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A predictive model for readmission within 1-year post-discharge in patients with schizophrenia

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Abstract

Background Schizophrenia is a pervasive and severe mental disorder characterized by significant disability and high rates of recurrence. The persistently high rates of readmission after discharge present a serious challenge and source of stress in treating this population. Early identification of this risk is critical for implementing targeted interventions. The present study aimed to develop an easy-to-use predictive instrument for identifying the risk of readmission within 1-year post-discharge among schizophrenia patients in China.

Methods A prediction model, based on static factors, was developed using data from 247 schizophrenia inpatients admitted to the Mental Health Center in Wuxi, China, from July 1 to December 31, 2020. For internal validation, an additional 106 patients were included. Multivariate Cox regression was applied to identify independent predictors and to create a nomogram for predicting the likelihood of readmission within 1-year post-discharge. The model's performance in terms of discrimination and calibration was evaluated using bootstrapping with 1000 resamples.

Results Multivariate cox regression demonstrated that involuntary admission (adjusted hazard ratio [aHR] 4.35, 95% confidence interval [CI] 2.13–8.86), repeat admissions (aHR 3.49, 95% CI 2.08–5.85), the prescription of antipsychotic polypharmacy (aHR 2.16, 95% CI 1.34–3.48), and a course of disease ≥ 20 years (aHR 1.80, 95% CI 1.04–3.12) were independent predictors for the readmission of schizophrenia patients within 1-year post-discharge. The area under the curve (AUC) and concordance index (C-index) of the nomogram constructed from these four factors were 0.820 and 0.780 in the training set, and 0.846 and 0.796 for the validation set, respectively. Furthermore, the calibration curves of the nomogram for both the training and validation sets closely approximated the ideal diagonal line. Additionally, decision curve analyses (DCAs) demonstrated a significantly better net benefit with this model.

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Conclusions A nomogram, developed using pre-discharge static factors, was designed to predict the likelihood of readmission within 1-year post-discharge for patients with schizophrenia. This tool may offer clinicians an accurate and effective way for the timely prediction and early management of psychiatric readmissions.

Keywords Hospital discharge, Psychiatric readmission, Schizophrenia, Predictive model, Nomogram

Introduction

Following the psychiatric medicine reform of deinstitutionalization, a new syndrome, termed the "Revolving Door (RD) phenomenon", was identified to denote repeated hospitalizations of the same patients who struggle to remain in the community for extended periods [1–3]. However, it can be argued that deinstitutionalization has not been comprehensively implemented in China, particularly for patients with severe mental illnesses who require the most care [4, 5]. Individuals with severe mental conditions, such as schizophrenia, experience a disease course marked by periods of symptom exacerbation and poor treatment adherence, leading to frequent relapses and a heightened risk of readmission [6–8]. Psychiatric readmissions and prolonged hospital stays for patients with schizophrenia are highly prevalent, costly, and associated with adverse outcomes [4, 9, 10]. This issue has long posed a significant challenge to the mental health reform efforts in China [4, 8, 11].

Putting aside the prolonged debates surrounding psychiatric deinstitutionalization, there is a general consensus that readmission adversely affects patients, their families, and the healthcare system [12, 13], and does not contribute to reducing the disease burden [8]. The readmission rate is a widely recognized quality indicator of care and a key focus for health sector policymakers [14–16], reflecting both the quality of care provided and the effectiveness of follow-up services. The rates of rehospitalization differ significantly across countries, ranging from 22 to 80%, a variability that is attributed to various factors and must be analyzed within the specific context of each country's mental health care system [17–20]. Previous studies on psychiatric readmission in China have predominantly concentrated on first-tier cities [8, 21, 22]. A notable study from Beijing reported 30-day and 1-year psychiatric readmission rates of 16.7% and 33.8%, respectively [8]. Although representing a minor fraction of the total inpatient population (less than 10%), patients experiencing the revolving door phenomenon account for a significant portion of medical resource consumption (20-30%) due to frequent readmissions [2, 23]. Given China's vast geography and large population, coupled with a developing country status, the lifetime prevalence of mental disorders is estimated at 16.6% [11]. This suggests that the proportion of psychiatric readmissions could be even higher nationwide. Furthermore, data released by the National Bureau of Statistics (www.stats.gov.cn) reveals that the total number of psychiatric beds in China has increased significantly in recent two decades. More specifically, this figure in 2016 was doubled that in 2002. This trend not only reflects the Chinese government's increasing focus on mental health but also underscores the significant role of high psychiatric readmission rates.

Hitherto, the risk factors for psychiatric readmission [8, 9, 15, 24, 25], including models to clinically predict readmission [26], have been explored, with evidence suggesting that interventions can effectively reduce readmission rates. However, the majority of these studies have been conducted in Western countries [14]. China is currently grappling with the dual pressures of therapeutic and economic resource constraints in the medical field, where the allocation and structure of mental health services differ markedly. In China, psychiatric hospitals are the backbone of mental health services, providing nearly 80% of such services [27], while community mental health services remain critically underdeveloped [28]. Despite significant progress in enhancing mental health services over the past decade, especially following the "National Mental Health Working Plan (2015–2020)", China continues to face substantial implementation challenges for serious and common mental disorders. These challenges include the need for precise care demand estimates, the development of specific outreach and treatment protocols, and evidence supporting community mental health services [5]. China's commitment to improving mental health services signifies a promising direction, and the coming years present a critical window of opportunity to develop a unified, seamless, and standardized mental health system at both local and national levels [29, 30]. Thus, studying the patterns of psychiatric readmission and its associated factors in China is crucial, in line with the World Health Organization's (WHO) recommendations to enhance the role of nursing [31].

Previous research has identified a broad range of potential factors influencing psychiatric readmission, presenting a high level of inconsistency, primarily involving both pre-discharge and post-discharge elements [9, 15]. This diversity in findings necessitates continuous and updated research, especially since certain factors appear to be context and time-specific [8, 25]. In China, a notable trend is the patient preference to bypass primary and secondary care levels in favor of seeking treatment directly at tertiary psychiatric hospitals, predominantly located in the urban areas of more developed regions [32]. Given the persisting regional disparities in service availability and clinical practices, the generalization and

application of research findings must be approached with caution and adapted to fit local contexts. Furthermore, discharge interventions designed to address key risk factors associated with psychiatric readmissions should be thoughtfully crafted and implemented, avoiding a one-size-fits-all approach. Importantly, there has been limited research into the risk factors for psychiatric readmission in China's eastern cities, where the development of transitional care services for individuals with severe mental illness warrants greater focus.

For the reasons mentioned above, we conducted the current study at a tertiary psychiatric hospital in an economically developed city in Jiangsu, China. The study aimed to examine the readmission rate among patients with schizophrenia and explore the influence of demographic and clinical features on readmission. Based on the preceding discussion, our hypotheses were as follows: (1) the 1-year psychiatric readmission rates for patients with schizophrenia might differ from those reported in previous studies [8, 33]; (2) the potential risk factors for psychiatric readmission might not align with previous major findings [15] and could effectively predict readmission in schizophrenia. Uncovering these unknown aspects within this region is crucial for better tailoring service strategies for this population. Thus, it aids in implementing nurse-led peri-discharge interventions and transitional care more effectively, which not only reduces the unnecessary expenditure of limited medical resources but also enhances care outcomes.

Materials and methods

Study setting

This study was conducted at the Wuxi Mental Health Center (WMHC), a university-affiliated tertiary psychiatric hospital in Wuxi City, Jiangsu Province, in eastern China. According to the National Bureau of Statistics of the People's Republic of China (www.stats.gov.cn), the total population of Wuxi City was approximately 5 million at the end of 2019. As an economically prosperous city situated in the southern part of Jiangsu Province, Wu xi's per capita Gross Domestic Product (GDP) is among the highest in the country. WMHC stands as the sole large-scale professional medical institution in the area that integrates clinical services, teaching, and scientific research. With around 1,300 available psychiatric beds, it offers treatment and rehabilitation services to individuals with mental illnesses from Wuxi and neighboring cities.

This was a 1-year follow-up study involving individuals with schizophrenia who were discharged from July to December 2020 and followed up until December 2021. Participants were observed in a natural, non-intervention state from their discharge date until 1-year post-discharge, meaning our research team did not directly participate in their treatment and care plans after discharge. Prior to discharge, we meticulously explained the follow-up timing and methods to the subjects and their families, securing written consent from them or their guardians and establishing a follow-up file for each participant. One week prior to their discharge date, we collected demographic characteristics, clinical information, and medication details from medical records, and evaluated their insight and attitude towards treatment. Follow-ups were conducted at one, three, six, and twelve months post-discharge through phone calls, We-chat video calls, or on-site visits, during which important information was recorded. Upon learning of a patient's readmission, we documented the precise readmission time and reviewed their electronic medical records to gather pertinent details.

