Electroconvulsive therapy and psychiatric readmission in major depressive disorder – A population-based register study

Linnea Stenmark1 | Charles H. Kellner2 © | Mikael Landén3,4 | Irya Larsson1 | Mussie Msghina1,5 | Axel Nordenskjöld1 ©

Abstract
Objective: The primary aim was to determine whether electroconvulsive therapy (ECT) is associated with reduced risk of psychiatric readmission in major depressive disorder (MDD).

Methods: This study was based on data from multiple Swedish population-based registries. All adult patients admitted to any Swedish hospital for moderate-to-severe MDD between 2012 and 2018 were included. Participants were divided into two groups depending on whether they received ECT during inpatient care. Follow-up was set at 30 and 90 days from discharge. Data were analyzed using logistic regression, and matching was conducted.

Results: A total of 27,851 unique patients contributed to 41,916 admissions. ECT was used in 26.8% of admissions. In the main multivariate analysis, the risk of both 30- and 90-day readmission was lower in the ECT group than in the non-ECT group. In a matched sensitivity model, the results pointed in the same direction for readmission risk within 30 days, but statistical significance was not reached. ECT-treated subgroups with superior outcomes on readmission risk compared with non-ECT treatment were older, unemployed, married, or widowed patients, those treated with antipsychotics or benzodiazepines before admission, with psychotic features, prior psychiatric hospitalizations, or family history of suicide. However, in patients below 35 years of age, ECT was associated with increased readmission risk.

Conclusion: This study suggests that ECT reduces the risk of psychiatric readmission in certain subgroups of patients with MDD. Since patients receiving ECT tend to be more difficult to treat, there is a risk of residual confounding.

KEYWORDS
electroconvulsive therapy, major depressive disorder, patient readmission, risk factors
1 | INTRODUCTION

Major depressive disorder (MDD) is a common mental illness with an estimated global point prevalence of 4.7%. It is currently ranked as one of the top five leading causes of years lost because of disability by the World Health Organization. MDD causes great societal costs, where one study found 10% of total costs to stem from admissions and readmissions. Studies have found several factors associated with increased risk of relapse and recurrence in patients with MDD, but the results have been inconsistent. To date, the most established predictors are childhood maltreatment, residual symptoms after treatment, and history of prior episodes. There is also some evidence, albeit weaker, that a comorbid anxiety disorder and younger age of onset could predict increased risk of relapse and recurrence.

Patients admitted for MDD are frequently readmitted within one year of discharge. Some studies have found that antidepressant drugs and lithium prevent recurrence and readmission. Electroconvulsive therapy (ECT) is considered a highly effective treatment and is mainly recommended for severe cases of MDD according to the American Psychiatric Association. ECT should be considered for patients with psychotic, catatonic, or suicidal features, and in those who are insufficiently responsive to medication or psychotherapy. ECT could also be considered for patients who have responded well to ECT in the past and for those who prefer it over other treatments. While ECT is mainly used as an acute treatment for depression and is much less commonly used as a continuation/maintenance treatment, it is uncertain whether it reduces the risk of psychiatric readmission in MDD.

Most previous studies investigating this subject have included study participants with mixed severe affective disorders. Slade et al. included 162,169 patients with MDD, bipolar disorder, or schizoaffective disorder and found ECT to be associated with reduced 30-day readmission risk. Tor et al. studied 121 patients with MDD or bipolar disorder and found a 35% reduction of readmissions within one year after ECT. The association was greater in patients with MDD than bipolar disorder. However, Lin et al. included 1,568 patients with MDD or bipolar disorder insufficiently responsive to antidepressant drugs and found no statistically significant association on psychiatric readmission within one year after ECT. Similar results were found by Stoudemire et al. who studied 94 older patients with MDD.

Thus, there is currently limited evidence supporting that ECT reduces the risk of psychiatric readmission in patients with MDD, although it is known that ECT is very efficient in achieving acute response and remission.

1.1 | Aims of the study

The primary aim of this study was to determine whether electroconvulsive therapy (ECT) was associated with reduced risk of psychiatric readmission in certain subgroups of patients with major depressive disorder. Subgroups with superior outcomes after ECT compared with non-ECT treatment included older patients, those with psychotic features, prior psychiatric hospitalizations, or family history of suicide. Age-dependent effects of ECT on readmission risk need to be further investigated.

2 | MATERIALS AND METHODS

2.1 | Study design

This was a registered study based on data from multiple Swedish population-based registries. Patients who had been admitted for moderate-to-severe MDD to any Swedish hospital from 1 January 2012 to 30 September 2018 were included. Study participants were divided into two groups depending on whether they received ECT or non-ECT treatment during inpatient care. Factors reported affecting the risk of psychiatric readmission were identified through a literature search. These potential confounders were included as covariates in both univariate and multivariate logistic regression analyses.
2.2 | Participants

All adult patients admitted with a main diagnosis of the first episode or recurrent moderate-to-severe MDD to any Swedish hospital from 1 January 2012 to 30 September 2018 were identified using the Swedish National Patient Register. Inclusion criteria were discharged before 1 October 2018 and no prior admission for mania, schizoaffective disorder, or schizophrenia. All psychiatric hospitalizations that met the inclusion criteria within this period were counted as new primary admissions. This meant that study participants readmitted for MDD were included several times in some analyses. Follow-up was set at 30 and 90 days from discharge. Readmissions with a main diagnosis of any psychiatric disorder within this period were identified. Study participants who died within the 90-day follow-up period were excluded.

2.3 | Data sources

The Swedish National Patient Register provides information about demographic factors, diagnoses, and inpatient and specialized outpatient care. Reporting to the register is mandatory for healthcare providers. It has a high degree of completeness, where some of the most frequently used variables are 99% complete. The International Statistical Classification of Diseases and Related Health Problems - Tenth Revision (ICD-10) is used to report diagnoses. Study participants were identified through searches in the register for specific ICD-10 codes (F32.1 and F33.1 for moderate major depressive disorder, F32.2 and F33.2 for severe major depressive disorder without psychotic features, and F32.3 and F33.3 for severe major depressive disorder with psychotic features). Psychiatric readmission was defined as readmission with a main diagnosis of any psychiatric disorder (ICD-10 codes F01-F99) within the follow-up period. Further variables obtained from the register were gender, age, psychiatric comorbidity, number of prior psychiatric hospitalizations, and whether the admission was voluntary or involuntary.

The Swedish National Quality Register for ECT (Q-ECT) contains information about indication for referral, ECT setting, response to treatment, and adverse effects. All Swedish hospitals that provide ECT report to the Q-ECT, which is an opt-out register. Of all patients treated with ECT in 2018, 91% were included in the Q-ECT.

The longitudinal integrated database for health insurance and labour market, studies (LISA) provides information about demographic and socioeconomic factors. It includes all Swedish citizens and residents above 15 years of age. Information about marital status, cohabitation status, level of education, and employment status was obtained from the LISA.

The Swedish Prescribed Drug Register contains information about all prescription drugs collected at Swedish pharmacies. It is classified according to the Anatomical Therapeutic Chemical (ATC) classification system. ATC codes were used to identify relevant drugs each study participant had collected within 100 days before admission (antidepressants, antipsychotics, anxiolytics, benzodiazepines, and lithium). The Antidepressant Treatment History Form (ATHF) is used to rate the adequacy of a patient’s antidepressant treatment. A slightly modified version of the ATHF was used in this study where antidepressant treatment within one year before admission was evaluated for each study participant based on drug doses collected at pharmacies. This modified version has been previously described by Brus et al.

The Multi-Generation Register provides information about over 11 million index persons in Sweden. It was used to identify first-degree relatives of the study participants. The register was linked to the Swedish National Patient Register to identify relatives with affective disorders (MDD or bipolar disorder).

The Swedish Cause of Death Register contains information about all deaths that have occurred in Sweden. These data were used to exclude subjects who died during the 90-day follow-up period and to identify first-degree relatives who have committed suicide.

2.4 | Electroconvulsive therapy setting

Study participants received a median of 8 sessions per treatment series (interquartile range (IQR): 6–10; range: 1–73). Electrode placement was unilateral during the first session in 8,578 cases (76.4%), bitemporal in 752 cases (6.7%), and bifrontal in 175 cases (1.6%); data were missing in 1,722 cases (15.3%). Electrode placement was unilateral during the last session in 8,462 cases (75.4%), bitemporal in 838 cases (7.5%), and bifrontal in 191 cases (1.7%); data were missing in 1,736 cases (15.5%). The mean ± standard deviation (SD) pulse width was 0.5 ± 0.1 ms during the first session, whereas the mean ± SD frequency was 64.3 ± 20.2 Hz, the mean ± SD stimulus duration was 6.7 ± 1.5 s, the mean ± SD current was 842.1 ± 55.8 mA, and the mean ± SD charge was 361.5 ± 153.8 mC. A total of 719 admissions (6.4%) were followed by continuation ECT within 14 days after discharge.
2.5 Statistical analyses

Chi-square test and Mann–Whitney U-test were used to compare group characteristics. Logistic regression analyses were conducted using univariate and multivariate models. The covariates included in the analyses were identified through a literature search and were consequently included in the multivariate analyses as they could be potential confounders. These covariates were inpatient treatment (ECT or non-ECT treatment), gender, age, marital status, cohabitation status, level of education, employment status, psychiatric comorbidity (anxiety disorder, alcohol use disorder, substance use disorder, and personality disorder), depression severity, whether the admission was voluntary or involuntary, number of prior psychiatric hospitalizations, ATHF score, psychiatric prescription drugs collected within 100 days before admission (antidepressants, antipsychotics, anxiolytics, benzodiazepines, and lithium), and family history of affective disorders or suicide. Study participants with missing data for demographic variables were imputed into the largest category. A separate model included all covariates mentioned as well as continuation ECT within 14 days after discharge. Multivariate logistic regression analyses were also conducted after stratification to identify differences in readmission risk between subgroups of the study population treated with or without ECT. Thereafter, the same multivariate model was applied by adding interaction terms to determine whether these differences were statistically significant.

Two sensitivity analyses were performed. In the first sensitivity model, only the first admission for each study participant was included. Finally, matching (1:1) was conducted as a second sensitivity model using only the first admission for each patient. Variables matched exactly were depression severity, number of prior psychiatric hospitalizations, and collection of antidepressants within 100 days before admission. Propensity score matching was used for all remaining covariates mentioned above. The threshold for statistical significance (alpha) was set at 0.05. Data management and statistical analyses were performed using SAS software (SAS Institute. Released 2013. Version 9.4. Cary, NC: SAS Institute Inc.) and SPSS (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.), respectively.

2.6 Ethical considerations

This study was granted approval by the regional ethical review board in Uppsala, Sweden (2014/174). Data collected from Swedish population-based registries were pseudonymized, and study participants were not identifiable at any time. Therefore, they were not informed of the study and were not required to provide written consent.

3 RESULTS

3.1 Participants

The inclusion criteria were met by 42,207 admissions. Subject death occurred within the 90-day follow-up period subsequent to 291 admissions (0.6% of the ECT group and 0.7% of the non-ECT group; \( p = 0.088 \)), which were excluded. Thus, the final number arrived at 27,851 unique study participants contributing to a total of 41,916 admissions. ECT was used in 11,227 admissions (26.8%), whereas non-ECT treatment was used in the remainder. Compared with the non-ECT group, study participants treated with ECT were significantly older and more likely to be female, married, cohabiting, and highly educated. Additionally, patients in the ECT group were more likely to have a higher number of prior psychiatric hospitalizations, greater severity of illness, family history of affective disorders or suicide, and being involuntarily admitted. Full characteristics are presented in Table 1.

3.2 Readmission rates

Before adjustment, the overall rate of readmission within 30 days was 15.1% in the ECT group and 15.4% in the non-ECT group, whereas the overall rate of readmission within 90 days was 26.2% in the ECT group and 25.3% in the non-ECT group. In the multivariate analysis, the risk of both 30- and 90-day readmission was lower in the ECT group than in the non-ECT group (odds ratio (OR): 0.90; 95% confidence interval (CI): 0.84–0.96; \( p = 0.002 \) and OR: 0.93; 95% CI: 0.88–0.99; \( p = 0.012 \), respectively). Further, continuation ECT after discharge was associated with decreased readmission risk within both 30- and 90-day readmission (OR: 0.54; 95% CI: 0.42–0.70; \( p = <0.001 \) and OR: 0.61; 95% CI: 0.50–0.74; \( p = <0.001 \), respectively).

