranged from 0.601 to 0.833. These results support the individual item contributions to the overall construct of post-transplant anxiety.

Internal consistency reliability was also strong. Cronbach's alpha values were 0.853 for the Kazakh-language version, 0.918 for the Russian-language version, and 0.893 in the total sample, confirming the scale's high internal reliability (Table 3).

Table 3

Post-KTx health and treatment-related anxiety scale validity

Language	Cronbach's α	Bartlett's test of sphericity	KMO MSA	CFI	TLI	RMSEA
Kazakh	0.853	$p < 0.001$	0.859	0.968	0.953	0.078
Russian	0.918	$p < 0.001$	0.903	0.954	0.931	0.126
Total	0.893	$p < 0.001$	0.901	0.967	0.951	0.093

To examine the scale's construct validity, EFA was first performed. The analysis supported a one-factor solution for both language versions. Sampling adequacy was confirmed with a KMO measure of 0.859 for the Kazakh-language group, 0.903 for the Russian-language group, and 0.901 for the total sample. Bartlett's test of sphericity was significant ($p < 0.001$ for all), indicating that the data were appropriate for factor analysis.

Confirmatory factor analysis (CFA) was subsequently conducted to validate the unidimensional structure identified by EFA. Model fit indices supported good fit in both language

Table 4

Correlation analysis

Variable	M $\pm$ SD	(1)	(2)	(3)	(4)	(5)
Months after KTx (1)	57.0 $\pm$ 47.0	-				
WHO-5 well-being index (2)	66.1 $\pm$ 24.6	0.012 ($p = 0.862$)	-			
Health and treatment-related anxiety (3)	3.65 $\pm$ 1.00	-0.136 ($p = 0.043$)	-0.253 ($p < 0.001$)	-		
Availability of post-KTx monitoring (4)	3.22 $\pm$ 0.97	0.025 ($p = 0.711$)	0.171 ($p = 0.011$)	-0.192 ($p = 0.004$)	-	
Ability to follow treatment regime (5)	4.16 $\pm$ 0.90	-0.039 ($p = 0.561$)	0.413 ($p < 0.001$)	-0.249 ($p < 0.001$)	0.173 (0.009)	-

versions and in the overall sample. For the Kazakh-language scale, the model yielded a CFI of 0.968, TLI of 0.953, and RMSEA of 0.078. The Russian-language version showed similarly adequate fit, with CFI = 0.954, TLI = 0.931, and RMSEA = 0.126. In the combined sample, CFI and TLI remained high (0.967 and 0.951, respectively), with an RMSEA of 0.093. These results are detailed in Table 3.

To further evaluate the criterion-related validity of the Health and Treatment-Related Anxiety Scale, Spearman correlation analysis was conducted among key psychological and treatment-related variables (Table 4).

Health and treatment-related anxiety was negatively correlated with the WHO-5 well-being index ($\rho = -0.253$, $p < 0.001$), indicating that higher anxiety levels were associated with lower subjective well-being. Additionally, anxiety showed a modest but significant negative correlation with perceived availability of post-transplant monitoring services ($\rho = -0.192$, $p = 0.004$), and with the self-reported ability to follow the treatment regimen ($\rho = -0.249$, $p < 0.001$). These findings suggest that greater anxiety may hinder both psychological well-being and treatment adherence behaviors, thereby supporting the scale's criterion-related validity.

In contrast, the WHO-5 well-being index positively correlated with both perceived monitoring availability ($\rho = 0.171$, $p = 0.011$) and ability to follow treatment ($r = 0.413$, $p < 0.001$), further reinforcing the interconnection between psychological health and treatment-related outcomes in kidney transplant recipients.

Predictors of health and treatment-related anxiety among kidney transplant recipients

Perceived emotional care following kidney transplantation, defined as emotional support received from relatives, friends, or healthcare workers, was reported as consistently available ("all of the time") by 72.2% of participants, occasionally ("sometimes") by 24.7%, and absent ("never") by 3.1%. Although a one-way ANOVA indicated a statistically significant difference in health and treatment-related anxiety levels across these groups ($p = 0.03$), subsequent post-hoc comparisons did not reveal significant pairwise differences. Participants who reported never receiving emotional support had the highest mean anxiety score (4.35 ± 0.67), followed by those who sometimes received support (3.78

Table 5

Predictors of health and treatment-related anxiety among kidney transplant recipients in Kazakhstan (F=2.22, p=0.004, R²=0.164)