This study received ethical approval from the Ethics Committee of WHMC (NO. WXMHCIRB2022LLky085). All researchers involved in the study signed a written pledge to uphold the privacy and rights of the participants.

Participants

Inclusion criteria were: (1) diagnosis of schizophrenia according to the International Classification of Diseases, 10th Revision (ICD-10) [34]; (2) psychiatric inpatients aged under 65 years; (3) discharge based on psychiatrists' medical advice; and (4) informed consent for participation in the study provided by the patient or their guardian. Exclusion criteria included: (1) severe neurological disorders (e.g., epilepsy, cognitive impairment, or genetic syndromes); (2) severe somatic diseases (e.g., cancer, end-stage renal disease, arrhythmia, hypertensive crisis); (3) the presence of cognitive deficits causing linguistic and comprehension difficulties; and (4) incomplete clinical records (e.g., cases of wanderers and beggars). Considering our main concern with the correlates of timely discharge and rehospitalization under nonintervention conditions, we also excluded inpatients who were quickly discharged or had long-term hospitalizations, including lengths of stay (LOS) shorter than 72 h or longer than 1 year, as these discharges were deemed temporary, urgent, and unconventional.

Initially, 41 patients were excluded due to severe diseases and cognitive disorders or incomplete initial data. Subsequently, an additional 33 discharged patients were excluded for various reasons: 17 were transferred to general hospitals due to somatic comorbidities, such as severe pneumonia and acute abdominal diseases; 5 were lost to follow-up because of relocation after discharge; 5 were involved in legal issues due to arson or homicide; 3 died from suicide or traffic accidents; and 3 were diagnosed with mental illnesses other than schizophrenia. Consequently, 353 patients successfully completed the study, and their data were collected. Based

on readmission occurrences post-index hospitalization, those readmitted to a psychiatric ward of a specialized psychiatric hospital or a general hospital at least once within 1-year post-discharge were categorized as readmitted patients with schizophrenia (RPS). Conversely, those with no readmissions post-index hospitalization were classified as the Zero-Re-admission group of patients with schizophrenia (NRPS).

Data collection

We collected information using a structured checklist developed specifically for this study. To protect privacy, subjects' names and unique medical record numbers were used solely for survey purposes. Baseline data at the time of discharge were primarily obtained through the electronic medical record system, with confirmation from patients or their families as needed. This data was independently recorded by two researchers using EpiData 3.1 (http://www.epidata.dk/). Any discrepancies found were resolved through a double-checking process of the electronic medical record database and/or discussion with a third investigator. Additionally, researchers collected data on both current and past hospitalizations, involving family members and other psychiatrists who have been involved in the patient's care throughout their illness.

Based on previous studies that identified several predischarge factors likely to influence readmission risk [15], along with recent research from China [8], we included variables that demonstrated a high degree of consistency among the analyzed factors. However, we excluded variables that were poorly consistent or irrelevant to China's current context, such as immigration status and discharge plans sent to general physicians. Additionally, we incorporated findings from our own research on long-term hospitalized patients with schizophrenia [4] to further refine our analysis. The analyzed variables were categorized as follows: (1) demographic data, which encompassed sex, age at discharge, education level, marital status, living situation (classified as urban or otherwise), family history of mental disorders, legal guardian or family caregiver, and the payment method for inpatient medical expenses. (2) Clinical data collected included the subtype of schizophrenia, the duration of the mental illness at the time of admission, the main positive symptoms observed during hospitalization, any concomitant physical diseases (e.g., diabetes, hypertension), the legal status of the hospitalization (voluntary or involuntary), the types of antipsychotics prescribed at discharge, mood stabilizers, and the LOS for the index admission. The Insight and Treatment Attitudes Questionnaire (ITAQ) was used to assess patients' understanding of their disease and their attitudes towards treatment. The ITAQ is a semi-structured questionnaire consisting of 11 questions. The total score ranges from 0 to 22, with higher scores indicating better insight into the illness [35]. The ITAQ assessment is conducted through a face-to-face interview by a senior psychiatrist and a psychiatric nurse, both of whom are familiar with the patient, within one week prior to hospital discharge. A baseline score of at least 5 is assigned if the patient acknowledges having a mental illness. Additional points are awarded for patient awareness of being hospitalized, knowledge of the medications they are on, and understanding of their diagnosis.

Under the *National Basic Public Health Service Standard* and the *Standard for Management and Treatment of Severe Mental Disorders*, patients diagnosed with severe mental disorders are entitled to ongoing treatment and rehabilitation services. Post-discharge, these patients should be monitored by trained community workers through either telephone calls or face-to-face interviews. The key areas of these interviews include assessing the stability of mental symptoms, the presence of any dangerous behaviors, medication adherence and side effects, and the recovery of living abilities and social functioning. During the follow-up period, discharged patients undergo standardized and consistent evaluations conducted in their natural environments. Researchers primarily track the patients' treatment adherence, lifestyle, and employment status post-discharge via telephone or on-site visits, meticulously documenting the timing and occurrences of readmissions. Time to Readmission, also known as Time in Community (TIC) [36], is calculated as the interval from the discharge date to either the date of first readmission or the end of the follow-up period (December 31, 2021, if there was no readmission). This measure indicates the duration that patients spend in the community after discharge.

Definitions of covariates and variables

From systematic reviews [15], we identified candidate variables for psychiatric readmission, focusing on those that are accessible and feasible to assess. The variables analyzed in this study included gender, age at the index admission (in years), education level, marital status, employment status before the index admission, medical insurance during the index hospitalization, family history of mental disorder, type of household registration, presence of a family caregiver, age of onset (in years) at the index admission, duration of illness (in months), subtype of schizophrenia, typical symptoms during the index hospitalization, presence of concomitant physical diseases during the index hospitalization, medication prescription protocol for maintenance treatment, insight and treatment attitudes at discharge, LOS for the index admission, TIC, and the number of psychiatric readmissions prior to the index date.

To clarify the meaning of each indicator and to aid in data analysis and interpretation of results, we defined the variables in our study based on previous research and a systematic review [4, 15], as detailed below: *Lower education level* is categorized according to China's Compulsory Education Law, including no schooling, lower secondary education (1–6 years), and secondary education (7–9 years). *Unmarried status* includes individuals without a spouse at the index admission, encompassing single, divorced, and widowed statuses. *Unemployment* refers to those who have been unemployed for at least six months prior to this index admission. *Family household registration type* is distinguished between rural and non-rural areas. *Family caregivers* are defined as individuals willing to provide unpaid care and take responsibility for a patient living at home, encompassing a wide array of relatives including spouses, parents, children, siblings, and other relatives. *Medical insurance* includes any form of medical insurance that reimburses part of the medical expenses, primarily Urban Employee Basic Medical Insurance, Urban Resident Basic Medical Insurance, and the New Rural Cooperative Medical Scheme. *Paranoid subtype* is assigned to patients clinically diagnosed with paranoid schizophrenia, characterized by positive symptoms such as hallucinations and delusions. *Age of onset* categorizes schizophrenia into early onset (before age 18) [37] and late-onset (after age 40) [38]. *Antipsychotic Polypharmacy* (APP) involves the use of two or more antipsychotic drugs in the maintenance treatment of schizophrenia [39]. To examine the relationship between *LOS* and readmission, patients were categorized into four LOS groups, namely ≤13 days (the short group), 14–26 days (the medium group), 27–40 days (the long group), and ≥41 days (the very long group) [40]. *Involuntary admission* is identified when hospitalization is necessary to prevent harm to the patient or others, facilitating care and security for those at risk [40]. *Impaired insight* is indicated by an ITAQ score below 6, suggesting a lack of acknowledgment of the mental illness, whereas a score above 10 signifies a high level of insight [35].

Statistical analysis

All data were analyzed using IBM SPSS Statistics (version 26.0) and R software (version 4.3.2). The level of significance was set at 0.05 (two-sided). To assess the robustness and discrimination of our model, patients were randomly divided into a training group and a validation group at a 7:3 ratio using R software. The baseline characteristics between these two groups were compared using the Chi-square test and Fisher's exact test. Variables associated with readmission were identified through univariate Cox regression analysis.

The log-rank test was utilized to compare the time from discharge to the endpoints of readmissions and follow-up, and a Cox proportional-hazards model was applied to estimate the hazard ratio (HR) and 95% confidence interval (CI) for outcomes associated with RPS and other risk factors [41]. Initially, the proportional hazards (PH) assumption was verified by creating a product term between follow-up time and RPS. Variables that had p-values < 0.1 in the univariate analyses were evaluated for the PH assumption, incorporating the Kaplan-Meier (KM) method and Time-Dependent Cox regression models, as indicated by previous studies [9, 15]. Covariates failing to meet the PH assumption were considered time-dependent and thus integrated into the Cox regression model accordingly. Subsequently, collinearity diagnostics were performed using linear regression, and variables with variance inflation factors (VIFs) greater than 2 were excluded from the model. Ultimately, the remaining eligible variables were included as covariates in the multivariate Cox regression analyses [Backward Stepwise (Likelihood Ratio)] to pinpoint the independent predictors of readmission.