3.3 Subgroups with differential associations between electroconvulsive therapy and readmission risk

Stratified multivariate logistic regression analyses demonstrated differences in readmission risk when subgroups of the ECT group were compared with the same subgroups of the non-ECT group (Table 2). The factors associated with decreased risk of both 30- and 90-day readmission in study
TABLE 1  Demographic and clinical characteristics of the study population including all admissions (n = 41,916)

| Characteristic                               | ECT group n = 11,227 | Non-ECT Group n = 30,689 | p-Value  |
|----------------------------------------------|-----------------------|---------------------------|----------|
| **Demographics**                             |                       |                           |          |
| Women, n (%)                                 | 6,860 (61.1)          | 17,315 (56.4)             | <0.001   |
| Age in years, median (IQR)                   | 59.0 (43.0–72.0)      | 45.0 (29.0–60.0)          | <0.001   |
| Married, n (%)                               | 4,373 (39.0)          | 8,087 (26.4)              | <0.001   |
| Divorced, n (%)                              | 2,036 (18.1)          | 5,774 (18.8)              |          |
| Widowed, n (%)                               | 1,211 (10.8)          | 1,669 (5.4)               |          |
| Unmarried, n (%)                             | 3,593 (32.0)          | 15,034 (49.0)             |          |
| Unknown marital status, n (%)                | 14 (0.1)              | 125 (0.4)                 |          |
| Cohabiting, n (%)                            | 5,942 (52.9)          | 15,251 (49.7)             | <0.001   |
| Not cohabiting, n (%)                        | 5,271 (46.9)          | 15,313 (49.9)             |          |
| Unknown cohabitation status, n (%)           | 14 (0.1)              | 125 (0.4)                 |          |
| Low education level, n (%)                   | 2,767 (24.6)          | 8,019 (26.1)              | <0.001   |
| Middle education level, n (%)                | 5,056 (45.0)          | 14,099 (45.9)             |          |
| High education level, n (%)                  | 3,291 (29.3)          | 8,066 (26.3)              |          |
| Unknown education level, n (%)               | 113 (1.0)             | 505 (1.6)                 |          |
| Employed, n (%)                              | 4,262 (38.0)          | 13,572 (44.2)             | <0.001   |
| Unemployed, n (%)                            | 6,951 (61.9)          | 16,992 (55.4)             |          |
| Unknown employment status, n (%)             | 14 (0.1)              | 125 (0.4)                 |          |
| **Depression severity**                      |                       |                           |          |
| Moderate, n (%)                              | 2,356 (21.0)          | 14,894 (48.5)             | <0.001   |
| Severe without psychotic features, n (%)     | 6,055 (53.9)          | 11,602 (37.8)             |          |
| Severe with psychotic features, n (%)        | 2,816 (25.1)          | 4,193 (13.7)              |          |
| **Inpatient characteristics**                |                       |                           |          |
| Involuntarily admitted, n (%)                | 1,844 (16.4)          | 4,282 (14.0)              | <0.001   |
| **Psychiatric comorbidity**                  |                       |                           |          |
| Anxiety disorder, n (%)                      | 4,157 (37.0)          | 10,674 (34.8)             | <0.001   |
| Alcohol use disorder, n (%)                  | 975 (8.7)             | 4,062 (13.2)              | <0.001   |
| Substance use disorder, n (%)                | 1,049 (9.3)           | 3,748 (12.2)              | <0.001   |
| Personality disorder, n (%)                  | 844 (7.5)             | 2,533 (8.3)               | 0.014    |
| **Prior psychiatric hospitalizations**       |                       |                           |          |
| Previously been hospitalized, n (%)          | 8,989 (80.1)          | 19,659 (64.1)             | <0.001   |
| Number of prior psychiatric hospitalizations, median (IQR) | 2 (1–6) | 1 (0–4) | <0.001 |
| **ATHF within 1 year before hospitalization** |                       |                           |          |
| Score, median (IQR)                          | 5 (2–8)               | 3 (1–6)                   | <0.001   |
| **Drugs collected within 100 days before admission** |                       |                           |          |
| Antidepressants, n (%)                       | 10,581 (94.2)         | 26,529 (86.4)             | <0.001   |
| Antipsychotics, n (%)                        | 3,912 (34.8)          | 6,877 (22.4)              | <0.001   |
| Anxiolytics (benzodiazepines excluded), n (%)| 1,809 (16.1)          | 4,876 (15.9)              | 0.578    |
| Benzodiazepines, n (%)                       | 5,187 (46.2)          | 9,800 (31.9)              | <0.001   |
| Lithium, n (%)                               | 1,282 (11.4)          | 1,923 (6.3)               | <0.001   |
| **Family history in first-degree relatives** |                       |                           |          |
| Family history of affective disorders         | 2,605 (23.2)          | 6,005 (19.6)              | <0.001   |
| Family history of suicide                    | 433 (3.9)             | 1,032 (3.4)               | 0.015    |

Note: Statistically significant results (p-value < 0.05) are presented using bold font.

Abbreviations: ATHF, antidepressant treatment history form; ECT, electroconvulsive therapy; IQR, interquartile range.
participants treated with ECT compared with those receiving non-ECT treatment were older age, being married, having psychotic features, prior psychiatric hospitalizations, higher ATHF score, having collected antidepressants, antipsychotics, or benzodiazepines within 100 days before admission, and having a family history of suicide. Younger age was associated with increased readmission risk within both 30 and 90 days in patients treated with ECT compared with those receiving non-ECT treatment. According to these estimates, the risk of readmission within 30 days is reduced by about 8 percentage points in patients aged 55 years and above with psychotic symptoms when treated with ECT compared with non-ECT treatment. Thus, the number needed to treat to prevent one readmission in this group is about 13 patients. The estimations indicate that the number needed to treat could be reduced to about 6 patients if continuation ECT is also provided.

### 3.4 First sensitivity analysis

In the first sensitivity model, only the first admission for each study participant that met the inclusion criteria was included. There were no statistically significant differences in 30- or 90-day readmission risk in the multivariate analysis (OR: 0.93; 95% CI: 0.85–1.02; \(p = 0.112\) and OR: 0.99; 95% CI: 0.92–1.07; \(p = 0.824\), respectively). Full characteristics and logistic regression analyses for this model are presented in Appendix A.

### 3.5 Second sensitivity analysis

Matching was conducted as a second sensitivity model. A total of 5,584 patients in the ECT group were matched to 5,584 patients in the non-ECT group. In this model, the overall rate of readmission within 30 days was 13.6% in the ECT group and 14.3% in the non-ECT group, whereas the overall rate of readmission within 90 days was 23.1% in the ECT group and 23.6% in the non-ECT group. No statistically significant differences in 30- or 90-day readmission risk were found in the multivariate analysis (OR: 0.93; 95% CI: 0.84–1.04; \(p = 0.221\) and OR: 0.97; 95% CI: 0.88–1.06; \(p = 0.444\), respectively). Full characteristics and logistic regression analyses for the matched model are presented in Appendix B.

### 3.6 Risk factors for psychiatric readmission

Full logistic regression analyses of risk factors for psychiatric readmission in the study population as a whole are presented in Appendix C.

---

4 | **DISCUSSION**

The results of this study support that ECT reduces the risk of psychiatric readmission in certain subgroups of patients with MDD. In the main analysis, ECT was associated with reduced overall risk of both 30- and 90-day readmission in a multivariate model when compared with non-ECT treatment. The association of ECT on readmission risk, however, was not as pronounced as in previous studies with positive results.13,14 Furthermore, although the results of both sensitivity analyses pointed in the same direction as the main analysis for readmission risk within 30 days, statistical significance was not reached in these analyses. This could be explained by insufficient power, as fewer study participants were included in these models, and that the association was unevenly distributed across subgroups with a modest overall effect. Moreover, there is risk of residual confounding. Therefore, there is still some uncertainty regarding to what degree ECT reduces the risk of psychiatric readmission in MDD. Having residual symptoms after treatment is a well-established risk factor for relapse and recurrence in MDD.5 The likely explanation of the superior outcomes of certain subgroups treated with ECT compared with those receiving non-ECT treatment is that the ECT-treated patients had fewer and less severe symptoms at discharge (i.e., were more effectively treated). This is in line with other studies which have shown ECT to be more effective than pharmacotherapy for the treatment of inpatients with depressive illness.17

Study participants treated with ECT for severe MDD with psychotic features were less likely to be readmitted than patients with the same diagnosis receiving non-ECT treatment in multivariate stratification and interaction analyses. By contrast, there was no statistically significant difference in readmission risk between study participants treated with ECT and those receiving non-ECT treatment in moderate-to-severe MDD without psychotic features. There is evidence supporting ECT as especially effective in preventing relapse and readmission in MDD with psychotic features.10,27,28 Depressed patients in ECT trials have previously been described to be more severely ill than those participating in pharmacotherapy trials.29 At the time of admission, the ECT group had more severe symptoms than the non-ECT group. Greater severity of illness has previously been associated with increased risk of relapse and readmission in MDD30,31 and was also found to predict increased risk of both 30- and 90-day readmission in the present study. Although we did adjust for depression severity as diagnosed with ICD-10, it is likely that within each diagnostic category, the ECT group tended to have more severe symptoms than the non-ECT group. If this was the case, the true effects of ECT on readmission risk are in fact likely to be underestimated in our models.
Table 2: Multivariate logistic regression analyses of the association between 30- and 90-day readmission risk for any psychiatric disorder and ECT stratified by different subgroups of the study population, with interaction term p-values

| Subgroup                  | 30 days OR (95% CI) | p-Value | Interaction term p-Value | 90 days OR (95% CI) | p-Value | Interaction term p-Value |
|---------------------------|---------------------|---------|--------------------------|---------------------|---------|--------------------------|
| **Demographics**          |                     |         |                          |                     |         |                          |
| Male                      | 0.83 (0.75–0.93)    | 0.001   | Reference                | 0.86 (0.79–0.94)    | 0.001   | Reference                |
| Female                    | 0.94 (0.86–1.02)    | 0.130   | 0.053                    | 0.98 (0.91–1.05)    | 0.554   | 0.007                    |
| Age group 18–24 years     | 1.68 (1.35–2.11)    | <0.001  | Reference                | 1.47 (1.20–1.81)    | <0.001  | Reference                |
| Age group 25–34 years     | 1.56 (1.32–1.84)    | <0.001  | 0.916                    | 1.44 (1.24–1.67)    | <0.001  | 0.881                    |
| Age group 35–44 years     | 1.12 (0.95–1.32)    | 0.164   | 0.014                    | 1.04 (0.90–1.20)    | 0.565   | 0.008                    |
| Age group 45–54 years     | 0.88 (0.75–1.03)    | 0.113   | <0.001                   | 0.95 (0.84–1.09)    | 0.483   | <0.001                   |
| Age group 55–64 years     | 0.64 (0.53–0.77)    | <0.001  | <0.001                   | 0.72 (0.62–0.83)    | <0.001  | <0.001                   |
| Age group 65–74 years     | 0.60 (0.50–0.72)    | <0.001  | <0.001                   | 0.70 (0.61–0.81)    | <0.001  | <0.001                   |
| Age group >75 years       | 0.88 (0.75–1.03)    | 0.113   | <0.001                   | 0.95 (0.84–1.09)    | 0.483   | <0.001                   |
| Married                   | 0.75 (0.66–0.85)    | <0.001  | <0.001                   | 0.82 (0.75–0.91)    | <0.001  | <0.001                   |
| Divorced                  | 0.86 (0.74–1.00)    | 0.051   | 0.001                    | 0.98 (0.87–1.11)    | 0.739   | 0.218                    |
| Widowed                   | 0.59 (0.46–0.76)    | <0.001  | 0.001                    | 0.79 (0.65–0.97)    | 0.023   | 0.096                    |
| Unmarried                 | 1.11 (1.00–1.23)    | 0.043   | Reference                | 1.02 (0.94–1.12)    | 0.605   | Reference                |
| Low education level       | 0.79 (0.69–0.91)    | 0.001   | Reference                | 0.88 (0.79–0.98)    | 0.023   | Reference                |
| Middle education level    | 0.98 (0.89–1.08)    | 0.626   | 0.005                    | 1.00 (0.92–1.08)    | 0.988   | 0.049                    |
| High education level      | 0.88 (0.78–1.00)    | 0.044   | 0.175                    | 0.88 (0.80–0.98)    | 0.021   | 0.886                    |
| Cohabiting                | 0.90 (0.82–0.99)    | 0.035   | Reference                | 0.92 (0.85–0.99)    | 0.030   | Reference                |
| Not cohabiting            | 0.89 (0.81–0.98)    | 0.019   | 0.705                    | 0.94 (0.87–1.02)    | 0.148   | 0.591                    |
| Employed                  | 0.96 (0.87–1.07)    | 0.489   | Reference                | 1.00 (0.92–1.09)    | 0.994   | Reference                |
| Unemployed                | 0.86 (0.79–0.93)    | <0.001  | 0.058                    | 0.89 (0.83–0.96)    | 0.002   | 0.015                    |
| **Psychiatric comorbidity**|                     |         |                          |                     |         |                          |
| No anxiety disorder       | 0.90 (0.82–0.99)    | 0.024   | Reference                | 0.96 (0.89–1.03)    | 0.269   | Reference                |
| Anxiety disorder          | 0.90 (0.82–0.99)    | 0.029   | 0.505                    | 0.90 (0.83–0.98)    | 0.017   | 0.092                    |
| No alcohol use disorder   | 0.86 (0.80–0.93)    | <0.001  | Reference                | 0.92 (0.87–0.98)    | 0.009   | Reference                |
| Alcohol use disorder      | 1.16 (0.97–1.38)    | 0.100   | 0.014                    | 1.02 (0.88–1.19)    | 0.786   | 0.721                    |
| No substance use disorder | 0.88 (0.82–0.95)    | 0.001   | Reference                | 0.93 (0.87–0.98)    | 0.012   | Reference                |
| Substance use disorder    | 0.96 (0.81–1.14)    | 0.639   | 0.439                    | 0.94 (0.81–1.09)    | 0.423   | 0.959                    |
| No personality disorder   | 0.89 (0.83–0.95)    | 0.001   | Reference                | 0.94 (0.89–1.00)    | 0.042   | Reference                |
| Personality disorder      | 1.00 (0.83–1.20)    | 0.981   | 0.354                    | 0.89 (0.76–1.06)    | 0.190   | 0.299                    |
| **Depression severity**   |                     |         |                          |                     |         |                          |
| Moderate                  | 0.94 (0.83–1.06)    | 0.314   | Reference                | 0.98 (0.88–1.09)    | 0.744   | Reference                |
| Severe without psychotic features | 0.92 (0.84–1.00) | 0.056 | 0.082 | 0.94 (0.87–1.02) | 0.116 | 0.039 |
| Severe with psychotic features | 0.80 (0.69–0.94) | 0.005 | 0.006 | 0.87 (0.77–0.99) | 0.028 | 0.002 |
| **Inpatient characteristics** |                     |         |                          |                     |         |                          |
| Voluntarily admitted      | 0.87 (0.81–0.94)    | <0.001  | Reference                | 0.90 (0.85–0.96)    | 0.001   | Reference                |
| Involuntarily admitted    | 1.05 (0.89–1.24)    | 0.556   | 0.234                    | 1.10 (0.96–1.26)    | 0.179   | 0.103                    |