Variable	β	β 95%CI	p
Gender Female – Male	0.035	-0.238 – 0.308	0.801
Age group 40–64 – 18–39 years	0.178	-0.149 – 0.506	0.284
Months after KTx	-0.100	-0.235 – 0.035	0.146
Education	0.023	-0.123 – 0.169	0.756
Residence Urban – Rural	-0.276	-0.670 – 0.116	0.166
Occupation Student – on disability benefits	-0.538	-1.084 – 0.008	0.053
Employed – on disability benefits	-0.606	-0.939 – -0.273	<0.001
Self-employed – on disability benefits	-0.411	-0.862 – 0.039	0.073
Unemployed – on disability benefits	-0.100	-0.619 – 0.418	0.703
Pensioner – on disability benefits	-0.138	-0.839 – 0.563	0.699
Marital status Married – Single	0.084	-0.463 – 0.630	0.763
Divorced – Single	-0.161	-0.769 – 0.447	0.603
Widow – Single	-0.543	-1.590 – 0.503	0.307
Children Yes – No	-0.187	-0.720 – 0.347	0.491
Comorbidities Yes – No	0.043	-0.236 – 0.321	0.763
Perceived emotional care after KTx All of the time – Never	-0.520	-1.288 – 0.249	0.184
Sometime – Never	-0.450	-1.239 – 0.339	0.262
Availability of post-KTx monitoring	-0.147	-0.288 – -0.006	0.042

± 1.03), and those who reported consistent emotional support (3.58 ± 1.00).

To identify predictors of health and treatment-related anxiety among kidney transplant recipients in Kazakhstan, a multiple linear regression analysis was conducted (F=2.22, p=0.004, R²=0.164). The model included sociodemographic, clinical, and psychosocial variables (Table 5). Among the predictors, being employed while on disability benefits was significantly associated with lower anxiety levels ($\beta = -0.606$, p < 0.001).

Availability of post-transplant monitoring was another significant predictor ($\beta = -0.147$, p=0.042), suggesting that patients who perceived greater monitoring support experienced lower anxiety. In contrast, gender, age group, months after transplantation, education level, marital status, presence of children or comorbidities, and emotional care were not statistically significant predictors in the adjusted model. Emotional support showed a protective trend but did not reach significance. These findings suggest that both occupational context and perceived healthcare support may play important roles in shaping transplant-related anxiety.

Predictors of Ability to Follow Treatment Regimen

To examine the factors associated with adherence to the post-transplant treatment regimen (Table 6), a multiple linear

Table 6

Predictors of ability to follow treatment regime among kidney transplant recipients in Kazakhstan (F=6.27, p<0.001, R²=0.370)

Variable	β	β 95%CI	p
Gender Female – Male	0.015	-0.222 – 0.253	0.898
Age group 40–64 – 18–39 years	0.066	-0.220 – 0.352	0.649
Months after KTx	-0.088	-0.206 – 0.030	0.142
Education	0.105	-0.022 – 0.232	0.106
Residence Urban – Rural	0.307	-0.037 – 0.650	0.080
Occupation Student – on disability benefits	-0.076	-0.555 – 0.403	0.756
Employed – on disability benefits	-0.113	-0.412 – 0.186	0.458
Self-employed – on disability benefits	-0.118	-0.513 – 0.277	0.557
Unemployed – on disability benefits	-0.129	-0.581 – 0.323	0.574
Pensioner – on disability benefits	0.048	-0.658 – 0.563	0.878
Marital status Married – Single	-0.104	-0.579 – 0.372	0.668
Divorced – Single	-0.877	1.407 – -0.347	0.001
Widow – Single	-0.362	-1.275 – 0.551	0.435
Children Yes – No	0.026	-0.439 – 0.490	0.912
Comorbidities Yes – No	-0.158	-0.400 – 0.085	0.201
Perceived emotional care after KTx All of the time – Never	1.509	0.837 – 2.180	<0.001
Sometime – Never	0.591	-0.098 – 1.279	0.093
Availability of post-KTx monitoring	-0.032	-0.156 – 0.092	0.612
Health and treatment-related anxiety	-0.199	-0.319 – -0.078	0.001

regression model was fitted, including sociodemographic, psychosocial, and clinical predictors, as well as health and treatment-related anxiety (F=6.27, p<0.001, R²=0.370).