Following the identification of independent predictors, a nomogram was constructed to forecast the likelihood of readmission. The model's performance was assessed in terms of discrimination and calibration. Discrimination evaluates the model's ability to distinguish between patients who were readmitted and those who were not, using the Area Under the Curve (AUC) of the receiver operating characteristic curve and Harrell's concordance index (C-index) to measure the model's sensitivity and specificity. Calibration, the agreement between predicted and observed outcomes, was visually examined through calibration curves based on a bootstrapped resample with 1,000 iterations. Additionally, the clinical utility of the nomogram was assessed using decision curve analysis (DCA), net reclassification improvement (NRI), and integrated discrimination improvement (IDI). The total points for all patients were calculated, and X-tile software was utilized to determine the optimal cutoff value for these points, categorizing patients into high or low-risk groups accordingly. Kaplan-Meier (K-M) analysis, complemented by the log-rank test, was then performed to compare the readmission probabilities between these two subgroups.

Results

Overview of all sample

According to the inclusion and exclusion criteria, a total of 353 individuals with schizophrenia were ultimately included in this study. All patients were randomly divided into a training group (247 cases) and a validation group (106 cases). There were no significant differences between the two groups in baseline data ($p > 0.05$) (Table 1).

Table 1 Comparisons between training set and validation set

Variable	Total ($n=353$)	Training set ($n=247$)	Validation set ($n=106$)	χ^2	p
Gender, n (%)				0.016	0.899
Male	188 (53.26)	131 (53.04)	57 (53.77)		
Female	165 (46.74)	116 (46.96)	49 (46.23)		
Age range (years), n (%)				5.268	0.384
≤ 19	10 (2.83)	8 (3.24)	2 (1.89)		
20–29	77 (21.81)	54 (21.86)	23 (21.70)		
30–39	95 (26.91)	64 (25.91)	31 (29.25)		
40–49	92 (26.06)	62 (25.10)	30 (28.30)		
50–59	60 (17)	48 (19.43)	12 (11.32)		
≥ 60	19 (5.38)	11 (4.45)	8 (7.55)		
Education level, n (%)				0.360	0.549
Low	145 (41.08)	104 (42.11)	41 (38.68)		
High	208 (58.92)	143 (57.89)	65 (61.32)		
Marital status, n (%)				0.222	0.637
Unmarried	230 (65.16)	159 (64.37)	71 (66.98)		
Married	123 (34.84)	88 (35.63)	35 (33.02)		
Employment, n (%)				1.338	0.247
Yes	59 (16.71)	45 (18.22)	14 (13.21)		
No	294 (83.29)	202 (81.78)	92 (86.79)		
Registration, n (%)				0.870	0.351
Rural	60 (17)	45 (18.22)	15 (14.15)		
Non-rural	293 (83)	202 (81.78)	91 (85.85)		
Caregiver, n (%)				3.061	0.080
Family	295 (83.57)	212 (85.83)	83 (78.30)		
Others	58 (16.43)	35 (14.17)	23 (21.70)		
Payment type, n (%)				0.703	0.402
Medical insurance	273 (77.34)	188 (76.11)	85 (80.19)		
Others	80 (22.66)	59 (23.89)	21 (19.81)		
Family history, n (%)				0.141	0.708
Yes	69 (19.55)	47 (19.03)	22 (20.75)		
No	284 (80.45)	200 (80.97)	84 (79.25)		
Admission status, n (%)				1.763	0.184
Involuntary	202 (57.22)	147 (59.51)	55 (51.89)		
Voluntary	151 (42.78)	100 (40.49)	51 (48.11)		
Repeat admission, n (%)				0.282	0.596
Yes	204 (57.79)	145 (58.70)	59 (55.66)		
No	149 (42.21)	102 (41.30)	47 (44.34)		
Diagnosis subtype, n (%)				1.218	0.270
Paranoid	169 (47.88)	123 (49.80)	46 (43.40)		
Others	184 (52.12)	124 (50.20)	60 (56.60)		
Age of onset (years), n (%)				1.001	0.606
≤ 19	130 (36.83)	94 (38.06)	36 (33.96)		
20–39	196 (55.52)	136 (55.06)	60 (56.60)		
≥ 40	27 (7.65)	17 (6.88)	10 (9.43)		
Course of disease (years), n (%)				0.682	0.711
≤ 10	136 (38.53)	94 (38.06)	42 (39.62)		
10–20	114 (32.29)	83 (33.60)	31 (29.25)		
≥ 20	103 (29.18)	70 (28.34)	33 (31.13)		
Drug prescription, n (%)				1.376	0.241
AMP	170 (48.16)	124 (50.20)	46 (43.40)		
APP	183 (51.84)	123 (49.80)	60 (56.60)		
Residual symptoms, n (%)				1.788	0.181

Table 1 (continued)

Variable	Total (*n* = 353)	Training set (*n* = 247)	Validation set (*n* = 106)	χ^2	*p*
Yes	291 (82.44)	208 (84.21)	83 (78.30)		
No	62 (17.56)	39 (15.79)	23 (21.70)		
Impaired insight, n (%)				0.007	0.933
Sever	101 (28.61)	71 (28.74)	30 (28.30)		
Mild or medium	252 (71.39)	176 (71.26)	76 (71.70)		
LOS (days), n (%)				0.616	0.893
Short group (≤ 13)	10 (2.83)	7 (2.83)	3 (2.83)		
Medium group (14–26)	58 (16.43)	43 (17.41)	15 (14.15)		
Long group (27–40)	93 (26.35)	65 (26.32)	28 (26.42)		
Very long group (≥ 41)	192 (54.39)	132 (53.44)	60 (56.60)		

Abbreviations: APP-Antipsychotic polypharmacy, AMP-Antipsychotic monotherapy, LOS-Length of stay

Among the included cases, 53.3% of the patients were men, with a mean age of 39.4 years (SD = 11.9), 65.2% were single, 41.1% had a lower education level, and 83.3% were unemployed. Approximately 20% of the patients had a family history of psychiatric illness, and 17% lived in rural areas, with a lack of family caregivers (16.4%). More than three-quarters of the inpatients were supported by medical insurance (77.3%). In terms of clinical characteristics, more than half had experienced repeated hospitalizations, 57.2% of all admissions were involuntary (compulsory) during the index hospitalization, and nearly half were diagnosed with the paranoid subtype (47.9%). The mean age of onset was 24.5 years (SD = 9.3), and the median duration of the disease was 13 years (IQR = 7, 21). Moreover, 51.8% of patients were prescribed two or more antipsychotic drugs, and most had some residual symptoms (82.4%) during maintenance treatment. More than one-quarter experienced severely impaired insight (28.6%) at discharge. In this study, the LOS for the index hospitalization ranged from 8 to 297 days, with a median of 44 days (IQR = 29, 58). Regarding readmissions, 109 rehospitalized patients accounted for a total of 145 readmissions, including once (72.5%) and at least twice (27.5%). The median TIC was 143 days (IQR = 55, 248.5), and the rates of readmission within 1 month, 6 months, and 1 year were 3.7%, 18.1%, and 30.9%, respectively.

Independent risk factors for RPS

In the univariate Cox analyses of the training set, seven variables were found to be associated with 1-year readmission of post-discharge patients with schizophrenia. These variables included admission status, repeat admissions, diagnosis subtype, course of mental disorder, age of onset, drug prescription, and residual symptoms (all $p < 0.05$). Furthermore, although no significant differences were found in gender ($p = 0.094$), payment type ($p = 0.097$), and LOS in the index hospitalization ($p = 0.078$), previous studies have consistently reported them as potential risk factors for readmission [8, 15, 25, 40]. Consequently, they were also included in the multivariate analysis (Table 2).

The KM method and time-dependent Cox regression models were used for categorical variables, revealing no significant deviation from the assumption. The VIFs for the above variables ranged from 1.04 to 1.29, and their tolerances were between 0.78 and 0.96, indicating no apparent collinearity. The multivariate Cox regression analysis identified several risk factors for 1-year readmission: involuntary admission (adjusted hazard ratio [aHR] = 4.35, 95% CI: 2.13–8.86; $p < 0.001$), repeat admissions (aHR = 3.49, 95% CI: 2.08–5.85; $p < 0.001$), a prescription of antipsychotic polypharmacy (APP) (aHR = 2.16, 95% CI: 1.34–3.48; $p = 0.001$), and a course of disease ≥ 20 years (aHR = 1.80, 95% CI: 1.04–3.12; $p = 0.037$), as detailed in Table 2.