(Continues)
## TABLE 2 (Continued)

| Subgroup                                           | 30 days OR (95% CI) | p-Value    | Interaction term p-Value | 90 days OR (95% CI) | p-Value    | Interaction term p-Value |
|----------------------------------------------------|---------------------|------------|--------------------------|---------------------|------------|--------------------------|
| Prior psychiatric hospitalizations                 |                     |            |                          |                     |            |                          |
| No prior hospitalization                           | 1.17 (1.00–1.37)    | 0.056      | Reference                | 1.10 (0.96–1.25)    | 0.173      | Reference                |
| 1 prior hospitalization                            | 0.87 (0.73–1.03)    | 0.103      | **<0.001**               | 0.97 (0.85–1.12)    | 0.717      | 0.098                    |
| 2–3 prior hospitalizations                         | 0.75 (0.65–0.87)    | **<0.001** | **<0.001**               | 0.91 (0.80–1.02)    | 0.099      | **<0.001**               |
| 4–6 prior hospitalizations                         | 0.81 (0.69–0.95)    | **0.011**  | **<0.001**               | 0.81 (0.70–0.92)    | **0.001**  | **<0.001**               |
| 7–10 prior hospitalizations                        | 0.70 (0.57–0.85)    | **0.001**  | **<0.001**               | 0.87 (0.74–1.03)    | 0.104      | **<0.001**               |
| >10 prior hospitalizations                         | 1.10 (0.95–1.27)    | 0.213      | 0.109                    | 0.95 (0.83–1.09)    | 0.690      | **0.006**                |
| ATHF within 1 year before hospitalization          |                     |            |                          |                     |            |                          |
| A score of 0                                        | 1.18 (1.02–1.37)    | **0.029**  | Reference                | 1.12 (0.99–1.27)    | 0.080      | Reference                |
| A score of 2–4                                     | 0.85 (0.75–0.96)    | **0.009**  | **<0.001**               | 0.97 (0.88–1.08)    | 0.577      | **0.014**                |
| A score of 5–8                                     | 0.81 (0.72–0.90)    | **<0.001** | **<0.001**               | 0.87 (0.79–0.96)    | **0.004**  | **<0.001**               |
| A score of >8                                      | 0.90 (0.77–1.05)    | 0.187      | **<0.001**               | 0.81 (0.71–0.92)    | **0.002**  | **<0.001**               |
| Drugs collected within 100 days before admission   |                     |            |                          |                     |            |                          |
| No antidepressants before                          | 1.08 (0.82–1.44)    | 0.583      | Reference                | 1.08 (0.85–1.36)    | 0.546      | Reference                |
| Antidepressants before                             | 0.89 (0.83–0.95)    | **0.001**  | **0.014**                | 0.93 (0.88–0.98)    | **0.008**  | **0.021**                |
| No antipsychotics before                           | 0.93 (0.86–1.01)    | 0.092      | Reference                | 0.99 (0.93–1.06)    | 0.801      | Reference                |
| Antipsychotics before                              | 0.84 (0.75–0.93)    | **0.001**  | **0.034**                | 0.84 (0.77–0.92)    | **<0.001** | **<0.001**               |
| No anxiolytics before                              | 0.91 (0.84–0.97)    | **0.007**  | Reference                | 0.95 (0.89–1.01)    | 0.077      | Reference                |
| Anxiolytics before                                 | 0.86 (0.73–1.01)    | 0.066      | 0.498                    | 0.86 (0.75–0.98)    | **0.024**  | 0.155                    |
| No benzodiazepines before                          | 1.03 (0.94–1.13)    | 0.532      | Reference                | 1.02 (0.95–1.10)    | 0.607      | Reference                |
| Benzodiazepines before                             | 0.76 (0.69–0.84)    | **<0.001** | **<0.001**               | 0.84 (0.77–0.91)    | **<0.001** | **<0.001**               |
| No lithium before                                  | 0.89 (0.83–0.95)    | **0.001**  | Reference                | 0.94 (0.88–0.99)    | **0.027**  | Reference                |
| Lithium before                                     | 0.92 (0.76–1.11)    | 0.382      | 0.735                    | 0.87 (0.74–1.02)    | 0.091      | 0.485                    |
| Family history in first-degree relatives           |                     |            |                          |                     |            |                          |
| No family history of affective disorders           | 0.86 (0.80–0.93)    | **<0.001** | Reference                | 0.92 (0.86–0.97)    | **0.006**  | Reference                |
| Family history of affective disorders              | 1.02 (0.89–1.17)    | 0.792      | 0.089                    | 0.98 (0.87–1.10)    | 0.744      | 0.616                    |
| No family history of suicide                       | 0.91 (0.86–0.98)    | **0.011**  | Reference                | 0.95 (0.89–1.00)    | 0.052      | Reference                |
| Family history of suicide                          | 0.56 (0.38–0.81)    | **0.002**  | **0.001**                | 0.64 (0.47–0.87)    | **0.004**  | **0.002**                |

Note: Statistically significant results (p-value < 0.05) are presented using bold font. All models are adjusted for sex, age, marital status, cohabitation status, level of education, employment status, psychiatric comorbidity (anxiety disorder, alcohol use disorder, substance use disorder, and personality disorder), depression severity, whether the admission was voluntary or involuntary, number of prior psychiatric hospitalizations, ATHF score, psychiatric prescription drugs collected within 100 days before admission (antidepressants, antipsychotics, anxiolytics, benzodiazepines, and lithium), and family history of affective disorders or suicide.

Abbreviations: ATHF, Antidepressant treatment history form; CI, confidence interval; ECT, electroconvulsive therapy; OR, odds ratio.
There was a strong correlation between a higher number of prior psychiatric hospitalizations and increased readmission risk in all analyses. To date, there is stronger evidence supporting a history of prior depressive episodes being associated with increased risk of relapse or recurrence than the specific number of prior depressive episodes or hospitalizations. However, some studies have found a higher number of prior psychiatric hospitalizations to correlate with increased readmission risk in patients with MDD. Additionally, some other studies have found a higher number of prior episodes to correlate with increased risk of recurrence. Study participants with a history of prior psychiatric hospitalizations had decreased risk of readmission in multivariate stratification and interaction analyses, especially within 30 days, when treated with ECT compared with those receiving non-ECT treatment. Patients without prior admissions did not have a significantly reduced readmission risk when treated with ECT. These results indicate that ECT is an especially suitable choice for patients with severe and recurrent depressive episodes.

Age was negatively associated with readmission risk in all analyses. In multivariate stratification and interaction analyses, older age was consistently associated with reduced risk of both 30- and 90-day readmission in study participants treated with ECT compared with the same subgroups receiving non-ECT treatment. Furthermore, younger age was associated with increased readmission risk in patients treated with ECT compared with non-ECT treatment. ECT has been found to be especially effective in younger patients. Psychotic symptoms and psychomotor retardation are more common in older individuals, and patients with such symptoms tend to respond better to ECT, which could explain the results of the present study.

To date, there is sparse evidence supporting that older patients have decreased risk of readmission after ECT and that younger individuals are at increased risk when compared with older patients treated with ECT. The increased readmission risk in younger individuals treated with ECT in the present study could perhaps be explained by residual confounding. Nevertheless, a meta-analysis of 372 randomized placebo-controlled antidepressant drug trials found the risk of suicidal ideation and suicidal behavior (preparation, attempted suicide, or completed suicide) associated with antidepressant use to be strongly age-dependent. Increasing age was associated with a protective effect. Age-dependent associations of ECT on readmission risk and of antidepressant drugs on suicidality could possibly be explained by differences in underlying disease mechanisms.

Most factors associated with readmission risk in the present study have been previously described to predict relapse or recurrence, including having a comorbid personality disorder, anxiety disorder, or higher ATHF score. To the best of our knowledge, no previous study has found having a higher education level or being voluntarily admitted to correlate with decreased risk of readmission, or having collected antipsychotics or benzodiazepines within 100 days before admission to be associated with increased readmission risk. However, some studies have found a similar association for such drugs collected after discharge. Study participants prescribed drugs other than antidepressants or lithium perhaps represent a subset of patients difficult to treat and, therefore, more likely to be readmitted. Nevertheless, when these study participants were treated with ECT, they were less likely to be readmitted than similar patients receiving non-ECT treatment. These results suggest that ECT is a valid option for such patients.

There were several other subgroups with decreased risk of readmission when treated with ECT compared with non-ECT treatment. Patients who were married, widowed, or unemployed were less likely to be readmitted after ECT. It has been suggested that family history of affective disorders or suicide should be considered when selecting appropriate candidates for ECT, and in this cohort family history of affective disorders was more common in the ECT group than in the non-ECT group. This study could neither confirm nor refute differential effects of ECT on readmission risk among patients with or without family history of affective disorders. However, family history of suicide was associated with decreased risk of readmission in study participants treated with ECT compared with those receiving non-ECT treatment. Therefore, it could be appropriate to ask about family history when considering a patient for ECT. These patients could perhaps represent a subset of patients with more severe family history of psychiatric disorders. To the best of our knowledge, no previous study has identified family history of suicide to be predictive of response, remission, or readmission in MDD. Further studies are needed to investigate potential differential effects of ECT in patients with family history of suicide, psychiatric disorders, or specific genetic factors.

This study shows considerable risk of readmission after inpatient treatment for MDD in patients treated with and without ECT. In addition to treatment with antidepressants, which most patients had been prescribed, lithium and continuation ECT have been shown to reduce the risk of relapse in MDD. There was an association between reduced readmission risk and continuation ECT after discharge in this study. A small minority of study participants had these treatments; outcomes could likely be improved by more systematic use of lithium and continuation ECT.

To date, this is one of the largest studies to have investigated whether ECT reduces the risk of psychiatric...
readmission in MDD compared with non-ECT treatment. The large sample is facilitated by the high rate of ECT use in Sweden and the existence of national registries. Patients treated at all Swedish hospitals were included. Nonetheless, there were several limitations to this study. Substantial differences have been reported in previous studies between patients treated with ECT and those receiving non-ECT treatment. Similar differences were also found in the present study, limiting the comparability between the groups. Matching was conducted to minimize these differences but made each group considerably smaller and reduced the statistical power. Potential confounders were identified through a literature search. However, some of these factors were not accessible in register data and could not be included in the analyses, such as childhood maltreatment, age of onset, and medication compliance. Even though ECT can be delivered in an outpatient setting, most patients in Sweden receive their index series in an inpatient setting. This could have increased the readmission risk among ECT-treated patients.

A few individual patients received a very high number of ECT sessions in their treatment series, suggesting unusually severe and persistent symptoms. Such patients are so unusual that statistical adjustment becomes uncertain. However, as they are so few their overall impact on the results is small. Only a minor proportion of patients received continuation ECT after their index series, and these patients are likely to differ from other patients in regard to previous response to pharmacotherapy or ECT and perceived risk of relapse as assessed by the treating psychiatrist. Further studies are required to adequately assess the effects of continuation ECT on readmission risk. Finally, the diagnoses were made in clinical practice, which means that there may be some uncertainty in the classifications. For instance, it is probable that a small subset of patients with bipolar disorder were included in this study despite the fact that patients with prior admissions for mania were excluded.

This study suggests that ECT reduces the risk of psychiatric readmission in certain subgroups of patients with MDD. ECT-treated subgroups with superior outcomes on readmission risk compared with non-ECT treatment were older, unemployed, married, or widowed patients, those treated with antipsychotics or benzodiazepines before admission, with psychotic features, prior psychiatric hospitalizations, or family history of suicide. However, in patients below 35 years of age, ECT was found to be associated with increased readmission risk. This study is limited by the risk of residual confounding, especially since patients treated by ECT tend to have more severe symptoms and are more difficult to treat.

ACKNOWLEDGMENTS
We would like to thank the patients, nurses and doctors who provided data to the Swedish National Quality Registry for ECT.

CONFLICT OF INTEREST
The authors report no conflicts of interest regarding this research.

PEER REVIEW
The peer review history for this article is available at https://pubons.com/publon/10.1111/acps.13373.

DATA AVAILABILITY STATEMENT
The data that support the findings of this study are available from the corresponding author, Axel Nordenskjöld, upon reasonable request.

ORCID
Charles H. Kellner https://orcid.org/0000-0001-9663-3571
Axel Nordenskjöld https://orcid.org/0000-0001-7454-3065