Among all variables, two emerged as statistically significant predictors. Perceived emotional care following transplantation was strongly associated with better treatment adherence. Specifically, participants who reported receiving emotional support “all of the time” demonstrated significantly higher adherence compared to those who reported never receiving such support ($\beta = 1.509$, p < 0.001). In contrast, health and treatment-related anxiety was negatively associated with treatment adherence ($\beta = -0.199$, p=0.001), indicating that higher anxiety levels were associated with lower self-reported ability to follow medical recommendations.

Marital status also had an effect, with divorced participants reporting significantly lower adherence compared to those who were single ($\beta = -0.877$, p=0.001). Other variables, including gender, age, months post-transplant, education level, residence, occupation, comorbidities, and perceived availability of monitoring services, were not significantly associated with adherence in the adjusted model.

To further investigate the mechanisms underlying the impact of perceived post-transplant care on treatment outcomes,

two mediation models were tested with health and treatment-related anxiety as the proposed mediator.

In the first model, we examined whether health and treatment-related anxiety mediated the relationship between the perceived availability of post-transplant monitoring and the ability to follow the treatment regimen (Table 7). The indirect effect was statistically significant ($\beta=0.056, p=0.017$), indicating that perceived monitoring availability reduced anxiety, which in turn was associated with better adherence. Component paths confirmed that availability of monitoring was associated with reduced anxiety, and that lower anxiety predicted higher adherence ($p<0.001$). While the direct effect of monitoring availability on adherence did not reach significance ($p=0.06$), the total effect was significant ($p=0.009$), supporting a partial mediation model.

The second model tested whether health and treatment-related anxiety mediated the effect of perceived monitoring

availability on psychological well-being, as measured by the WHO-5 index (Table 8). Again, the indirect effect was significant ($\beta=1.038, p=0.032$), indicating that perceived availability of post-KTx monitoring improved well-being indirectly through its anxiety-reducing effect. Specifically, better perceived monitoring was associated with reduced anxiety ($p<0.001$), and lower anxiety was significantly related to higher well-being ($p=0.005$). The direct effect of perceived monitoring on well-being remained significant ($p=0.005$), and the total effect was also significant ($\beta=4.596, p=0.006$), again supporting a partial mediation model.

Together, these findings highlight that health and treatment-related anxiety is a key psychological mechanism linking perceived healthcare support with both behavioral (treatment adherence) and emotional (well-being) outcomes in kidney transplant recipients.

Discussion

This study aimed to develop and validate a Health and Treatment-Related Anxiety Scale (HTRAS) in Kazakh and Russian languages, identify predictors of such anxiety, and examine its impact on adherence to treatment and well-being among kidney transplant recipients in Kazakhstan. The HTRAS demonstrated strong psychometric properties and proved to be a reliable, culturally appropriate tool for measuring transplant-specific anxiety. Overall, our results indicated that elevated anxiety was significantly associated with reduced treatment adherence and lower psychological well-being. Conversely, perceived emotional support, post-transplant medical monitoring, and being employed under disability benefits were associated with lower anxiety. These findings emphasize the importance of addressing psychological and structural factors in post-transplant care.

Validity of the HTRAS

The HTRAS demonstrated robust psychometric validity, with a unidimensional structure and high internal consistency (Cronbach’s $\alpha = 0.893$), confirmed through CFA. Unlike generic anxiety tools, the HTRAS in this study directly targets post-transplant stressors specific to adult kidney transplant recipients in Kazakhstan, highlighting dominant anxieties such as concern about financial costs associated with prescribed post-transplant treatment ($M=4.18$) in Kazakh and ($M=3.65$) in Russian, concern about how well the function of the transplanted kidney will be maintained ($M=4.11$). Financial strain emerged as the most severe anxiety driver, mirroring findings in heart transplant populations where long-term financial burdens were the leading stressor [15]. This aligns with finding that cost-related anxiety predicts non-adherence, as patients balancing medication expenses against perceived benefits often experience heightened emotional distress [16]. By focusing on context-specific stressors, the HTRAS addresses critical gaps in anxiety assessment.