Development and validation of the nomogram

Based on the identified independent risk factors, w developed a nomogram to predict the 1-year readmission of patients with schizophrenia (Fig. 1). Overall performance of the nomogram was rigorously assessed, yielding a C-index of 0.780 (95% CI: 0.729–0.832) in the training group and 0.796 (95% CI: 0.726–0.866) in the validation group. These results indicate the model's adequate discriminative ability. Additionally, the receiver operating characteristic (ROC) curve analysis revealed an area under the curve (AUC) of 0.820 in the training group and 0.846 in the validation group, demonstrating the model's good distinguishing capacity (Fig. 2A-B). Moreover, calibration curves for both the training and validation groups displayed a high level of concordance between the predicted outcomes by the nomogram and the actual observed results, indicating accurate predictive performance (Fig. 3A-B). DCA further demonstrated a significantly better net benefit with the predictive model, underscoring its clinical utility (Fig. 4A-B)

Table 2 Univariate and multivariate cox regression (Backward: LR)

Variables	Beta	S.E.	Z	*p*	HR (95%CI)	m_Beta	m_S.E.	m_Z	ap	aHR (95%CI)
Admission status										
Voluntary					Ref					Ref
Involuntary	1.82	0.35	26.26	< 0.001	6.18 (3.08–12.41)	1.47	0.36	16.37	< 0.001	4.35 (2.13–8.86)
Repeat admission										
No					Ref					Ref
Yes	1.57	0.26	37.42	< 0.001	4.83 (2.92–8.00)	1.25	0.26	22.43	< 0.001	3.49 (2.08–5.85)
Drug prescription										
AMP					Ref					Ref
APP	0.73	0.24	9.30	0.002	2.08 (1.30–3.32)	0.77	0.24	10.08	0.001	2.16 (1.34–3.48)
Course (years)										
≤ 10					Ref					Ref
10–20	0.23	0.30	0.58	0.446	1.25 (0.70–2.25)	0.04	0.30	0.02	0.882	1.05 (0.58–1.89)
≥ 20	0.79	0.28	8.07	0.004	2.21 (1.28–3.92)	0.59	0.28	4.37	0.037	1.80 (1.04–3.12)
Gender										
Female					Ref					
Male	0.39	0.23	2.80	0.094	1.48 (0.93–2.35)					
Age(years)										
≤ 29					Ref					
30–49	-0.12	0.27	0.18	0.672	0.89 (0.52–1.52)					
≥ 50	-0.10	0.32	0.10	0.751	0.90 (0.48–1.69)					
Education level										
High					Ref					
Low	0.12	0.23	0.27	0.602	1.13 (0.72–1.77)					
Marital status										
Married					Ref					
Unmarried	0.14	0.24	0.34	0.560	1.15 (0.71–1.86)					
Employment										
Yes					Ref					
No	0.235	0.315	0.559	0.455	1.26 (0.68–2.34)					
Registration										
Rural					Ref					
Non-rural	0.31	0.33	0.90	0.343	1.36 (0.72–2.58)					
Caregiver										
Family					Ref					
Others	0.17	0.34	0.24	0.622	1.18 (0.61–2.30)					
Payment type										
Insurance					Ref					
Others	-0.51	0.31	2.76	0.097	0.60 (0.33–1.10)					
Family history										
Yes					Ref					
No	0.23	0.32	0.56	0.456	1.26 (0.68–2.34)					
Diagnosis subtype										
Paranoid					Ref					
Others	0.47	0.23	4.03	0.045	1.62 (1.01–2.54)					
Age onset (years)										
≥ 40					Ref					
≤ 19	1.62	1.01	2.62	0.105	5.17 (0.71–37.69)					
20–39	2.18	1.01	4.63	0.031	8.85 (1.21–64.41)					
Residual symptoms										
Yes					Ref					
No	-1.12	0.46	5.88	0.015	0.33 (0.13–0.81)					
Impaired insight										
Mild or medium					Ref					

Table 2 (continued)

Variables	Beta	S.E.	Z	*p*	HR (95%CI)	m_Beta	m_S.E.	m_Z	ap	aHR (95%CI)
Sever	0.17	0.25	0.46	0.498	1.18 (0.73–1.92)					
LOS (days)										
Longer (≥ 27)					Ref					
Shorter (≤ 26)	-0.60	0.34	3.11	0.078	0.55 (0.28–1.07)					

Omnibus Tests of Model Coefficients: -2Log Likelihood = 728.93, Chi-square = 78.33, $p < 0.001$

Abbreviations: APP-Antipsychotic Polypharmacy, AMP-Antipsychotic monotherapy, LOS-Length of stay

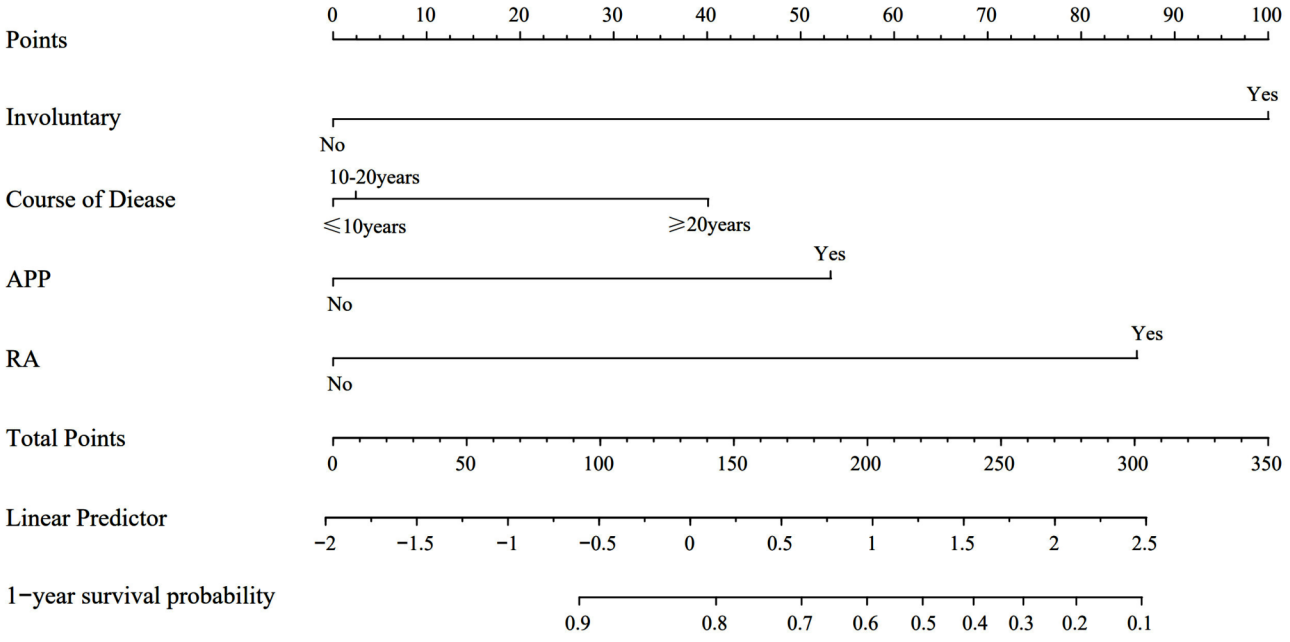

Fig. 1 The graph showed nomogram for predicting 1-year readmission in schizophrenia patients

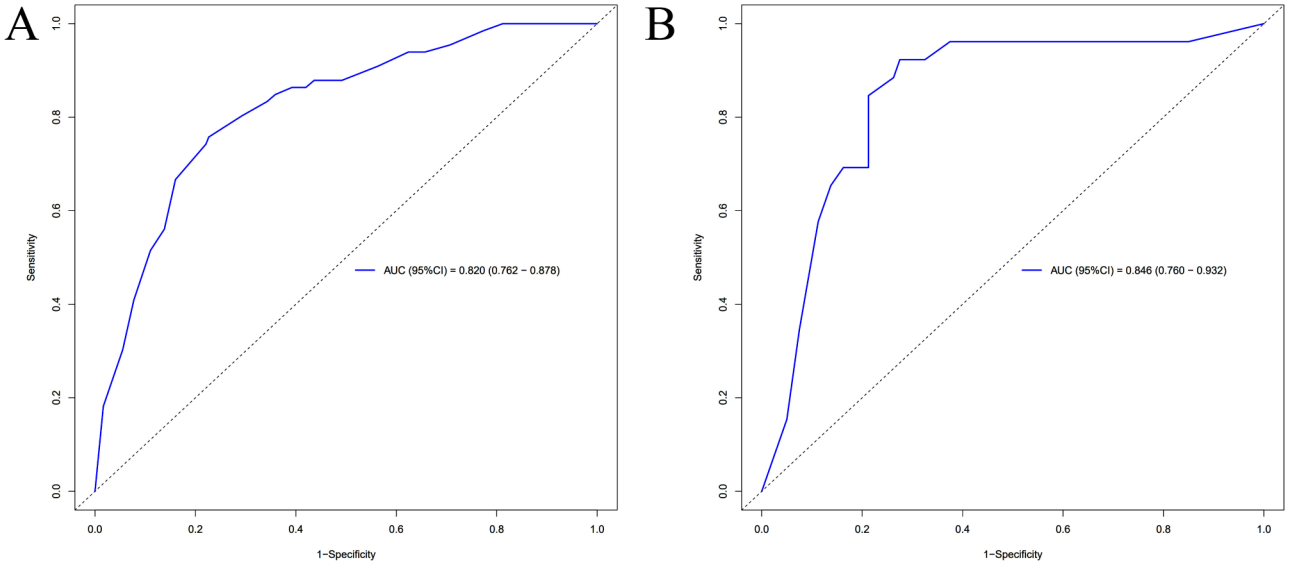

Fig. 2 The comparison of ROC curves of nomogram at 1-year readmission in the training group (**A**) and validation group (**B**)