REFERENCES
1. Ferrari AJ, Somerville AJ, Baxter AJ, et al. Global variation in the prevalence and incidence of major depressive disorder: a systematic review of the epidemiological literature. Psychol Med. 2013;43(3):471-481.
2. GBD 2017 Disease and Injury Incidence and Prevalence Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: a systematic analysis for the global burden of disease study 2017. Lancet. 2018;392(10159):1789-1858.
3. Ekman M, Granström O, Omérov S, Jacob J, Landén M. The societal cost of depression: evidence from 10,000 Swedish patients in psychiatric care. J Affect Disord. 2013;150(3):790-797.
4. Greenberg PE, Fournier AA, Sisitsky T, Pike CT, Kessler RC. The economic burden of adults with major depressive disorder in the United States (2005 and 2010). J Clin Psychiatry. 2015;76(2):155-162.
5. Buckman JE, Underwood A, Clarke K, et al. Risk factors for relapse and recurrence of depression in adults and how they operate: a four-phase systematic review and meta-synthesis. Clin Psychol Rev. 2018;64:13-38.
6. Lin CH, Chen MC, Chou LS, Lin CH, Chen CC, Lane HY. Time to rehospitalization in patients with major depression vs. those with schizophrenia or bipolar I disorder in a public psychiatric hospital. Psychiatry Res. 2010;180(2-3):74-79.
7. Sim K, Lau WK, Sim J, Sum MY, Baldessarini RJ. Prevention of relapse and recurrence in adults with major depressive disorder: systematic review and meta-analyses of controlled trials. Int J Neuropsychopharmacol. 2016;19(2):pyv076.
8. Tiihonen J, Tanskanen A, Hoti F, et al. Pharmacological treatments and risk of readmission to hospital for unipolar depression in Finland: a nationwide cohort study. Lancet Psychiatry. 2017;4(7):547-553.
9. Baethge C, Gruschka P, Smolka MN, et al. Effectiveness and outcome predictors of long-term lithium prophylaxis in unipolar major depressive disorder. J Psychiatry Neurosci. 2003;28(5):355-361.
10. Brus O, Cao Y, Hammar Å, et al. Lithium for suicide and readmission prevention after electroconvulsive therapy for unipolar depression: population-based register study. Bjspsych. Open. 2019;5(3):e46.
11. American Psychiatric Association. Practice Guideline for the Treatment of Patients with Major Depressive Disorder, 3rd ed. American Psychiatric Association; 2010.
12. American Psychiatric Association. Clinical Practice Guideline for the Treatment of Depression Across Three Age Cohorts. American Psychiatric Association; 2019.
13. Slade EP, Jahn DR, Regenold WT, Case BG. Association of electroconvulsive therapy with psychiatric readmissions in US hospitals. JAMA Psychiatry. 2017;74(8):798-804.
14. Tor PC, Bin Abdin E. Mirror readmission study of of electroconvulsive therapy with a 1-year mood disorder readmissions in a tertiary mood disorder unit. J ECT. 2020;36(2):111-114.
15. Lin CY, Chen IM, Tsai HH, Wu CS, Liao SC. Effectiveness of electroconvulsive therapy on treatment-resistant depressive disorder: a population-based mirror-image study. J Psychiatr Res. 2020;121:101-107.
16. Stoudemire A, Hill CD, Dalton ST, Marquardt MG. Rehospitalization rates in older depressed adults after antidepessant and electroconvulsive therapy treatment. J Am Geriatr Soc. 1994;42(12):1282-1285.
17. UK Ect Review Group. Efficacy and safety of electroconvulsive therapy in depressive disorders: a systematic review and meta-analysis. Lancet. 2003;361(9360):799-808.
18. Socialstyrelsen. Bortfall och kvalitet om Patientregistret [Internet]. Stockholm: Socialstyrelsen; 2019 [updated 2020-03-06; cited 2021-01-19]. https://www.socialstyrelsen.se/statistik-och-data/register/alla-register/patientregistret/bortfall-och-kvalitet/
19. Ludvigsson JF, Andersson E, Ekborn A, et al. External review and validation of the Swedish national inpatient register. BMC Public Health. 2011;11:450.
20. Nordanskog P, Hultén M, Landén M, Lundberg J, von Knorring L, Nordenskjöld A. Electroconvulsive therapy in Sweden 2013: data from the national quality register for ECT. J ECT. 2015;31(4):263-267.
21. Elvin T, Nordenskjöld A. Swedish National Quality Registry for ECT – annual report 2019. Region Örebro län; 2020.
22. Ludvigsson JF, Svedberg P, Olén O, Bruze G, Neovius M. The longitudinal integrated database for health insurance and labour market studies (LISA) and its use in medical research. Eur J Epidemiol. 2019;34(4):423-437.
23. Wallerstedt SM, Wettermark B, Hoffmann M. The first decade in a tertiary mood disorder unit. J ECT. 2020;36(2):111-114.
24. Sackeim HA, Aaronson ST, Bunker MT, et al. The assessment of resistance to antidepressant treatment: rationale for the Antidepressant Treatment History Form: Short Form (ATHF-SF). J Psychiatr Res. 2019;113:125-136.
25. Statistics Sweden. Population and Welfare Statistics 2017:2 - Multi-Generation Register 2016 – A description of contents and quality. Statistics Sweden; 2017.
26. Socialstyrelsen. Bortfall och kvalitet på dödsorsaksregistret [Internet]. Stockholm: Socialstyrelsen; 2019 [updated 2019-10-18; cited 2021-01-19]. https://www.socialstyrelsen.se/statistik-och-data/register/alla-register/dodsorsaksregistret/
27. Wagennakers MJ, Oudega ML, Vansteelandt K, et al. Psychotic late-life depression less likely to relapse after electroconvulsive therapy. J Affect Disord. 2020;276:984-990.
28. Birkenhäuser TK, van den Broek WW, Mulder PG, de Lely A. One-year outcome of psychotic depression after successful electroconvulsive therapy. J ECT. 2005;21(4):221-226.
29. Kellner CH, Kaicher DC, Banerjee H, et al. Depression severity in electroconvulsive therapy (ECT) versus pharmacotherapy trials. J ECT. 2015;31(1):31-33.
30. O’Leary D, Costello F, Gormley N, Webb M. Remission onset and relapse in depression. An 18-month prospective study of course for 100 first admission patients. J Affect Disord. 2000;57(1-3):159-171. 10.1016/S0165-0327(99)00086-5
31. Rucci P, Frank E, Calugi S, et al. Incidence and predictors of relapse during continuation treatment of major depression with SSRI, interpersonal psychotherapy, or their combination. Depress Anxiety. 2011;28(11):955-962.
32. Baeza FLC, da Rocha NS, Fleck MPA. Readmission in psychiatry inpatients within a year of discharge: the role of symptoms at discharge and post-discharge care in a Brazilian sample. Gen Hosp Psychiatry. 2018;51:63-70.
33. Lin CH, Chen YS, Lin CH, Lin KS. Factors affecting time to rehospitalization for patients with major depressive disorder. Psychiatry Clin Neurosci. 2007;61(3):249-254.
34. Hardeveld F, Spijker J, De Graaf R, Nolen WA, Beekman AT. Prevalence and predictors of recurrence of major depressive disorder in the adult population. Acta Psychiatr Scand. 2010;122(3):184-191.
35. Mueller TI, Leon AC, Keller MB, et al. Recurrence after recovery from major depressive disorder during 15 years of observational follow-up. Am J Psychiatry. 1999;156(7):1000-1006.
36. ten Doesschate MC, Bockting CL, Koeter MW, Schene AH. Prediction of recurrence in recurrent depression: a 5.5-year prospective study. J Clin Psychiatry. 2010;71(8):984-991.
37. van Diermen L, van den Amelee S, Kamperman AM, et al. Prediction of electroconvulsive therapy response and remission in major depression: meta-analysis. Br J Psychiatry. 2018;212(2):71-80.
38. Heinjnen W, Kamperman AM, Tjongerlopo LD, Hoogendijk WJG, van den Broek WW, Birkenhäuser TK. Influence of age on ECT efficacy in depression and the mediating role of psychomotor retardation and psychotic features. J Psychiatr Res. 2019;109:41-47.
39. van Diermen L, Schrijvers D, Cools O, Birkenhäuser TK, Fransen E, Sabbe BGC. Distinguishing Subgroups Based on Psychomotor Functioning among Patients with Major Depressive Disorder. Neuropsychobiology. 2017;76(4):199-208.
40. Rosen BH, Kung S, Lapid MI. Effect of age on psychiatric rehospitalization rates after electroconvulsive therapy for patients with depression. J ECT. 2016;32(2):93-98.
41. Stone M, Laughren T, Jones ML, et al. Risk of suicidality in clinical trials of antidepressants in adults: analysis of proprietary data submitted to US Food and Drug Administration. BMJ. 2009;339:b2880.
42. Grilo CM, Stout RL, Markowitz JC, et al. Personality disorders predict relapse after remission from an episode of
major depressive disorder: a 6-year prospective study. J Clin Psychiatry. 2010;71(12):1629-1635.
43. Nordenskjöld A, von Knorring L, Engström I. Predictors of time to relapse/recurrence after electroconvulsive therapy in patients with major depressive disorder: a population-based cohort study. Depress Res Treat. 2011;2011:470985.
44. Kellner CH, Popeo DM, Pasculli RM, Briggs MC, Gamss S. Appropriateness for electroconvulsive therapy (ECT) can be assessed on a three-item scale. Med Hypotheses. 2012;79(2):204-206.
45. Lambrichts S, Detraux J, Vansteelandt K, et al. Does lithium prevent relapse following successful electroconvulsive therapy for major depression? A systematic review and meta-analysis. Acta Psychiatr Scand. 2021;143(4):294-306.
46. Kellner CH, Husain MM, Knapp RG, et al. A novel strategy for continuation ECT in geriatric depression: phase 2 of the PRIDE study. Am J Psychiatry. 2016;173(11):1110-1118.
47. Nordenskjöld A, von Knorring L, Ljung T, Carlborg A, Brus O, Engström I. Continuation electroconvulsive therapy with pharmacotherapy versus pharmacotherapy alone for prevention of relapse of depression: a randomized controlled trial. J ECT. 2013;29(2):86-92.
48. Kaster TS, Blumberger DM, Gomes T, et al. Patient-level characteristics and inequitable access to inpatient electroconvulsive therapy for depression: a population-based cross-sectional study: caractéristiques au niveau du patient et accès inéquitable à la thérapie electroconvulsive pour patients hospitalisés. Can J Psychiatry. 2020;66(2):147-158.

How to cite this article: Stenmark L, Kellner CH, Landén M, Larsson I, Msghina M, Nordenskjöld A. Electroconvulsive therapy and psychiatric readmission in major depressive disorder – A population-based register study. Acta Psychiatr Scand. 2021;144:599–625. https://doi.org/10.1111/acps.13373
### APPENDIX A  FIRST SENSITIVITY ANALYSIS

| Characteristic                                                                 | ECT group n = 6,257 | Non-ECT group n = 21,594 | p-Value |
|--------------------------------------------------------------------------------|---------------------|--------------------------|---------|
| Demographics                                                                    |                     |                          |         |
| Women, n (%)                                                                   | 3,609 (57.7)        | 11,902 (55.1)            | <0.001  |
| Age in years, median (IQR)                                                     | 58.0 (41.0–71.0)    | 43.0 (28.0–59.0)         | <0.001  |
| Married, n (%)                                                                 | 2,520 (40.3)        | 5,619 (26.0)             | <0.001  |
| Divorced, n (%)                                                                | 1,120 (17.9)        | 3,809 (17.6)             |         |
| Widowed, n (%)                                                                 | 552 (8.8)           | 1,147 (5.3)              |         |
| Unmarried, n (%)                                                               | 2,054 (32.8)        | 10,914 (50.5)            |         |
| Unknown marital status, n (%)                                                  | 11 (0.2)            | 105 (0.5)                |         |
| Cohabiting, n (%)                                                              | 3,437 (54.9)        | 11,003 (51.0)            | <0.001  |
| Not cohabiting, n (%)                                                          | 2,809 (44.9)        | 10,486 (48.6)            |         |
| Unknown cohabitation status, n (%)                                             | 11 (0.2)            | 105 (0.5)                |         |
| Low education level, n (%)                                                      | 1,510 (24.1)        | 5,716 (26.5)             | <0.001  |
| Middle education level, n (%)                                                   | 2,794 (44.7)        | 9,932 (46.0)             |         |
| High education level, n (%)                                                     | 1,900 (30.4)        | 5,548 (25.7)             |         |
| Unknown education level, n (%)                                                  | 53 (0.8)            | 398 (1.8)                |         |
| Employed, n (%)                                                                | 2,672 (42.7)        | 9,956 (46.1)             | <0.001  |
| Unemployed, n (%)                                                              | 3,574 (57.1)        | 11,553 (53.4)            |         |
| Unknown employment status, n (%)                                               | 11 (0.2)            | 105 (0.5)                |         |
| Depression severity                                                            |                     |                          |         |
| Moderate, n (%)                                                                | 1,201 (19.3)        | 10,945 (50.7)            | <0.001  |
| Severe without psychotic features, n (%)                                       | 3,375 (53.9)        | 7,842 (36.3)             |         |
| Severe with psychotic features, n (%)                                          | 1,672 (26.7)        | 2,807 (13.0)             |         |
| Inpatient characteristics                                                       |                     |                          |         |
| Involuntarily admitted, n (%)                                                  | 1,088 (17.4)        | 2,921 (13.5)             | <0.001  |
| Psychiatric comorbidity                                                        |                     |                          |         |
| Anxiety disorder, n (%)                                                        | 1,908 (30.5)        | 5,789 (26.8)             | <0.001  |
| Alcohol use disorder, n (%)                                                    | 459 (7.3)           | 2,441 (11.3)             | <0.001  |
| Substance use disorder, n (%)                                                  | 465 (7.4)           | 2,048 (9.5)              | <0.001  |
| Personality disorder, n (%)                                                    | 351 (5.6)           | 1,099 (5.1)              | 0.103   |
| Prior psychiatric hospitalizations                                              |                     |                          |         |
| Previously been hospitalized, n (%)                                            | 4,019 (64.2)        | 10,564 (48.9)            | <0.001  |
| Number of prior psychiatric hospitalizations, median (IQR)                     | 1 (0–3)             | 0 (0–2)                  | <0.001  |
| ATHF within 1 year before hospitalization                                      |                     |                          |         |
| Score, median (IQR)                                                           | 4 (1–6)             | 2 (0–5)                  | <0.001  |
| Drugs collected within 100 days before admission                               |                     |                          |         |
| Antidepressants, n (%)                                                         | 5,704 (91.2)        | 17,757 (82.2)            | <0.001  |
| Antipsychotics, n (%)                                                          | 1,563 (25.0)        | 3,167 (14.7)             | <0.001  |
| Anxiolytics (benzodiazepines excluded), n (%)                                  | 1,127 (18.0)        | 3,445 (16.0)             | <0.001  |
| Benzodiazepines, n (%)                                                         | 2,779 (44.4)        | 6,027 (27.9)             | <0.001  |
| Lithium, n (%)                                                                | 464 (7.4)           | 788 (3.6)                | <0.001  |
| Family history in first-degree relatives                                       |                     |                          |         |
| Family history of affective disorders                                          | 1,427 (22.8)        | 4,292 (19.9)             | <0.001  |
| Family history of suicide                                                      | 232 (3.7)           | 706 (3.3)                | 0.091   |

Note: Statistically significant results (p-value < 0.05) are presented using bold font.