The HTRAS’s cultural adaptation process including dual-language validation and patient-centric item refinement ensures relevance to Kazakhstan’s multiethnic population, adhering to transcultural guidelines. Its unidimensional design prioritizes systemic challenges over broad psychosocial domains, resonating with calls for nuanced tools tailored to underserved populations [17]. This contrasts with multidimensional scales like the Transplant Effects Questionnaire (TxEQ) [18] or donor-

Table 7 Indirect Effect of Health and Treatment-Related Anxiety on the Relationship Between Availability of Post-Transplant Monitoring and Ability to Follow Treatment Regimen Among Kidney Transplant Recipients

Type	Effect	beta	SE	p
Indirect	[Availability of post-KTx monitoring] → [Health and treatment-related anxiety] → [Ability to follow treatment regime]	0.056	0.019	0.017
Component	[Availability of post-KTx monitoring] → [Health and treatment-related anxiety]	-0.229	0.068	<0.001
	[Health and treatment-related anxiety] → [Ability to follow treatment regime]	-0.199	0.059	<0.001
Direct	[Availability of post-KTx monitoring] → [Ability to follow treatment regime]	0.116	0.061	0.060
Total	[Availability of post-KTx monitoring] → [Ability to follow treatment regime]	0.161	0.061	0.009

Table 8 Indirect Effect of Health and Treatment-Related Anxiety on the Relationship Between Availability of Post-Transplant Monitoring and Psychological Well-Being Among Kidney Transplant Recipients

Type	Effect	beta	SE	p
Indirect	[Availability of post-KTx monitoring] → [Health and treatment-related anxiety] → [Well-being]	1.038	0.483	0.032
Component	[Availability of post-KTx monitoring] → [Health and treatment-related anxiety]	-0.229	0.068	<0.001
	[Health and treatment-related anxiety] → [Well-being]	-4.530	1.628	0.005
Direct	[Availability of post-KTx monitoring] → [Well-being]	3.558	1.688	0.005
Total	[Availability of post-KTx monitoring] → [Well-being]	4.596	1.679	0.006

specific tools such as the Fear of Kidney Failure questionnaire [19], which emphasize broader psychosocial or pediatric/donor-centric anxieties.

Clinically, the HTRAS enables early identification of high-risk patients, such as those reporting severe financial strain ($M=4.18$), allowing for targeted interventions like subsidized immunosuppressants or adherence counseling. This is critical in mitigating non-adherence risks, which are strongly linked to graft rejection and mortality [1, 16]. Furthermore, mediation analyses revealed that anxiety partially explains the relationship between perceived care monitoring and adherence (indirect effect: $\beta=1.038$, $p = 0.032$), underscoring the dual necessity of emotional support and medical oversight in post-transplant care. Such insights align with Bosworth et al.'s (2010) model, where clinician-patient relationship fosters trust, reducing anxiety and enhancing compliance [20].

Predictors of Health- and Treatment-Related Anxiety

Interestingly, consistent with the second aim, regression analyses identified two protective factors against health- and treatment-related anxiety, addressing the study's second aim: employment under disability benefits ($p<0.001$) and perceived availability of post-transplant monitoring ($p<0.05$). These predictors highlight the interplay of socioeconomic stability and healthcare accessibility in mitigating anxiety.

Disability employment in Kazakhstan provides a guaranteed income, reducing stress over medication costs and follow-up care expenses. This directly alleviates a primary anxiety driver. Cukor et al. (2007) reported that income instability and occupational stress exacerbate psychological distress in patients with chronic kidney disease (CKD), aligning with broader evidence that socioeconomic pressures often amplify mental health burdens in chronically ill populations [21]. Also, in some studies, being employed after transplantation showed a better quality of life than unemployed patients [22, 23]. This distinction underscores the importance of contextualizing employment's impact: while being unemployed may heighten distress, regulated employment under disability benefits can alleviate anxiety by addressing systemic vulnerabilities (e.g., financial strain, fragmented care, access to medications).

Another significant predictor was the availability of post-transplant monitoring, which suggests that patients who perceived monitoring experienced lower anxiety. The other study supported that monitoring of kidney function at least every 2–3 months after the first-year post-transplantation is important [24]. However, our findings extend beyond frequency to emphasize patient perceptions of care accessibility. In Kazakhstan's context, where rural-urban disparities often limit healthcare access [11], perceived monitoring availability likely reduces anxiety by fostering trust in clinical oversight and reducing fears about graft rejection. Moreover, this discrepancy may reflect the specific characteristics of kidney transplant recipients, whose anxiety levels are more strongly influenced by clinical and treatment-related factors than by general sociodemographic variables [25].

Predictors of ability to follow treatment regimen

Results from this study identified perceived emotional care after kidney transplantation and marital status as predictors for treatment adherence among kidney transplant recipients in Kazakhstan. Perceived emotional care or consistent psychosocial support from healthcare workers, family, or peers was strongly positively related to adherence ($p<0.001$). These findings are in

line with existing literature where emotional interventions were said to lower distress and facilitate self-management in chronic disease groups [26, 27]. Furthermore, the mediation analyses specify the protective function of emotional care, in that anxiety mediates at least in part the link between perceived post-transplant monitoring and adherence (indirect effect: $p<0.05$). This dual mechanism implies that care models should include both medical monitoring and emotional support because the last one lowers anxiety, which mediates the effect of monitoring on adherence.