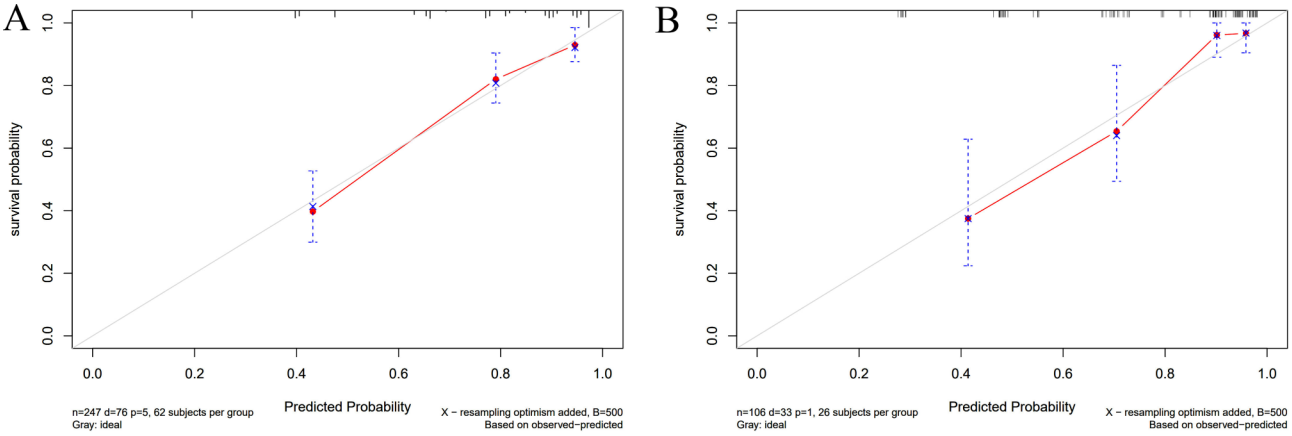

Fig. 3 The calibration curves of 1-year readmission in the training group (**A**) and validation group (**B**). The dashed line represents an excellent match between nomogram prediction (X-axis) and actual survival outcome (Y-axis). Closer distances from the points to the dashed line indicate higher prediction accuracy

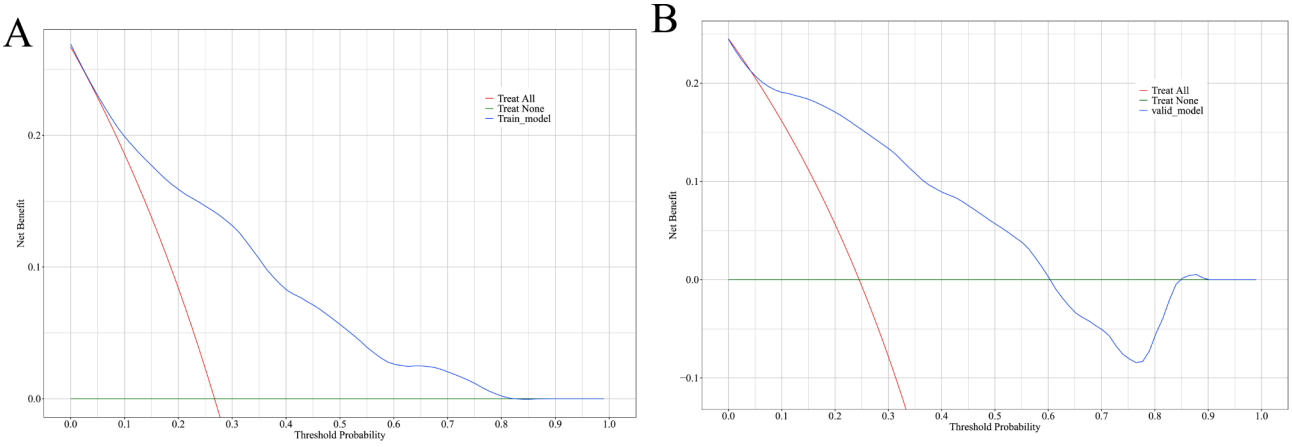

Fig. 4 The DCAs for 1- year readmission prediction in training group (**A**) and validation group (**B**)

Ability of nomogram to stratify patient's readmission risk

Total points for all patients were calculated according to the nomogram, and the optimal cutoff value was determined to be 137.02 by the software. Following this determination, patients were classified into low (total points < 137.02) and high (total points ≥ 137.02) readmission risk subgroups (Fig. 5). Kaplan-Meier survival analysis, coupled with the log-rank test, revealed a statistically significant difference ($P<0.001$) in the survival curves between the two subgroups in both the training and validation groups (Fig. 6A-B). Notably, patients categorized within the high-risk score subgroup exhibited a greater probability of readmission compared to those in the low-risk score subgroup.

Discussion

With the global advancement of the deinstitutionalization policy, the traditional model of long-term hospital isolation for psychiatric patients has shifted towards a pattern of repeated hospitalizations. Evidence suggests that deinstitutionalization and similar strategies have not effectively mitigated the issue of readmissions, with the rate of readmissions among individuals with mental disorders steadily climbing both domestically and internationally [2, 8, 10]. The growing urgency to further investigate the risk factors contributing to readmissions in this demographic is clear. Moreover, transforming these insights into practical tools for clinical application emerges as a critical step towards lowering readmission rates for such patients. To the best of our knowledge, this study represents the first endeavor to develop a model predicting the likelihood of post-discharge 1-year readmission using a Chinese cohort. Although previous reports on psychiatric readmissions in China have largely concentrated on identifying risk factors or predictors [8, 21] and exploring targeted intervention strategies [42], our study identifies previous repeat admissions, involuntary admission during the index hospitalization, APP prescription, and a prolonged disease course as predictors of post-discharge 1-year readmission in patients

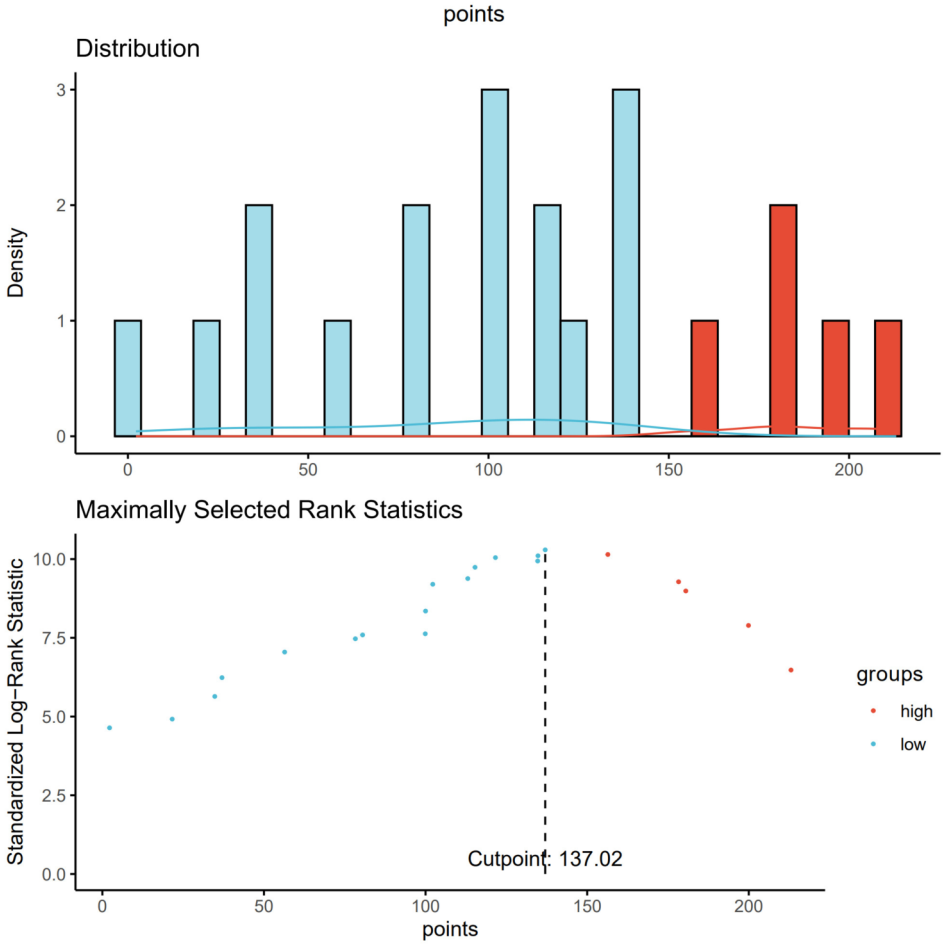

Fig. 5 The best cutoff value was determined as 137.02. Subsequently, the patients were divided into low and high readmission risk subgroups