Abbreviations: ATHF, Antidepressant Treatment History Form; ECT, electroconvulsive therapy; IQR, interquartile range; OR, odds ratio.
Multivariate logistic regression analyses of the association between 30- and 90-day readmission risk for any psychiatric disorder and ECT stratified by different subgroups of the study population including only the first admission for each participant, with interaction term p-values

| Subgroup | 30 days OR (95% CI) | p-Value | Interaction term p-value | 90 days OR (95% CI) | p-value | Interaction term p-value |
|----------|---------------------|---------|--------------------------|---------------------|---------|--------------------------|
| **Demographics** | | | | | | |
| Male | 0.91 (0.79–1.05) | 0.212 | Reference | 0.96 (0.86–1.08) | 0.521 | Reference |
| Female | 0.93 (0.83–1.05) | 0.248 | 0.828 | 1.01 (0.91–1.11) | 0.876 | 0.646 |
| Age group 18–24 years | 1.69 (1.27–2.25) | <0.001 | Reference | 1.54 (1.19–1.99) | 0.001 | Reference |
| Age group 25–34 years | 1.55 (1.25–1.93) | <0.001 | 0.776 | 1.41 (1.16–1.71) | <0.001 | 0.619 |
| Age group 35–44 years | 1.34 (1.07–1.68) | 0.011 | 0.117 | 1.30 (1.07–1.58) | 0.008 | 0.145 |
| Age group 45–54 years | 1.13 (0.91–1.39) | 0.269 | 0.009 | 1.11 (0.93–1.33) | 0.253 | 0.006 |
| Age group 55–64 years | 0.70 (0.54–0.89) | 0.004 | <0.001 | 0.81 (0.67–0.99) | 0.036 | <0.001 |
| Age group 65–74 years | 0.51 (0.39–0.66) | <0.001 | <0.001 | 0.68 (0.56–0.84) | <0.001 | <0.001 |
| Age group >75 years | 0.41 (0.31–0.54) | <0.001 | <0.001 | 1.01 (0.91–1.11) | 0.008 | 0.001 |
| Married | 0.87 (0.74–1.02) | 0.094 | 0.005 | 0.92 (0.81–1.05) | 0.233 | 0.015 |
| Divorced | 0.99 (0.80–1.21) | 0.891 | 0.098 | 1.20 (1.01–1.42) | 0.038 | 0.747 |
| Widowed | 0.34 (0.22–0.53) | <0.001 | <0.001 | 0.62 (0.46–0.83) | 0.002 | <0.001 |
| Unmarried | 1.09 (0.95–1.26) | 0.218 | Reference | 1.05 (0.94–1.19) | 0.392 | Reference |
| Low education level | 0.95 (0.80–1.14) | 0.606 | Reference | 1.01 (0.91–1.20) | 0.689 | Reference |
| Middle education level | 0.97 (0.84–1.10) | 0.603 | 0.963 | 1.01 (0.90–1.13) | 0.867 | 0.725 |
| High education level | 0.85 (0.71–1.01) | 0.065 | 0.304 | 0.93 (0.81–1.07) | 0.303 | 0.282 |
| Cohabiting | 1.03 (0.91–1.17) | 0.605 | Reference | 1.05 (0.94–1.16) | 0.399 | Reference |
| Not cohabiting | 0.82 (0.71–0.94) | 0.004 | 0.004 | 0.94 (0.84–1.04) | 0.228 | 0.187 |
| Employed | 1.12 (0.98–1.28) | 0.109 | Reference | 1.13 (1.01–1.27) | 0.034 | Reference |
| Unemployed | 0.80 (0.71–0.90) | <0.001 | <0.001 | 0.90 (0.81–0.99) | 0.035 | 0.001 |
| **Psychiatric comorbidity** | | | | | | |
| No anxiety disorder | 0.92 (0.82–1.04) | 0.182 | Reference | 1.01 (0.92–1.11) | 0.905 | Reference |
| Anxiety disorder | 0.94 (0.81–1.09) | 0.385 | 0.559 | 0.97 (0.86–1.10) | 0.658 | 0.215 |
| No alcohol use disorder | 0.89 (0.80–0.98) | 0.017 | Reference | 0.97 (0.90–1.05) | 0.493 | Reference |
| Alcohol use disorder | 1.27 (0.98–1.64) | 0.072 | 0.057 | 1.16 (0.92–1.46) | 0.202 | 0.633 |
| No substance use disorder | 0.91 (0.83–1.01) | 0.069 | Reference | 0.98 (0.90–1.06) | 0.569 | Reference |
| Substance use disorder | 1.04 (0.80–1.36) | 0.755 | 0.350 | 1.10 (0.87–1.38) | 0.429 | 0.474 |
| No personality disorder | 0.89 (0.81–0.98) | 0.021 | Reference | 0.99 (0.91–1.07) | 0.736 | Reference |
| Personality disorder | 1.24 (0.93–1.65) | 0.151 | 0.036 | 1.03 (0.79–1.34) | 0.844 | 0.922 |
| **Depression severity** | | | | | | |
| Moderate | 1.05 (0.88–1.25) | 0.615 | Reference | 1.10 (0.95–1.28) | 0.198 | Reference |
| Severe without psychotic features | 1.01 (0.89–1.14) | 0.944 | 0.111 | 1.04 (0.94–1.16) | 0.445 | 0.059 |
| Severe with psychotic features | 0.71 (0.58–0.87) | 0.001 | <0.001 | 0.84 (0.71–0.99) | 0.033 | <0.001 |
| **Inpatient characteristics** | | | | | | |
| Voluntarily admitted | 0.89 (0.81–0.99) | 0.031 | Reference | 0.97 (0.89–1.05) | 0.424 | Reference |
| Involuntarily admitted | 1.09 (0.88–1.36) | 0.433 | 0.190 | 1.12 (0.93–1.34) | 0.220 | 0.287 |
| **Prior psychiatric hospitalizations** | | | | | | |
| No prior hospitalization | 1.17 (1.00–1.37) | 0.056 | Reference | 1.10 (0.96–1.25) | 0.173 | Reference |
| 1 prior hospitalization | 0.78 (0.62–0.98) | 0.035 | 0.004 | 0.92 (0.76–1.10) | 0.340 | 0.092 |
| 2–3 prior hospitalizations | 0.77 (0.62–0.95) | 0.014 | <0.001 | 0.93 (0.79–1.10) | 0.388 | 0.007 |
| 4–6 prior hospitalizations | 0.86 (0.67–1.12) | 0.266 | 0.005 | 0.87 (0.70–1.07) | 0.189 | 0.007 |
| 7–10 prior hospitalizations | 0.70 (0.49–1.01) | 0.056 | 0.001 | 1.11 (0.83–1.49) | 0.466 | 0.364 |
| >10 prior hospitalizations | 1.13 (0.86–1.48) | 0.375 | 0.348 | 1.00 (0.79–1.28) | 0.980 | 0.098 |
### Table A2 (Continued)

| Subgroup | 30 days OR (95% CI) | p-Value | Interaction term p-value | 90 days OR (95% CI) | p-value | Interaction term p-value |
|----------|---------------------|---------|--------------------------|---------------------|---------|--------------------------|
| ATHF within 1 year before hospitalization | | | | | | |
| A score of 0 | 1.16 (0.97–1.38) | 0.098 | Reference | 1.15 (1.00–1.33) | 0.059 | Reference |
| A score of 2–4 | 0.86 (0.73–1.01) | 0.064 | **0.001** | 1.00 (0.87–1.14) | 0.962 | 0.068 |
| A score of 5–8 | 0.83 (0.70–0.99) | **0.037** | **0.001** | 0.91 (0.79–1.05) | 0.210 | **0.005** |
| A score of >8 | 0.93 (0.72–1.20) | 0.558 | **0.026** | 0.88 (0.71–1.09) | 0.236 | **0.005** |

**Drugs collected within 100 days before admission**

| | | | | | | |
|---|---|---|---|---|---|
| No antidepressants before | 1.04 (0.76–1.43) | 0.795 | Reference | 1.11 (0.85–1.43) | 0.451 | Reference |
| Antidepressants before | 0.92 (0.83–1.01) | 0.078 | 0.105 | 0.98 (0.91–1.06) | 0.688 | 0.152 |
| No antipsychotics before | 0.99 (0.89–1.10) | 0.846 | Reference | 1.05 (0.96–1.15) | 0.271 | Reference |
| Antipsychotics before | 0.80 (0.67–0.95) | **0.011** | **0.004** | 0.86 (0.75–1.00) | 0.052 | **0.001** |
| No anxiolytics before | 0.93 (0.84–1.03) | 0.172 | Reference | 1.01 (0.93–1.10) | 0.751 | Reference |
| Anxiolytics before | 0.93 (0.75–1.16) | 0.524 | 0.520 | 0.92 (0.77–1.10) | 0.339 | 0.103 |
| No benzodiazepines before | 1.07 (0.95–1.21) | 0.259 | Reference | 1.08 (0.98–1.19) | 0.119 | Reference |
| Benzodiazepines before | 0.77 (0.67–0.89) | **<0.001** | **<0.001** | 0.88 (0.79–0.99) | **0.030** | **0.001** |
| No lithium before | 0.94 (0.85–1.03) | 0.170 | Reference | 1.00 (0.92–1.08) | 0.942 | Reference |
| Lithium before | 0.83 (0.60–1.15) | 0.258 | 0.554 | 0.91 (0.69–1.19) | 0.477 | 0.569 |

**Family history in first-degree relatives**

| | | | | | | |
|---|---|---|---|---|---|
| No family history of affective disorders | 0.94 (0.84–1.04) | 0.207 | Reference | 0.99 (0.91–1.08) | 0.883 | Reference |
| Family history of affective disorders | 0.91 (0.75–1.10) | 0.322 | 0.367 | 0.99 (0.84–1.16) | 0.896 | 0.411 |
| No family history of suicide | 0.95 (0.86–1.04) | 0.238 | Reference | 1.01 (0.93–1.09) | 0.824 | Reference |
| Family history of suicide | 0.56 (0.34–0.94) | **0.027** | 0.063 | 0.60 (0.39–0.92) | **0.019** | **0.006** |

**Note:** Statistically significant results (p-value < 0.05) are presented using bold font. All models are adjusted for gender, age, marital status, cohabitation status, level of education, employment status, psychiatric comorbidity (anxiety disorder, alcohol use disorder, substance use disorder, and personality disorder), depression severity, whether the admission was voluntary or involuntary, number of prior psychiatric hospitalizations, ATHF score, psychiatric prescription drugs collected within 100 days before admission (antidepressants, antipsychotics, anxiolytics, benzodiazepines, and lithium), and family history of affective disorders or suicide.

**Abbreviations:** ATHF, Antidepressant Treatment History Form; CI, confidence interval; ECT, electroconvulsive therapy; OR, odds ratio.
# Appendix B  Second Sensitivity Analysis

## Table B1  Demographic and Clinical Characteristics of the Matched Study Population Including Only the First Admission for Each Participant \( (n = 11,168) \)

| Characteristic                              | ECT group \( n = 5,584 \) | Non-ECT group \( n = 5,584 \) | \( p \)-Value |
|---------------------------------------------|-----------------------------|-------------------------------|--------------|
| **Demographics**                            |                             |                               |              |
| Women, \( n \) (%)                          | 3,197 (57.3)                | 3,217 (57.6)                 | 0.702        |
| Age in years, median (IQR)                  | 55.0 (39.0–69.0)            | 54.0 (40.3–68.0)             | 0.310        |
| Married, \( n \) (%)                        | 2,109 (37.8)                | 2,153 (38.6)                 | 0.459        |
| Divorced, \( n \) (%)                       | 1,040 (18.6)                | 973 (17.4)                   |              |
| Widowed, \( n \) (%)                        | 468 (8.4)                   | 489 (8.8)                    |              |
| Unmarried, \( n \) (%)                      | 1,956 (35.0)                | 1,961 (35.1)                 |              |
| Unknown marital status, \( n \) (%)         | 11 (0.2)                    | 8 (0.1)                      |              |
| Cohabiting, \( n \) (%)                     | 3,002 (53.8)                | 3,016 (54.0)                 | 0.767        |
| Not cohabiting, \( n \) (%)                 | 2,571 (46.0)                | 2,560 (45.8)                 |              |
| **Depression Severity**                     |                             |                               |              |
| Moderate, \( n \) (%)                       | 1,159 (20.8)                | 1,159 (20.8)                 | 1.000        |
| Severe without psychotic features, \( n \) (%) | 2,992 (53.6)                | 2,992 (53.6)                 |              |
| Severe with psychotic features, \( n \) (%) | 1,433 (25.7)                | 1,433 (25.7)                 |              |
| **Inpatient Characteristics**               |                             |                               |              |
| Involuntarily admitted, \( n \) (%)         | 948 (17.0)                  | 939 (16.8)                   | 0.820        |
| Anxiety disorder, \( n \) (%)               | 1,742 (31.2)                | 1,729 (31.0)                 | 0.790        |
| Alcohol use disorder, \( n \) (%)           | 455 (8.1)                   | 447 (8.0)                    | 0.781        |
| Substance use disorder, \( n \) (%)         | 466 (8.3)                   | 462 (8.3)                    | 0.891        |
| Personality disorder, \( n \) (%)           | 340 (6.1)                   | 342 (6.1)                    | 0.937        |
| **Psychiatric Comorbidity**                 |                             |                               |              |
| Previously been hospitalized, \( n \) (%)   | 3,456 (61.9)                | 3,456 (61.9)                 | 1.000        |
| Number of prior psychiatric hospitalizations, median (IQR) | 1 (0–3) | 1 (0–3) | 0.992 |
| **ATHF within 1 year before hospitalization** |                             |                               |              |
| Score, median (IQR)                         | 4 (1–6)                     | 4 (1–6)                      | 0.227        |
| **Drugs Collect within 100 Days before Admission** |                     |                               |              |
| Antidepressants, \( n \) (%)                | 5,150 (92.2)                | 5,150 (92.2)                 | 1.000        |
| Antipsychotics, \( n \) (%)                 | 1,305 (23.4)                | 1,283 (23.0)                 | 0.622        |
| Anxiolytics (benzodiazepines excluded), \( n \) (%) | 997 (17.9) | 951 (17.0) | 0.251 |
| Benzodiazepines, \( n \) (%)                | 2,389 (42.8)                | 2,364 (42.3)                 | 0.632        |
| Lithium, \( n \) (%)                        | 377 (6.8)                   | 373 (6.7)                    | 0.880        |
| **Family History in First-Degree Relatives** |                             |                               |              |
| Family history of affective disorders        | 1,233 (22.1)                | 1,179 (21.1)                 | 0.214        |
| Family history of suicide                    | 212 (3.8)                   | 195 (3.5)                    | 0.391        |