In addition, marital status constituted another significant predictor: divorced participants were less adherent than were those who declared themselves as single ($p<0.01$). This confirms findings of Reber et al. (2016), whereby social isolation and lack of spousal support somehow fostered non-adherence in transplant populations [28]. The absence of a stable support network may exacerbate practical barriers (e.g., medication management) and amplify emotional burdens, increasing risks of missed doses or clinic visits. Non-adherence, whether due to inadequate emotional care or social instability, carries severe consequences, including graft rejection, graft loss, and mortality. These risks underscore the importance of addressing psychosocial determinants of adherence in post-transplant care.

The mediation models helped explain the interactions between perceived monitoring availability, anxiety, and outcomes. Perceived availability of monitoring reduced anxiety ($p<0.001$), while lower anxiety predicted better adherence ($p<0.01$). The post-transplant monitoring's indirect effect on well-being ($p<0.05$) further confirms the mediation role of anxiety between health-care support and psychological outcomes. The findings from previous study indicates that monitoring of emotional state of patients after transplantation is necessary to address anxiety [29]. Such results recommend interventions that target anxiety such as structured counseling, peer-support programs and others to maximize the outcome of clinical monitoring.

Implications

Our findings suggest several actionable recommendations. First, the HTRAS could be used for routine screening in post-transplant care programs to identify patients experiencing high anxiety. Early detection may allow for timely psychological intervention. Second, integrating emotional support services such as counselling into post-transplant care could enhance adherence and emotional resilience. Third, policy-level interventions to support low-income and rural patients, including financial subsidies, transfer to healthcare settings for rural patients and other initiatives may help reduce structural barriers to recovery.

Strengths and limitations

This study offers several strengths, including the development of a validated instrument for measuring transplant-specific anxiety and the inclusion of a linguistically and geographically diverse sample. Mediation analysis added depth to the interpretation of psychological mechanisms linking system-level variables to behavioral outcomes. However, the cross-sectional design limits causal inference. Self-reported data may be subject to bias, and the absence of clinical outcomes (e.g., graft function, hospitalization) restricts broader clinical interpretation. Additionally, the use of disability benefits as a proxy for social support should be interpreted cautiously. Because receiving economic support does not necessarily mean social

support. Someone might receive benefits but still be isolated, unsupported. Future longitudinal studies should incorporate objective clinical indicators and explore the effectiveness of targeted interventions for anxiety reduction.

Future studies should examine longitudinal changes in anxiety and adherence across the transplant timeline, ideally integrating clinical metrics like graft survival or clinical complications. Validating the HTRAS in other solid organ transplant populations, as well as in other regions, could expand its use. Finally, a deeper examination of structural inequities, including regional disparities and systemic barriers, will be essential for improving equity in transplant care.

Conclusion

This study is the first in Kazakhstan to develop and validate a culturally and linguistically appropriate instrument – the Health and Treatment-Related Anxiety Scale (HTRAS) – to assess anxiety specific to kidney transplant recipients. The HTRAS demonstrated robust psychometric properties and effectively captured core concerns related to post-transplant health, including medication side effects, financial strain, and uncertainty about graft function. Importantly, higher anxiety levels were associated with reduced treatment adherence and lower psychological well-being, underscoring the psychological burden faced by this patient population.

Key protective factors against anxiety included employment under disability benefits and perceived availability of post-transplant monitoring, both of which reflect the importance of structural and contextual supports. Emotional care from family, healthcare providers, and peers emerged as a significant predictor of adherence, highlighting the need for integrated psychosocial support in post-transplant care. Mediation analyses confirmed that anxiety plays a critical role in linking healthcare system factors, such as perceived care availability, to patient outcomes, including both adherence and well-being. These findings emphasize that managing anxiety is not only a matter of mental health but also a determinant of medical success in transplantation.

Routine use of the HTRAS may allow clinicians to identify at-risk individuals early and implement timely interventions. Future research should focus on longitudinal validation of

the HTRAS and evaluate the impact of targeted psychosocial interventions. Addressing the psychological dimensions of transplantation care will be essential to improving long-term outcomes, particularly in regions with socioeconomic and healthcare access disparities such as Kazakhstan.

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Data availability statement: The raw data supporting the conclusions of this article will be made available by the authors on request.

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