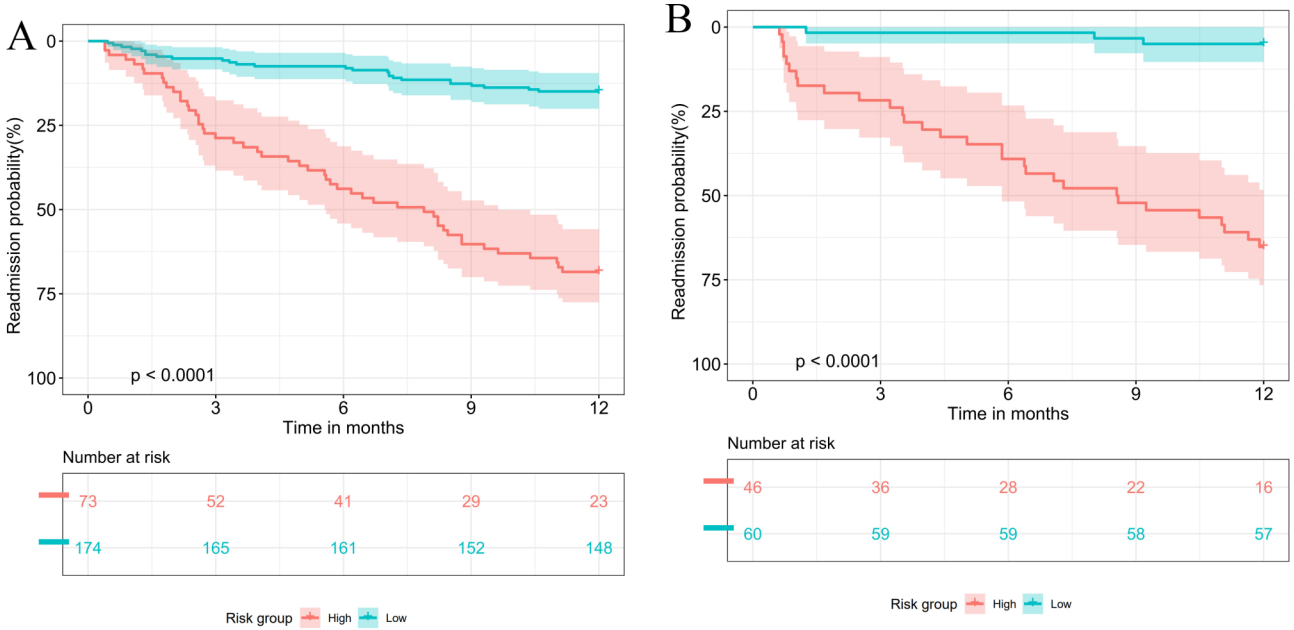

Fig. 6 Kaplan-Meier survival curves of two readmission risk subgroups in the training group (**A**) and validation group (**B**)

with schizophrenia. These four predictors are objective and easily quantifiable clinical features, which could be identified quickly and early, more so than findings from many previous research studies on this topic. This might be particularly useful for non-medical staff who do not directly care for patients. The timely recognition of these predictors can assist clinical managers and policy-makers in executing evidence-based interventions to better manage the disease's overall prognosis.

Previous investigations have explored the roles of various predictors in the context of psychiatric readmission [9, 15]. A total of 138 papers were included in the aforementioned reviews, mainly from the USA and focusing on some major influencing factors of readmission in patients with severe mental disorders, but the results were not always homogeneous. In contrast, our study, based on a representative Chinese cohort, used multivariate analytical methods to explore the roles of various predictors, which not only further confirmed some previously inconsistent findings but also found that polypharmacy prescription played a very important role in psychiatric readmission, which seemed to have been underestimated in previous studies [39]. Moreover, given that some vital confounders were not strictly controlled in nearly 50% of the articles [15] and the majority of studies have not employed validation methods [9, 15], this research aims to build a reliable and easy-to-use prediction model to overcome the aforementioned shortcomings. The nomogram, a visual statistical model, integrates multiple predictors and is widely adopted for its simplicity and robust capability to identify disease outcomes. Despite this focus, the development of sophisticated risk prediction models for psychiatric readmission among patients with mental illness remains scarce [26]. A systematic review encompassing 41 risk prediction models for readmission highlighted that 24 models exhibited sub-optimal performance (c-statistics < 0.75), with merely one model dedicated to forecasting early readmission in psychiatric conditions [43]. An additional model demonstrated moderate discrimination (c-statistic = 0.63) by identifying seven independent variables, thereby establishing a preliminary framework for subsequent inquiry in this domain [26]. The current study proposes a clinical predictive model based on four pre-discharge static indicators, which may be advantageous due to the straightforwardness of data acquisition and processing. Subsequent evaluation of the model's predictive accuracy and clinical applicability through ROC curves, DCA, NRI, and IDI has unveiled that the novel nomogram exhibits enhanced predictive performance, marking a significant advancement in our study similar to those reported in existing studies [44, 45]. This research contributes to a deeper comprehension of the stratification of readmission risk and highlights the critical need for diligent follow-ups and case management in patients with severe mental illness at high risk of readmission.

Our study developed a four-item predictive model designed to objectively, rapidly, and accurately predict psychiatric readmission within one year post-discharge in patients with schizophrenia. A clinical risk index, termed READMIT, along with a thorough analysis of 13 studies, identified prior multiple hospital admissions as the most consistently significant predictor of readmission within 30 days following discharge [26, 46]. Extending this line of inquiry, our study also recognizes repeat admissions as a significant risk factor for readmission within 1-year post-discharge. This association likely mirrors the intrinsic complexity encountered in managing patients with severe mental illness. The phenomenon of "revolving door" hospitalizations has emerged as a pervasive issue, marking a natural progression throughout the illness trajectory. Notably, the cycle of repeated hospitalizations fosters social isolation and a dependency on hospital care among patients. Such patterns substantially degrade their daily living competencies and social skills [47]. Within the context of service accessibility and resource distribution, mental health services in China predominantly concentrate in metropolitan centers or major local mental hospitals, a factor contributing to the recurrent hospitalizations observed [27, 30]. More broadly, beyond the history of prior admissions, the literature consistently identifies prolonged illness duration as a critical predictor of readmission. Extended disease courses suggest an earlier onset, with early disease onset recognized as a significant factor influencing rehospitalization rates [48]. In this investigation, approximately 80% of patients experiencing lengthy disease duration exhibited social withdrawal among other hallmark symptoms, presenting a rather bleak prognosis. A systematic review underscored post-discharge symptomatic factors and challenging behaviors as key predictors for rehospitalization [9]. Furthermore, involuntary or emergency admissions have been independently linked to higher readmission risks in individuals with psychosis across several studies [26, 40]. Our study reveals that the incidence of hazardous behaviors in the RPS was more than double that observed in the NRPS, not only posing risks to self and others but also potentially exacerbating interpersonal strife and eroding social support networks. Moreover, our model identified antipsychotic polypharmacy as a significant indicator of adverse prognosis in schizophrenia patients, a factor seldom incorporated into current tools for assessing readmission risk, particularly within structured scales [49]. Schizophrenia, as a lifelong condition, necessitates a focus on long-term outcomes, including relapse prevention and mitigation of the negative physical health impacts associated with chronic antipsychotic use, which are critical for patient well-being [39, 50].

Although specific polypharmacy strategies, such as the combination of aripiprazole with clozapine, have shown efficacy in reducing rehospitalization risks [39], there is a concern that the benefits of polypharmacy may be overestimated. Current treatment guidelines are evolving to refine their recommendations, generally advising against antipsychotic polypharmacy in the maintenance treatment of schizophrenia due to the heightened risk of side effects and the financial burden associated with polypharmacy, for which prior studies have not provided supportive evidence [51]. It is imperative for practitioners to adhere more rigorously to clinical guidelines to minimize the risk of exposing patients to the potentially fatal side effects of antipsychotic polypharmacy.