Abbreviations: ATHF, Antidepressant Treatment History Form; ECT, electroconvulsive therapy; IQR, interquartile range.
| Subgroup | 30 days OR (95% CI) | p-Value | Interaction term p-Value | 90 days OR (95% CI) | p-Value | Interaction term p-value |
|-----------|---------------------|---------|-------------------------|---------------------|---------|------------------------|
| Demographics | | | | | | |
| Male | 0.90 (0.76–1.06) | 0.212 | Reference | 0.91 (0.79–1.05) | 0.204 | Reference |
| Female | 0.96 (0.83–1.11) | 0.558 | 0.602 | 1.00 (0.89–1.13) | 0.994 | 0.357 |
| Age group 18–24 years | 1.71 (1.15–2.55) | **0.009** | Reference | 1.14 (0.81–1.60) | 0.457 | Reference |
| Age group 25–34 years | 1.65 (1.22–2.22) | **0.001** | 0.551 | 1.31 (1.02–1.69) | **0.036** | 0.741 |
| Age group 35–44 years | 1.16 (0.88–1.53) | 0.297 | 0.060 | 1.22 (0.96–1.55) | 0.108 | 0.989 |
| Age group 45–54 years | 1.31 (1.02–1.70) | **0.038** | 0.200 | 1.21 (0.97–1.49) | 0.086 | 0.934 |
| Age group 55–64 years | 0.65 (0.49–0.86) | **0.003** | <0.001 | 0.77 (0.61–0.96) | **0.023** | **0.022** |
| Age group 65–74 years | 0.58 (0.42–0.79) | **0.001** | <0.001 | 0.73 (0.57–0.92) | **0.009** | **0.018** |
| Age group >75 years | 0.39 (0.28–0.54) | <0.001 | <0.001 | 0.66 (0.52–0.84) | **0.001** | **0.004** |
| Married | 0.86 (0.71–1.03) | 0.107 | 0.052 | 0.91 (0.78–1.06) | 0.231 | 0.407 |
| Divorced | 1.02 (0.79–1.32) | 0.891 | 0.602 | 1.22 (0.99–1.51) | 0.062 | 0.129 |
| Widowed | 0.32 (0.20–0.52) | <0.001 | <0.001 | 0.55 (0.39–0.77) | **0.001** | **0.003** |
| Unmarried | 1.12 (0.94–1.33) | 0.219 | Reference | 0.99 (0.86–1.15) | 0.938 | Reference |
| Low education level | 0.98 (0.79–1.22) | 0.870 | Reference | 0.99 (0.82–1.19) | 0.909 | Reference |
| Middle education level | 0.97 (0.83–1.14) | 0.739 | 0.948 | 1.00 (0.87–1.14) | 0.958 | 0.906 |
| High education level | 0.81 (0.66–1.00) | **0.048** | 0.226 | 0.89 (0.75–1.05) | 0.168 | 0.505 |
| Cohabitating | 1.00 (0.87–1.17) | 0.957 | Reference | 1.04 (0.92–1.18) | 0.545 | Reference |
| Not cohabiting | 0.86 (0.73–1.01) | 0.061 | 0.190 | 0.89 (0.78–1.02) | 0.082 | 0.113 |
| Employed | 1.13 (0.96–1.33) | 0.152 | Reference | 1.11 (0.97–1.27) | 0.142 | Reference |
| Unemployed | 0.81 (0.70–0.94) | **0.006** | **0.004** | 0.87 (0.77–0.99) | **0.028** | **0.012** |
| Psychiatric comorbidity | | | | | | |
| No anxiety disorder | 0.93 (0.81–1.07) | 0.309 | Reference | 0.98 (0.87–1.10) | 0.705 | Reference |
| Anxiety disorder | 0.93 (0.78–1.11) | 0.433 | 0.905 | 0.94 (0.81–1.09) | 0.420 | 0.775 |
| No alcohol use disorder | 0.91 (0.81–1.02) | 0.098 | Reference | 0.95 (0.86–1.04) | 0.253 | Reference |
| Alcohol use disorder | 1.14 (0.82–1.58) | 0.446 | 0.131 | 1.11 (0.83–1.49) | 0.475 | 0.172 |
| No substance use disorder | 0.93 (0.83–1.05) | 0.235 | Reference | 0.97 (0.88–1.06) | 0.477 | Reference |
| Substance use disorder | 0.93 (0.67–1.30) | 0.677 | 0.847 | 0.91 (0.68–1.22) | 0.535 | 0.948 |
| No personality disorder | 0.91 (0.81–1.02) | 0.097 | Reference | 0.98 (0.89–1.07) | 0.610 | Reference |
| Personality disorder | 1.16 (0.81–1.65) | 0.416 | 0.120 | 0.87 (0.63–1.22) | 0.422 | 0.471 |
| Depression severity | | | | | | |
| Moderate | 1.17 (0.92–1.50) | 0.199 | Reference | 1.18 (0.97–1.44) | 0.101 | Reference |
| Severe without psychotic features | 0.98 (0.84–1.13) | 0.747 | 0.257 | 0.96 (0.85–1.08) | 0.455 | 0.087 |
| Severe with psychotic features | 0.69 (0.55–0.87) | **0.001** | **0.004** | 0.83 (0.69–1.01) | 0.056 | **0.018** |
| Inpatient characteristics | | | | | | |
| Voluntarily admitted | 0.92 (0.81–1.03) | 0.151 | Reference | 0.96 (0.87–1.06) | 0.394 | Reference |
| Involuntarily admitted | 0.99 (0.76–1.29) | 0.928 | 0.497 | 0.99 (0.79–1.23) | 0.923 | 0.711 |
| Prior psychiatric hospitalizations | | | | | | |
| No prior hospitalization | 1.20 (0.98–1.46) | 0.080 | Reference | 1.03 (0.88–1.22) | 0.687 | Reference |
| 1 prior hospitalization | 0.72 (0.55–0.95) | **0.018** | **0.005** | 0.92 (0.74–1.15) | 0.481 | 0.518 |
| 2–3 prior hospitalizations | 0.90 (0.70–1.15) | 0.389 | 0.070 | 1.00 (0.82–1.22) | 0.985 | 0.811 |
| 4–6 prior hospitalizations | 0.79 (0.58–1.07) | 0.123 | 0.029 | 0.82 (0.64–1.06) | 0.138 | 0.158 |
| 7–10 prior hospitalizations | 0.69 (0.44–1.09) | 0.109 | 0.032 | 0.94 (0.65–1.37) | 0.755 | 0.650 |
| >10 prior hospitalizations | 1.10 (0.81–1.50) | 0.536 | 0.584 | 0.99 (0.76–1.31) | 0.962 | 0.683 |

(Continues)
| Subgroup | 30 days OR (95% CI) | p-Value | Interaction term p-Value | 90 days OR (95% CI) | p-Value | Interaction term p-Value |
|----------|----------------------|---------|--------------------------|---------------------|---------|--------------------------|
| ATHF within 1 year before hospitalization | | | | | | |
| A score of 0 | 1.15 (0.92–1.43) | 0.232 | Reference | 1.11 (0.92–1.34) | 0.271 | Reference |
| A score of 2–4 | 0.84 (0.69–1.03) | 0.087 | **0.042** | 0.95 (0.81–1.11) | 0.527 | 0.206 |
| A score of 5–8 | 0.97 (0.79–1.18) | 0.739 | 0.206 | 1.00 (0.85–1.18) | 0.996 | 0.407 |
| A score of >8 | 0.81 (0.60–1.09) | 0.171 | 0.051 | 0.74 (0.57–0.95) | **0.019** | **0.006** |

Drugs collected within 100 days before admission

| | | | | | | |
| No antidepressants before | 1.04 (0.68–1.59) | 0.876 | Reference | 1.01 (0.71–1.44) | 0.974 | Reference |
| Antidepressants before | 0.93 (0.83–1.04) | 0.187 | 0.575 | 0.96 (0.88–1.06) | 0.428 | 0.862 |
| No antipsychotics before | 0.98 (0.86–1.12) | 0.771 | Reference | 1.03 (0.92–1.14) | 0.643 | Reference |
| Antipsychotics before | 0.82 (0.66–1.01) | 0.062 | 0.143 | 0.82 (0.69–0.98) | **0.027** | **0.041** |
| No anxiolytics before | 0.93 (0.82–1.04) | 0.209 | Reference | 0.97 (0.88–1.07) | 0.543 | Reference |
| Anxiolytics before | 0.96 (0.73–1.25) | 0.743 | 0.780 | 0.93 (0.75–1.16) | 0.526 | 0.791 |
| No benzodiazepines before | 1.09 (0.94–1.27) | 0.230 | Reference | 1.07 (0.95–1.21) | 0.258 | Reference |
| Benzodiazepines before | 0.77 (0.65–0.91) | **0.002** | **0.002** | 0.84 (0.74–0.97) | **0.013** | **0.010** |
| No lithium before | 0.94 (0.84–1.05) | 0.293 | Reference | 0.97 (0.89–1.07) | 0.571 | Reference |
| Lithium before | 0.79 (0.53–1.18) | 0.249 | 0.606 | 0.84 (0.60–1.17) | 0.301 | 0.496 |

Family history in first-degree relatives

| | | | | | | |
| No family history of affective disorders | 0.96 (0.85–1.09) | 0.512 | Reference | 0.98 (0.88–1.08) | 0.683 | Reference |
| Family history of affective disorders | 0.86 (0.68–1.09) | 0.222 | 0.394 | 0.93 (0.76–1.13) | 0.459 | 0.575 |
| No family history of suicide | 0.94 (0.84–1.05) | 0.297 | Reference | 0.98 (0.89–1.07) | 0.582 | Reference |
| Family history of suicide | 0.63 (0.33–1.23) | 0.177 | 0.383 | 0.72 (0.42–1.25) | 0.248 | 0.269 |

Note: Statistically significant results (p-value < 0.05) are presented using bold font. All models are adjusted for gender, age, marital status, cohabitation status, level of education, employment status, psychiatric comorbidity (anxiety disorder, alcohol use disorder, substance use disorder, and personality disorder), depression severity, whether the admission was voluntary or involuntary, number of prior psychiatric hospitalizations, ATHF score, psychiatric prescription drugs collected within 100 days before admission (antidepressants, antipsychotics, anxiolytics, benzodiazepines, and lithium), and family history of affective disorders or suicide.

Abbreviations: ATHF, Antidepressant Treatment History Form; CI, confidence interval; ECT, electroconvulsive therapy; OR, odds ratio.
APPENDIX C  RISK FACTORS FOR PSYCHIATRIC READMISSION

| Reference variable | Variable                        | Univariate OR (95% CI) | p-Value | Multivariate OR (95% CI) | p-Value |
|--------------------|--------------------------------|------------------------|---------|--------------------------|---------|
| Treatment          |                                 |                        |         |                          |         |
| Non-ECT            | ECT                             | 0.97 (0.92–1.04)       | 0.394   | 0.90 (0.84–0.96)         | 0.002   |
| Demographics       |                                 |                        |         |                          |         |
| Male               |                                 |                        |         |                          |         |
| Age 18–24 years    | Age 25–34 years                 | 1.04 (0.94–1.14)       | 0.454   |                          |         |
| Age 35–44 years    | Age 45–54 years                 | 0.98 (0.89–1.08)       | 0.653   |                          |         |
| Age 55–64 years    | Age 65–74 years                 | 0.79 (0.71–0.88)       |         |                          |         |
| Age ≥75 years      |                                 | 0.77 (0.69–0.86)       |         |                          |         |
| Married            | Divorced                        | 1.17 (1.08–1.27)       |         | 0.98 (0.89–1.08)         | 0.621   |
| Widowed            |                                 | 1.05 (0.94–1.18)       | 0.409   | 1.03 (0.90–1.19)         | 0.648   |
| Unmarried          |                                 | 1.21 (1.14–1.29)       |         | 0.94 (0.86–1.03)         | 0.156   |
| Cohabitating       | Not cohabitating                | 1.17 (1.11–1.24)       |         | 1.06 (0.99–1.14)         | 0.104   |
| Low education level| Middle education level          | 0.95 (0.89–1.02)       | 0.145   | 0.97 (0.91–1.04)         | 0.396   |
| Educated           |                                 |                        |         |                          |         |
| Employed           | Unemployed                      | 1.15 (1.08–1.21)       |         | 0.99 (0.93–1.06)         | 0.751   |
| Psychiatric comorbidity | Anxiety disorder | 1.88 (1.78–1.98)       | <0.001  | 1.07 (1.00–1.14)         | 0.049   |
| Anxiety disorder   |   Alcohol use disorder           | 1.66 (1.55–1.79)       | <0.001  | 1.02 (0.94–1.11)         | 0.577   |
| Alcohol use disorder| Substance use disorder         | 2.00 (1.86–2.15)       | <0.001  | 1.06 (0.97–1.15)         | 0.191   |
| Personality disorder |                            | 2.49 (2.30–2.69)       | <0.001  | 1.15 (1.04–1.26)         | 0.005   |
| Depression severity | Moderate                      | 1.09 (1.03–1.16)       | 0.003   | 1.08 (1.02–1.15)         | 0.010   |
| Severe without psychotic features |         | 0.96 (0.89–1.04)       | 0.322   | 1.07 (0.98–1.16)         | 0.148   |
| Severe with psychotic features |            | 0.34 (0.25–1.44)       |         |                          |         |
| Inpatient characteristics | Involuntarily admitted | 0.92 (0.86–0.99)       | 0.034   | 0.98 (0.90–1.06)         | 0.542   |
| Prior psychiatric hospitalizations | No prior hospitalization | 1.37 (1.25–1.50)       | <0.001  | 1.34 (1.22–1.47)         | <0.001  |
| 1–3 prior hospitalizations |                        | 1.71 (1.57–1.86)       | <0.001  | 1.64 (1.50–1.81)         | <0.001  |
| 4–6 prior hospitalizations |                      | 2.11 (1.93–2.31)       | <0.001  | 1.98 (1.78–2.20)         | <0.001  |
| 7–10 prior hospitalizations |                    | 2.52 (2.27–2.80)       | <0.001  | 2.35 (2.08–2.66)         | <0.001  |
| >10 prior hospitalizations |                  | 4.25 (3.90–4.63)       | <0.001  | 3.63 (3.20–4.12)         | <0.001  |
| ATHF within 1 year before hospitalization | A score of 0–1 | 1.34 (1.25–1.44)       | <0.001  | 1.11 (1.02–1.20)         | 0.020   |
| A score of 2–4     |                                 | 1.55 (1.44–1.67)       | <0.001  | 1.08 (0.99–1.19)         | 0.087   |
| A score of >8      |                                 | 2.11 (1.94–2.30)       | <0.001  | 1.23 (1.10–1.37)         | <0.001  |

(Continues)
Several factors associated with increased or decreased risk of psychiatric readmission in the study population as a whole were identified (Table A5 and Table A6). Factors associated with increased risk of both 30- and 90-day readmission in the multivariate analyses were having a comorbid anxiety or personality disorder, severe MDD without psychotic features, higher number of prior psychiatric hospitalizations, higher ATHF score, and having collected antipsychotics, anxiolytics, or benzodiazepines within 100 days before admission. Older age was associated with decreased risk of both 30- and 90-day readmission. Family history of affective disorders was associated with increased readmission risk only within 30 days, whereas being voluntarily admitted was associated with decreased risk of readmission only within 90 days. Additionally, these analyses were also conducted including only the first admission for each patient and the matched sample. Full logistic regression analyses are presented in Table A7–A10.