Of note, our study further indicated that some factors were not independent risk factors for readmission within 1 year of discharge in schizophrenia patients, such as age, urban resident, age of onset [15, 52]. In our univariate and multivariate analyses, we employed not only purely statistical methods but also considered potential variables associated with readmission based on context and experience, including medical insurance, LOS, and gender. Although these variables did not ultimately remain in our prediction model, they still warrant attention due to their potential mediating effects. Among our readmitted individuals, males comprised 62.4%, and involuntary admissions accounted for 89%. The influence of gender may have been diminished when included simultaneously in the multivariate analysis. However, this does not imply that gender is unimportant; generally, admissions among male patients with schizophrenia tend to be urgent and fraught with risks [4, 8], as evidenced by the fact that the majority of involuntary admissions in our study were males (60.9%). Furthermore, no significant differences were observed in longer LOS (≥27 days); however, antipsychotic polypharmacy was notably higher at 86.9% in the longer LOS group compared to 74.1% in the shorter LOS group ($P=0.015$). Therefore, we believe a significant reason for prolonged hospital stays may be that add-on treatments are initiated when monotherapy fails to sufficiently control symptom worsening, suggesting that the effect sizes for polypharmacy are likely underestimated in previous studies [39]. Taken together, the complexity and interconnections of factors that affect readmission in schizophrenia patients and also emphasize the importance of our study.

In this study, we evaluated pre-discharge predictors of 1-year readmission among patients with schizophrenia, leading to the development of a risk prediction model aimed at forecasting and mitigating unplanned readmissions in this population. The model's accuracy and consistency were affirmed through internal validation, demonstrating its net benefit. The nomogram offers a visual and individualized tool that can quantify the probability of readmission within one year for patients with schizophrenia by combining the determined independent predictors. Furthermore, after evaluating the predictive accuracy and clinical usefulness of the model, the results from ROC curves, DCA, NRI, and IDI collectively demonstrated that the newly proposed nomogram might offer better and more accurate predictive capabilities, particularly suited for the Chinese context compared to existing models [26, 52]. Another strength of this study is its potential to aid us or our peers in developing a web-based survival calculator in the future, which would facilitate the clinical application of this model.

Despite its strengths, our study has several limitations. Being a retrospective analysis, it is prone to potential selection bias. The absence of post-discharge factors as predictors also represents a significant limitation, as these could influence the accuracy of psychiatric readmission predictions. Like many models, ours shows only moderate discriminative ability. We recognize that including additional patient characteristics, such as poor drug compliance and other relevant psychosocial factors like economic conditions, could enhance the model's predictive accuracy. Additionally, our study's single-center design and the limited sample size may also restrict its generalizability. Furthermore, while the model serves as a valuable reference for clinicians, it has not been directly compared with established frameworks like the READMIT [26] and LACE [52] staging systems, which may affect its perceived reliability and applicability. Moving forward, we aim to expand our study to include a broader range of predictors and conduct external validations across multiple centers. This strategy will allow us to refine the model, improving its performance and utility across diverse clinical settings.

Conclusions

Despite healthcare advancements, psychiatric readmission remains a significant challenge in China. Our study introduces a predictive nomogram, targeted to the Chinese context, to aid in developing interventions for a smoother transition from hospital to community care. This tool's ability to identify high-risk readmission patients could mark an important step towards reducing unnecessary readmissions, offering a strategic direction for improving mental health care and patient outcomes in China.

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Author contributions

I declare that all co-authors have made a substantial contribution to the conception and design of the study and drafting or revising the manuscript. All authors approve the final manuscript submitted to BMC Psychiatry. Mingru Hou, Jun Wang, Zhenhe Zhou and Xianwen Li: Conceived and designed the

study; Analyzed and interpreted the data; Wrote and revised the paper. Yuqing Wu and Jianhua Xue: Performed the investigation; Screened and extracted data; Methodology, analysis tools or data; Data curation. Ruifen Zhang, Yan Zhang and Libo Yu: Contributed materials. Qiongni Chen, Zhenhe Zhou: Project administration and Supervision.

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Data availability
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The study analyzed the demographic and clinical characteristics of patients approved by the local Ethics Committee of the Affiliated Mental Health Center of Jiangnan University. Ethics review board approved the study protocol of MHC (NO. WXMHCIRB2022LLky085). All participants provided informed consent for participation in the study. Additionally, all patients were in full possession of their faculties and capable of understanding and willing, while patients with cognitive deficits were not included in the study.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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References

1. Montgomery P, Kirkpatrick H. Understanding those who seek frequent psychiatric hospitalizations. Arch Psychiatr Nurs. 2002;16(1):16–24.
2. Di Lorenzo R, Sagona M, Landi G, Martire L, Piemonte C, Del GC. The revolving door phenomenon in an Italian acute psychiatric ward: a 5-year retrospective analysis of the potential risk factors. J Nerv Ment Dis. 2016;204(9):686–92.
3. Lassemo E, Myklebust LH, Salazzari D, Kalseth J. Psychiatric readmission rates in a multi-level mental health care system - a descriptive population cohort study. BMC Health Serv Res. 2021;21(1):378.
4. Hou MR, Wang J, Xue JH, Pei JQ, Shi Y, Li XW. Gender differences among long-stay inpatients with schizophrenia in China: a cross-sectional study. Heliyon. 2023;9(5):e15719.
5. Liang D, Mays VM, Hwang WC. Integrated mental health services in China: challenges and planning for the future. Health Policy Plan. 2018;33(1):107–22.
6. Sood S, Ramos G, Van Der Veer N, Bay C, Kaur BR, Nasef A, Ayutyanot N. Risk factors for rehospitalization for patients following release from court-ordered evaluation: a retrospective study. Psychiatr Psychol Law. 2020;27(4):637–46.
7. Boaz TL, Becker MA, Andel R, Van Dorn RA, Choi J, Sikirica M. Risk factors for early readmission to acute care for persons with schizophrenia taking antipsychotic medications. Psychiatr Serv. 2013;64(12):1225–9.
8. Han X, Jiang F, Tang Y, Needleman J, Guo M, Chen Y, Zhou H, Liu Y. Factors associated with 30-day and 1-year readmission among psychiatric inpatients in Beijing China: a retrospective, medical record-based analysis. BMC Psychiatry. 2020;20(1):113.
9. Sfetcu R, Musat S, Haaramo P, Ciutan M, Scintee G, Vladescu C, Wahlbeck K, Katschnig H. Overview of post-discharge predictors for psychiatric re-hospitalisations: a systematic review of the literature. BMC Psychiatry. 2017;17(1):227.
10. Zhong Q, Tan Y, Chen W, Huang H, Huang J, Li S, Teng Z, Shen M, Wu C, Wang L, et al. Disease burden of schizophrenia patients visiting a Chinese regional mental health centre. J Comp Eff Res. 2020;9(7):469–81.
11. Huang Y, Wang Y, Wang H, Liu Z, Yu X, Yan J, Yu Y, Kou C, Xu X, Lu J, et al. Prevalence of mental disorders in China: a cross-sectional epidemiological study. Lancet Psychiat. 2019;6(3):211–24.
12. Kripalani S, Theobald CN, Anctil B, Vasilevskis EE. Reducing hospital readmission rates: current strategies and future directions. Annu Rev Med. 2014;65:471–85.
13. Evans LJ, Harris V, Newman L, Beck A. Rapid and frequent psychiatric readmissions: associated factors. Int J Psychiatry Clin Pract. 2017;21(4):271–6.
14. Tyler N, Wright N, Waring J. Interventions to improve discharge from acute adult mental health inpatient careto the community: systematic review and narrative synthesis. BMC Health Serv Res. 2019;19(1):883.
15. Donisi V, Tedeschi F, Wahlbeck K, Haaramo P, Amaddeo F. Pre-discharge factors predicting readmissions of psychiatric patients: a systematic review of the literature. BMC Psychiatry. 2016;16(1):449.
16. Berry JG, Toomey SL, Zaslavsky AM, Jha AK, Nakamura MM, Klein DJ, Feng JY, Shulman S, Chiang VW, Kaplan W, et al. Pediatric readmission prevalence and variability across hospitals. JAMA. 2013;309(4):372–80.
17. Yussuf AD, Kuranga SA, Balogun OR, Ajiboye PO, Issa BA, Adegunloye O, Parakoyi MT. Predictors of psychiatric readmissions to the psychiatric unit of a tertiary health facility in a Nigerian city - a 5-year study. Afr J Psychiatry (Johannesbg). 2008;11(3):187–90.
18. Jaramillo-Gonzalez LE, Sanchez-Pedraza R, Herazo MI. The frequency of rehospitalization and associated factors in Colombian psychiatric patients: a cohort study. BMC Psychiatry. 2014;14:161.
19. Rieke K, McGeary C, Schmid KK, Watanabe-Galloway S. Risk factors for inpatient psychiatric readmission: are there gender differences? Community Ment Health J. 2016;52(6):675–82.
20. Zanardo G, Silveira L, Rocha C, Rocha KB. Psychiatric admission and readmission in a general hospital of Porto Alegre: sociodemographic, clinic, and use of network for psychosocial care characteristics. Rev Bras Epidemiol. 2017;20(3):460–74.
21. Zhang Y, Dai G. Predictors of re-hospitalization over a two-year follow-up period among patients with schizophrenia enrolled in a community management program in Chengdu, China. Shanghai Arch Psychiatry. 2012;24(1):30–7.
22. Zhou Y, Rosenheck RA, Mohamed S, Fan N, Ning Y, He H. Retrospective assessment of factors associated with readmission in a large psychiatric hospital in Guangzhou, China. Shanghai Arch Psychiatry. 2014;26(3):138–48.
23. Lichtenberg P, Levinson D, Sharshevsky Y, Feldman D, Lachman M. Clinical case management of revolving door patients - a semi-randomized study. Acta Psychiatr Scand. 2008;117(6):449–54.
24. Tulloch AD, David AS, Thornicroft G. Exploring the predictors of early readmission to psychiatric hospital. Epidemiol Psychiatr Sci. 2016;25(2):181–93.
25. Barker LC, Gruneir A, Fung K, Herrmann N, Kurdyak P, Lin E, Rochon PA, Seitz D, Taylor VH, Vigod SN. Predicting psychiatric readmission: sex-specific models to predict 30-day readmission following acute psychiatric hospitalization. Soc Psychiatry Psychiatr Epidemiol. 2018;53(2):139–49.
26. Vigod SN, Kurdyak PA, Seitz D, Herrmann N, Fung K, Lin E, Perlman C, Taylor VH, Rochon PA, Gruneir A. READMIT: a clinical risk index to predict 30-day readmission after discharge from acute psychiatric units. J Psychiatr Res. 2015;61:205–13.
27. Jiang F, Liu T, Zhou H, Rakofsky JJ, Liu H, Liu Y, Tang YL. Developing medical record-based, healthcare quality indicators for psychiatric hospitals in China:

a modified Delphi-analytic hierarchy process study. Int J Qual Health Care. 2019;31(10):733–40.
28. Zhang W, Li X, Lin Y, Zhang X, Qu Z, Wang X, Xu H, Jiao A, Guo M, Zhang Y, et al. Pathways to psychiatric care in urban north China: a general hospital based study. Int J Ment Health Syst. 2013;7(1):22.
29. Li H, Yuan B, Wang D, Meng Q. Motivating factors on performance of primary care workers in China: a systematic review and meta-analysis. BMJ Open. 2019;9(11):e28619.
30. Li X, Lu J, Hu S, Cheng KK, De Maeseneer J, Meng Q, Mossialos E, Xu DR, Yip W, Zhang H, et al. The primary health-care system in China. Lancet. 2017;390(10112):2584–94.
31. Ajuebor O, McCarthy C, Li Y, Al-Blooshi SM, Makhanya N, Cometto G. Are the global strategic directions for strengthening nursing and midwifery 2016–2020 being implemented in countries? Findings from a cross-sectional analysis. Hum Resour Health. 2019;17(1):54.
32. Fang M, Hall BJ, Lin Y, Hu SX. Structural changes to enhance mental health services in China: experience and challenges. Asian J Psychiatr. 2019;43:177–8.
33. Hung YY, Chan HY, Pan YJ. Risk factors for readmission in schizophrenia patients following involuntary admission. PLoS ONE. 2017;12(10):e186768.
34. Cheniaux E, Landeira-Fernandez J, Versiani M. The diagnoses of schizophrenia, schizoaffective disorder, bipolar disorder and unipolar depression: interrater reliability and congruence between DSM-IV and ICD-10. Psychopathology. 2009;42(5):293–8.
35. McEvoy JP, Apperson LJ, Appelbaum PS, Ortlip P, Brecosky J, Hammill K, Geller JL, Roth L. Insight in schizophrenia. Its relationship to acute psychopathology. J Nerv Ment Dis. 1989;177(1):43–7.
36. Frick U, Frick H, Langguth B, Landgrebe M, Hubner-Liebermann B, Hajak G. The revolving door phenomenon revisited: time to readmission in 17'145 patients with 37'697 hospitalisations at a German psychiatric hospital. PLoS ONE. 2013;8(10):e75612.
37. Guo S, Liu J, Li W, Yang Y, Lv L, Xiao X, Li M, Guan F, Luo XJ. Genome wide association study identifies four loci for early onset schizophrenia. Transl Psychiatry. 2021;11(1):248.
38. Egashira K, Matsuo K, Mihara T, Nakano M, Nakashima M, Watanuki T, Matsubara T, Watanabe Y. Different and shared brain volume abnormalities in late- and early-onset schizophrenia. Neuropsychobiology. 2014;70(3):142–51.
39. Tiihonen J, Taipale H, Mehtala J, Vattulainen P, Correll CU, Tanskanen A. Association of Antipsychotic Polypharmacy vs Monotherapy with Psychiatric rehospitalization among adults with Schizophrenia. JAMA Psychiat. 2019;76(5):499–507.
40. Lin CE, Chung CH, Chen LF, Chen PC, Cheng HY, Chien WC. Compulsory admission is associated with an increased risk of readmission in patients with schizophrenia: a 7-year, population-based, retrospective cohort study. Soc Psychiatry Psychiatr Epidemiol. 2019;54(2):243–53.
41. Zhang YB, Chen C, Pan XF, Guo J, Li Y, Franco OH, Liu G, Pan A. Associations of healthy lifestyle and socioeconomic status with mortality and incident cardiovascular disease: two prospective cohort studies. BMJ. 2021;373:n604.
42. Wong CH, Cheung WK, Zhong CC, Yeoh EK, Hung CT, Yip BH, Wong EL, Wong SY, Chung VC. Effectiveness of nurse-led peri-discharge interventions for reducing 30-day hospital readmissions: network meta-analysis. Int J Nurs Stud. 2021;117:103904.
43. Mahmoudi E, Kamdar N, Kim N, Gonzales G, Singh K, Waljee AK. Use of electronic medical records in development and validation of risk prediction models of hospital readmission: systematic review. BMJ. 2020;369:m958.
44. Tong Y, Cui Y, Jiang L, Pi Y, Gong Y, Zhao D. Clinical characteristics, prognostic factor and a novel dynamic prediction model for overall survival of elderly patients with chondrosarcoma: a population-based study. Front Public Health. 2022;10:901680.
45. Xiang D, Yang X, Qian H, Zhang L, Han Y, Sun Y, Lu Y, Chen Y, Cao D, Hu M, et al. Development and validation of a model for the early prediction of progression from essential thrombocythemia to post-essential thrombocythemia myelofibrosis: a multicentre retrospective study. EClinicalMedicine. 2024;67:102378.
46. Durbin J, Lin E, Layne C, Teed M. Is readmission a valid indicator of the quality of inpatient psychiatric care? J Behav Health Serv Res. 2007;34(2):137–50.
47. Killaspy H, Cook S, Mundy T, Craig T, Holloway F, Leavey G, Marston L, McCrone P, Koeser L, Arbuthnott M, et al. Study protocol: cluster randomised controlled trial to assess the clinical and cost effectiveness of a staff training intervention in inpatient mental health rehabilitation units in increasing service users' engagement in activities. BMC Psychiatry. 2013;13:216.
48. Berardelli I, Sarubbi S, Rogante E, Erbuto D, Cifrodelli M, Giuliani C, Calabro G, Lester D, Innamorati M, Pompili M. Exploring risk factors for re-hospitalization in a psychiatric inpatient setting: a retrospective naturalistic study. BMC Psychiatry. 2022;22(1):821.
49. Jones SL, Cheon O, Manzano JM, Park AK, Lin HY, Halm JK, Baek J, Graviss EA, Nguyen DT, Kash BA, et al. Comparison of LACE and HOSPITAL readmission risk scores for CMS target and nontarget conditions. AM J Med Qual. 2022;37(4):299–306.
50. Correll CU, Rubio JM, Kane JM. What is the risk-benefit ratio of long-term antipsychotic treatment in people with schizophrenia? World Psychiatry. 2018;17(2):149–60.
51. Boskailo E, Malkoc A, McCurry DB, Venter J, Drachman D, Ramos GM. Assessment of inpatient psychiatric readmission risk among patients discharged on an antipsychotic polypharmacy regimen: a retrospective cohort study. Acta Med Acad. 2017;46(2):133–44.
52. Baig M, Zhang E, Robinson R, Ullah E, Whitakker R. Evaluation of patients at risk of hospital readmission (PARR) and LACE risk score for New Zealand context. Stud Health Technol Inf. 2018;252:21–6.

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