| Reference variable | Variable                      | Univariate OR (95% CI) | p-Value | Multivariate OR (95% CI) | p-Value |
|--------------------|-------------------------------|-------------------------|---------|--------------------------|---------|
| Drugs collected within 100 days before admission |                              |                         |         |                          |         |
| No antidepressants | Antidepressants               | 1.59 (1.44–1.75)        | <0.001  | 0.96 (0.85–1.08)         | 0.484   |
| No antipsychotics | Antipsychotics                | 1.66 (1.57–1.76)        | <0.001  | 1.11 (1.04–1.19)         | 0.002   |
| No anxiolytics    | Anxiolytics                   | 1.08 (1.01–1.16)        | 0.028   | 1.10 (1.02–1.19)         | 0.010   |
| No benzodiazepines| Benzodiazepines               | 1.31 (1.24–1.38)        | <0.001  | 1.18 (1.11–1.25)         | <0.001  |
| No lithium        | Lithium                       | 1.69 (1.55–1.84)        | <0.001  | 1.00 (0.91–1.10)         | 0.983   |
| Family history in first-degree relatives |                              |                         |         |                          |         |
| No family history of affective disorders | Family history of affective disorders | 1.18 (1.11–1.26) | <0.001 | 1.16 (1.09–1.24) | <0.001 |
| No family history of suicide | Family history of suicide | 1.12 (0.97–1.28) | 0.121 | 1.02 (0.88–1.18) | 0.812 |

Note: Statistically significant results (p-value < 0.05) are presented using bold font.
Abbreviations: ATHF, Antidepressant Treatment History Form; CI, confidence interval; ECT, electroconvulsive therapy; OR, odds ratio.
| Reference variable | Variable                        | Univariate OR (95% CI) | p-Value | Multivariate OR (95% CI) | p-Value |
|--------------------|---------------------------------|------------------------|---------|--------------------------|---------|
| **Treatment**      |                                 |                        |         |                          |         |
| Non-ECT            | ECT                             | 1.05 (1.00–1.11)       | 0.043   | 0.93 (0.88–0.99)         | 0.012   |
| **Demographics**   |                                 |                        |         |                          |         |
| Male               | Female                          | 1.16 (1.11–1.22)       | <0.001  | 1.01 (0.97–1.07)         | 0.564   |
| Age 18–24 years    | Age 25–34 years                 | 1.04 (0.96–1.12)       | 0.385   | 0.83 (0.76–0.91)         | <0.001  |
|                    | Age 35–44 years                 | 1.07 (0.99–1.16)       | 0.110   | 0.77 (0.70–0.85)         | <0.001  |
|                    | Age 45–54 years                 | 0.98 (0.90–1.06)       | 0.540   | 0.68 (0.62–0.75)         | <0.001  |
|                    | Age 55–64 years                 | 0.89 (0.82–0.97)       | 0.007   | 0.60 (0.54–0.67)         | <0.001  |
|                    | Age 65–74 years                 | 0.82 (0.75–0.90)       | <0.001  | 0.56 (0.50–0.62)         | <0.001  |
|                    | Age ≥75 years                   | 0.83 (0.76–0.91)       | <0.001  | 0.59 (0.52–0.67)         | <0.001  |
| Married            | Divorced                        | 1.16 (1.09–1.24)       | <0.001  | 0.99 (0.92–1.08)         | 0.840   |
|                    | Widowed                         | 1.05 (0.95–1.15)       | 0.356   | 0.99 (0.88–1.12)         | 0.905   |
|                    | Unmarried                       | 1.21 (1.15–1.28)       | <0.001  | 1.00 (0.93–1.08)         | 0.906   |
| Cohabiting         | Not cohabiting                  | 1.16 (1.11–1.21)       | <0.001  | 1.02 (0.96–1.08)         | 0.520   |
| Low education level| Middle education level          | 0.94 (0.89–0.99)       | 0.023   | 0.96 (0.91–1.02)         | 0.153   |
|                    | High education level            | 0.93 (0.87–0.98)       | 0.012   | 0.97 (0.91–1.02)         | 0.422   |
| Employed           | Unemployed                      | 1.17 (1.12–1.22)       | <0.001  | 0.96 (0.91–1.02)         | 0.172   |
| **Psychiatric comorbidity** |                              |                        |         |                          |         |
| No anxiety disorder| Anxiety disorder                | 2.08 (1.99–2.18)       | <0.001  | 1.13 (1.07–1.19)         | <0.001  |
| No alcohol use disorder | Alcohol use disorder          | 1.77 (1.66–1.88)       | <0.001  | 1.06 (0.99–1.14)         | 0.100   |
| No substance use disorder | Substance use disorder     | 2.11 (1.98–2.24)       | <0.001  | 1.04 (0.97–1.12)         | 0.269   |
| No personality disorder | Personality disorder         | 2.87 (2.67–3.08)       | <0.001  | 1.25 (1.15–1.36)         | <0.001  |
| **Depression severity** |                                |                        |         |                          |         |
| Moderate           | Severe without psychotic features| 1.14 (1.08–1.19)       | <0.001  | 1.11 (1.05–1.17)         | <0.001  |
|                    | Severe with psychotic features  | 0.98 (0.92–1.04)       | 0.491   | 1.06 (0.99–1.14)         | 0.113   |
| **Inpatient characteristics** |                             |                        |         |                          |         |
| Involuntarily admitted | Voluntarily admitted        | 0.89 (0.83–0.94)       | <0.001  | 0.92 (0.86–0.98)         | 0.012   |
| **Prior psychiatric hospitalizations** |                            |                        |         |                          |         |
| No prior hospitalization | 1 prior hospitalization    | 1.46 (1.36–1.57)       | <0.001  | 1.36 (1.26–1.47)         | <0.001  |
|                    | 2–3 prior hospitalizations     | 1.92 (1.79–2.06)       | <0.001  | 1.71 (1.58–1.85)         | <0.001  |
|                    | 4–6 prior hospitalizations     | 2.52 (2.34–2.71)       | <0.001  | 2.14 (1.96–2.34)         | <0.001  |
|                    | 7–10 prior hospitalizations    | 3.04 (2.79–3.31)       | <0.001  | 2.53 (2.28–2.81)         | <0.001  |
|                    | >10 prior hospitalizations     | 5.14 (4.77–5.54)       | <0.001  | 3.87 (3.47–4.31)         | <0.001  |
| **ATHF within 1 year before hospitalization** |                         |                        |         |                          |         |
| A score of 0–1     | A score of 2–4                  | 1.48 (1.39–1.57)       | <0.001  | 1.20 (1.11–1.28)         | <0.001  |
|                    | A score of 5–8                  | 1.84 (1.73–1.95)       | <0.001  | 1.23 (1.14–1.32)         | <0.001  |
|                    | A score of >8                   | 2.60 (2.42–2.80)       | <0.001  | 1.43 (1.31–1.57)         | <0.001  |
| **Drugs collected within 100 days before admission** |                    |                        |         |                          |         |
| No antidepressants | Antidepressants                | 1.79 (1.66–1.94)       | <0.001  | 0.94 (0.86–1.04)         | 0.230   |
| No antipsychotics  | Antipsychotics                 | 1.89 (1.80–1.98)       | <0.001  | 1.18 (1.12–1.25)         | <0.001  |
| No anxiolytics     | Anxiolytics                    | 1.13 (1.06–1.19)       | <0.001  | 1.14 (1.07–1.21)         | <0.001  |

(Continues)
| Reference variable | Variable              | Univariate OR (95% CI) | p-Value | Multivariate OR (95% CI) | p-Value |
|--------------------|-----------------------|------------------------|---------|--------------------------|---------|
| No benzodiazepines | Benzodiazepines       | 1.39 (1.33–1.46)       | <0.001  | 1.18 (1.12–1.25)         | <0.001  |
| No lithium         | Lithium               | 1.79 (1.66–1.93)       | <0.001  | 0.98 (0.90–1.06)         | 0.547   |

Family history in first-degree relatives

| No family history of affective disorders | Family history of affective disorders | 1.08 (1.03–1.14) | 0.003 | 1.05 (1.00–1.12) | 0.071 |
| No family history of suicide           | Family history of suicide              | 1.00 (0.93–1.08) | 0.995 | 0.98 (0.86–1.10) | 0.688 |

Note: Statistically significant results (p-value < 0.05) are presented using bold font.

Abbreviations: ATHF, Antidepressant Treatment History Form; CI, confidence interval; ECT, electroconvulsive therapy; OR, odds ratio.

### TABLE C3: Logistic regression analysis of 30-day readmission risk for any psychiatric disorder including only the first admission for each participant

| Reference variable | Variable                      | Univariate OR (95% CI) | p-Value | Multivariate OR (95% CI) | p-Value |
|--------------------|-------------------------------|------------------------|---------|--------------------------|---------|
| Treatment          | Non-ECT                       | 1.01 (0.93–1.10)       | 0.751   | 0.93 (0.85–1.02)         | 0.112   |

Demographics

| Age 18–24 years   | Female                        | 1.03 (0.96–1.10)       | 0.452   | 0.96 (0.89–1.04)        | 0.321   |
|                  | Age 25–34 years               | 0.93 (0.82–1.05)       | 0.229   | 0.80 (0.70–0.91)        | 0.001   |
|                   | Age 35–44 years               | 0.98 (0.86–1.11)       | 0.692   | 0.78 (0.68–0.90)        | 0.001   |
|                   | Age 45–54 years               | 0.95 (0.84–1.08)       | 0.435   | 0.71 (0.62–0.83)        | <0.001  |
|                   | Age 55–64 years               | 0.85 (0.74–0.96)       | 0.012   | 0.60 (0.52–0.71)        | <0.001  |
|                   | Age 65–74 years               | 0.74 (0.64–0.85)       | <0.001  | 0.53 (0.45–0.63)        | <0.001  |
|                   | Age ≥75 years                 | 0.78 (0.68–0.90)       | 0.001   | 0.62 (0.52–0.75)        | <0.001  |
| Married           | Divorced                      | 1.19 (1.08–1.33)       | 0.001   | 1.03 (0.91–1.16)        | 0.667   |
|                   | Widowed                       | 0.84 (0.71–0.99)       | 0.042   | 0.80 (0.66–0.98)        | 0.031   |
|                   | Unmarried                     | 1.15 (1.06–1.26)       | 0.001   | 0.93 (0.83–1.05)        | 0.237   |
| Cohabiting        | Not cohabiting                | 1.10 (1.02–1.18)       | 0.008   | 1.03 (0.94–1.13)        | 0.557   |
| Low education level| Middle education level        | 0.90 (0.83–0.98)       | 0.014   | 0.93 (0.85–1.01)        | 0.088   |
|                   | High education level          | 0.85 (0.77–0.93)       | 0.001   | 0.91 (0.82–1.01)        | 0.083   |
| Employed          | Unemployed                    | 1.12 (1.04–1.20)       | 0.002   | 0.99 (0.91–1.08)        | 0.780   |

Psychiatric comorbidity

| No anxiety disorder | Anxiety disorder             | 1.82 (1.69–1.96)       | <0.001  | 1.15 (1.05–1.26)        | 0.003   |
| No alcohol use disorder | Alcohol use disorder        | 1.78 (1.61–1.97)       | <0.001  | 1.14 (1.02–1.28)        | 0.023   |
| No substance use disorder | Substance use disorder    | 1.91 (1.72–2.12)       | <0.001  | 1.05 (0.93–1.19)        | 0.409   |
| No personality disorder | Personality disorder       | 2.45 (2.16–2.77)       | <0.001  | 1.25 (1.08–1.44)        | 0.003   |

Depression severity

| Moderate           | Severe without psychotic features | 1.14 (1.05–1.23)       | 0.001   | 1.15 (1.06–1.25)        | 0.001   |
|                   | Severe with psychotic features   | 1.08 (0.97–1.20)       | 0.153   | 1.21 (1.08–1.36)        | 0.001   |

Inpatient characteristics

| Involuntarily admitted | Voluntarily admitted           | 0.92 (0.83–1.01)       | 0.082   | 0.97 (0.88–1.08)        | 0.622   |

(Continues)
**TABLE C3** (Continued)

| Reference variable | Variable                      | Univariate OR (95% CI) | p-Value | Multivariate OR (95% CI) | p-Value |
|--------------------|-------------------------------|------------------------|---------|--------------------------|---------|
| Prior psychiatric hospitalizations | No prior hospitalization | 1.31 (1.18–1.46) | <0.001 | 1.22 (1.09–1.36) | 0.001 |
|                    | 2–3 prior hospitalizations  | 1.68 (1.51–1.86) | <0.001 | 1.50 (1.34–1.69) | <0.001 |
|                    | 4–6 prior hospitalizations  | 2.03 (1.80–2.28) | <0.001 | 1.74 (1.51–2.01) | <0.001 |
|                    | 7–10 prior hospitalizations | 2.45 (2.11–2.85) | <0.001 | 2.03 (1.70–2.44) | <0.001 |
|                    | >10 prior hospitalizations  | 3.32 (2.93–3.76) | <0.001 | 2.44 (2.04–2.93) | <0.001 |
| ATHF within 1 year before hospitalization | A score of 0–1 | 1.29 (1.18–1.40) | <0.001 | 1.15 (1.04–1.27) | 0.008 |
|                    | A score of 2–4               | 1.43 (1.30–1.57) | <0.001 | 1.13 (1.01–1.26) | 0.034 |
|                    | A score of >8               | 1.86 (1.64–2.12) | <0.001 | 1.28 (1.10–1.49) | 0.001 |
| Drugs collected within 100 days before admission | No antidepressants | 1.39 (1.25–1.54) | <0.001 | 0.97 (0.85–1.11) | 0.656 |
|                    | Antidepressants              | 1.59 (1.46–1.73) | <0.001 | 1.10 (1.00–1.21) | 0.049 |
|                    | Antipsychotics               | 1.10 (1.00–1.20) | 0.054 | 1.08 (0.98–1.19) | 0.114 |
|                    | Anxiolytics                  | 1.28 (1.19–1.37) | <0.001 | 1.19 (1.10–1.29) | <0.001 |
|                    | Benzodiazepines              | 1.48 (1.27–1.72) | <0.001 | 0.96 (0.82–1.13) | 0.641 |
| Family history in first-degree relatives | No family history of affective disorders | 1.11 (1.02–1.21) | 0.016 | 1.07 (0.98–1.17) | 0.115 |
|                    | Family history of suicide    | 1.18 (0.98–1.42) | 0.082 | 1.10 (0.91–1.33) | 0.332 |

*Note:* Statistically significant results (p-value <0.05) are presented using bold font.

**Abbreviations:** ATHF, Antidepressant Treatment History Form; CI, confidence interval; ECT, electroconvulsive therapy; OR, odds ratio.

**TABLE C4** Logistic regression analysis of 90-day readmission risk for any psychiatric disorder including only the first admission for each participant

| Reference variable | Variable | Univariate OR (95% CI) | p-Value | Multivariate OR (95% CI) | p-Value |
|--------------------|----------|------------------------|---------|--------------------------|---------|
| Treatment          | Non-ECT  | 1.12 (1.04–1.19) | 0.002 | 0.99 (0.92–1.07) | 0.824 |
|                    | ECT      | 1.07 (1.01–1.13) | 0.022 | 0.99 (0.93–1.06) | 0.780 |
| Demographics       | Male     | 0.94 (0.85–1.04) | 0.234 | 0.82 (0.73–0.91) | <0.001 |
|                    | Age 25–34 years | 0.96 (0.87–1.07) | 0.475 | 0.79 (0.70–0.89) | <0.001 |
|                    | Age 35–44 years | 0.96 (0.86–1.06) | 0.368 | 0.74 (0.65–0.83) | <0.001 |
|                    | Age 55–64 years | 0.89 (0.80–0.99) | 0.032 | 0.66 (0.58–0.75) | <0.001 |
|                    | Age 65–74 years | 0.81 (0.72–0.90) | 0.001 | 0.60 (0.52–0.70) | <0.001 |
|                    | Age ≥75 years | 0.84 (0.75–0.94) | 0.002 | 0.70 (0.60–0.81) | <0.001 |
|                    | Married  | 1.20 (1.10–1.31) | <0.001 | 1.05 (0.95–1.16) | 0.366 |
|                    | Divorced | 0.93 (0.81–1.06) | 0.283 | 0.86 (0.74–1.02) | 0.077 |
|                    | Widowed  | 1.20 (1.12–1.28) | <0.001 | 1.05 (0.95–1.15) | 0.370 |
|                    | Unmarried | 1.20 (1.12–1.28) | <0.001 | 1.05 (0.95–1.15) | 0.370 |

(Continues)
| Reference variable | Variable                        | Univariate OR (95% CI) | p-Value | Multivariate OR (95% CI) | p-Value |
|--------------------|---------------------------------|------------------------|---------|--------------------------|---------|
| Cohabiting         | Not cohabiting                  | 1.11 (1.05–1.18)       | <0.001  | 0.99 (0.92–1.07)         | 0.814   |
| Low education level| Middle education level          | 0.92 (0.86–0.98)       | 0.013   | 0.95 (0.88–1.02)         | 0.143   |
|                   | High education level            | 0.85 (0.79–0.92)       | <0.001  | 0.92 (0.84–1.00)         | 0.045   |
| Employed           | Unemployed                      | 1.14 (1.08–1.21)       | <0.001  | 0.97 (0.90–1.04)         | 0.376   |
| Psychiatric comorbidity | Anxiety disorder               | 1.97 (1.86–2.10)       | <0.001  | 1.19 (1.10–1.28)         | <0.001  |
|                    | Alcohol use disorder            | 1.81 (1.67–1.97)       | <0.001  | 1.11 (1.01–1.23)         | 0.037   |
|                    | Substance use disorder          | 1.96 (1.80–2.15)       | <0.001  | 1.02 (0.92–1.12)         | 0.730   |
|                    | Personality disorder            | 2.64 (2.37–2.95)       | <0.001  | 1.24 (1.09–1.41)         | 0.001   |
| Depression severity| Moderate                        | 1.17 (1.10–1.24)       | <0.001  | 1.16 (1.08–1.24)         | <0.001  |
|                    | Severe without psychotic features| 1.06 (0.98–1.16)       | 0.154   | 1.15 (1.05–1.27)         | 0.002   |
| Inpatient characteristics | Involuntarily admitted   | 0.88 (0.82–0.96)       | 0.002   | 0.92 (0.84–1.00)         | 0.053   |
| Prior psychiatric hospitalizations | 1 prior hospitalization    | 1.35 (1.24–1.47)       | <0.001  | 1.23 (1.12–1.34)         | <0.001  |
|                    | 2–3 prior hospitalizations      | 1.84 (1.69–2.00)       | <0.001  | 1.61 (1.46–1.77)         | <0.001  |
|                    | 4–6 prior hospitalizations      | 2.35 (2.13–2.60)       | <0.001  | 1.97 (1.75–2.22)         | <0.001  |
|                    | 7–10 prior hospitalizations     | 2.62 (2.30–2.98)       | <0.001  | 2.11 (1.82–2.46)         | <0.001  |
|                    | >10 prior hospitalizations      | 3.97 (3.56–4.43)       | <0.001  | 2.90 (2.48–3.38)         | <0.001  |
| ATHF within 1 year before hospitalization | A score of 0–1   | 1.37 (1.28–1.47)       | <0.001  | 1.21 (1.11–1.31)         | <0.001  |
|                    | A score of 2–4                  | 1.60 (1.49–1.73)       | <0.001  | 1.24 (1.13–1.36)         | <0.001  |
|                    | A score of >8                   | 2.16 (1.94–2.41)       | <0.001  | 1.44 (1.27–1.64)         | <0.001  |
| Drugs collected within 100 days before admission | No antipsychotics | 1.50 (1.38–1.64)       | <0.001  | 0.96 (0.87–1.07)         | 0.497   |
|                    | Antidepressants                 | 1.69 (1.58–1.82)       | <0.001  | 1.10 (1.02–1.20)         | 0.019   |
|                    | Anxiolytics                     | 1.15 (1.06–1.24)       | <0.001  | 1.13 (1.04–1.22)         | 0.002   |
|                    | Benzodiazepines                 | 1.34 (1.26–1.42)       | <0.001  | 1.18 (1.10–1.26)         | <0.001  |
|                    | Lithium                         | 1.58 (1.39–1.79)       | <0.001  | 0.94 (0.82–1.08)         | 0.403   |
| Family history in first-degree relatives | No family history of affective disorders | 1.08 (1.01–1.16)       | 0.037   | 1.03 (0.96–1.11)         | 0.445   |
|                    | Family history of suicide       | 1.06 (0.96–1.16)       | 0.256   | 1.05 (0.89–1.23)         | 0.564   |

Note: Statistically significant results (p-value < 0.05) are presented using bold font.
Abbreviations: ATHF, Antidepressant Treatment History Form; CI, confidence interval; ECT, electroconvulsive therapy; OR, odds ratio.
| Reference variable | Variable                        | Univariate OR (95% CI) | p-Value | Multivariate OR (95% CI) | p-Value |
|---------------------|--------------------------------|------------------------|---------|--------------------------|---------|
| Treatment           | Non-ECT                        | 0.94 (0.85–1.05)       | 0.275   | 0.93 (0.84–1.04)         | 0.221   |
|                     | ECT                            |                        |         |                          |         |
| Demographics        | Male                            |                        |         |                          |         |
|                     | Female                          | 1.10 (0.99–1.23)       | 0.075   | 0.99 (0.88–1.12)         | 0.891   |
|                     | Age 18–24 years                 | 0.86 (0.68–1.09)       | 0.206   | 0.86 (0.67–1.09)         | 0.212   |
|                     | Age 35–44 years                 | 0.80 (0.64–1.01)       | 0.059   | 0.75 (0.58–0.97)         | 0.026   |
|                     | Age 45–54 years                 | 0.62 (0.50–0.78)       | <0.001  | 0.56 (0.44–0.73)         | <0.001  |
|                     | Age 55–64 years                 | 0.56 (0.44–0.70)       | <0.001  | 0.50 (0.38–0.76)         | <0.001  |
|                     | Age 65–74 years                 | 0.41 (0.33–0.53)       | <0.001  | 0.37 (0.28–0.50)         | <0.001  |
|                     | Age ≥75 years                   | 0.51 (0.40–0.64)       | <0.001  | 0.48 (0.36–0.65)         | <0.001  |
|                     | Married                         |                        |         |                          |         |
|                     | Divorced                        | 1.18 (1.01–1.38)       | 0.033   | 1.13 (0.93–1.37)         | 0.207   |
|                     | Widowed                         | 0.88 (0.70–1.09)       | 0.238   | 0.98 (0.75–1.30)         | 0.902   |
|                     | Unmarried                       | 1.34 (1.18–1.52)       | <0.001  | 0.98 (0.82–1.17)         | 0.805   |
|                     | Cohabiting                      |                        |         |                          |         |
|                     | Not cohabiting                  | 1.00 (0.89–1.11)       | 0.921   | 0.88 (0.76–1.02)         | 0.084   |
|                     | Low education level             |                        |         |                          |         |
|                     | Middle education level          | 0.91 (0.80–1.04)       | 0.165   | 0.89 (0.77–1.02)         | 0.094   |
|                     | High education level            | 0.81 (0.70–0.93)       | 0.004   | 0.85 (0.73–1.00)         | 0.052   |
|                     | Employed                        | 1.04 (0.94–1.16)       | 0.452   | 0.99 (0.86–1.13)         | 0.868   |
| Psychiatric comorbidity | No anxiety disorder              |                        |         |                          |         |
|                     | Anxiety disorder                | 1.69 (1.51–1.88)       | <0.001  | 1.09 (0.96–1.25)         | 0.197   |
|                     | No alcohol use disorder         | 1.91 (1.62–2.26)       | <0.001  | 1.18 (0.98–1.43)         | 0.083   |
|                     | No substance use disorder       | 2.01 (1.71–2.37)       | <0.001  | 1.06 (0.87–1.28)         | 0.584   |
|                     | No personality disorder         | 2.62 (2.19–3.12)       | <0.001  | 1.32 (1.07–1.63)         | 0.011   |
| Depression severity | Moderate                        |                        |         |                          |         |
|                     | Severe without psychotic features| 1.05 (0.91–1.20)       | 0.493   | 1.09 (0.95–1.26)         | 0.218   |
|                     | Severe with psychotic features  | 0.90 (0.77–1.06)       | 0.220   | 1.06 (0.89–1.27)         | 0.487   |
| Inpatient characteristics | Involuntarily admitted           |                        |         |                          |         |
|                     | Voluntarily admitted            | 0.89 (0.78–1.03)       | 0.113   | 0.93 (0.80–1.08)         | 0.333   |
| Prior psychiatric hospitalizations | No prior hospitalization        |                        |         |                          |         |
|                     | 1 prior hospitalization         | 1.22 (1.04–1.44)       | 0.015   | 1.20 (1.01–1.43)         | 0.037   |
|                     | 2–3 prior hospitalizations      | 1.39 (1.19–1.63)       | <0.001  | 1.36 (1.14–1.63)         | 0.001   |
|                     | 4–6 prior hospitalizations      | 1.85 (1.55–2.21)       | <0.001  | 1.72 (1.40–2.12)         | <0.001  |
|                     | 7–10 prior hospitalizations     | 2.02 (1.60–2.56)       | <0.001  | 1.87 (1.42–2.45)         | <0.001  |
|                     | >10 prior hospitalizations      | 3.08 (2.59–3.68)       | <0.001  | 2.43 (1.88–2.13)         | <0.001  |
| ATHF within 1 year before hospitalization | A score of 0–1                |                        |         |                          |         |
|                     | A score of 2–4                  | 1.15 (0.99–1.33)       | 0.062   | 1.04 (0.89–1.23)         | 0.607   |
|                     | A score of 5–8                  | 1.26 (1.09–1.46)       | 0.002   | 1.05 (0.88–1.25)         | 0.612   |
|                     | A score of >8                   | 1.79 (1.49–2.14)       | <0.001  | 1.29 (1.04–1.59)         | 0.021   |
| Drugs collected within 100 days before admission | No antidepressants           |                        |         |                          |         |
|                     | Antidepressants                 | 1.27 (1.02–1.57)       | 0.032   | 0.91 (0.71–1.18)         | 0.480   |
|                     | No antipsychotics               | 1.43 (1.26–1.61)       | <0.001  | 1.03 (0.89–1.18)         | 0.723   |
|                     | No anxiolytics                  | 0.97 (0.84–1.11)       | 0.627   | 0.97 (0.84–1.12)         | 0.679   |

(Continues)
### Table C5 (Continued)

| Reference variable | Variable                      | Univariate OR (95% CI) | p-Value | Multivariate OR (95% CI) | p-Value |
|--------------------|-------------------------------|------------------------|---------|--------------------------|---------|
| No benzodiazepines | Benzodiazepines               | 1.12 (1.00–1.25)       | **0.041** | 1.17 (1.04–1.32)         | **0.009** |
| No lithium         | Lithium                       | 1.42 (1.17–1.72)       | <**0.001** | 0.97 (0.79–1.19)         | 0.762   |

Family history in first-degree relatives

|                      |                                 |                       |         |                         |         |
|----------------------|----------------------------------|------------------------|---------|--------------------------|---------|
| No family history of affective disorders | Family history of affective disorders | 1.06 (0.93–1.20)       | 0.406   | 1.10 (0.96–1.26)         | 0.160   |
| No family history of suicide           | Family history of suicide        | 1.03 (0.77–1.36)       | 0.859   | 0.96 (0.71–1.28)         | 0.767   |

**Note:** Statistically significant results (p-value < 0.05) are presented using bold font.

**Abbreviations:** ATHF, Antidepressant Treatment History Form; CI, confidence interval; ECT, electroconvulsive therapy; OR, odds.

### Table C6 Logistic regression analysis of 90-day readmission risk for any psychiatric disorder in the matched sample

| Reference variable | Variable                      | Univariate OR (95% CI) | p-Value | Multivariate OR (95% CI) | p-Value |
|--------------------|-------------------------------|------------------------|---------|--------------------------|---------|
| Treatment          | Non-ECT                       | ECT                    | 0.97 (0.89–1.06) | 0.571 | 0.97 (0.88–1.06)         | 0.444   |
| Demographics       |                                |                        |         |                          |         |
| Male               | Female                        | 1.15 (1.05–1.26)       | **0.002** | 1.03 (0.93–1.13)         | 0.612   |
| Age 18–24 years    | Age 25–34 years               | 0.76 (0.62–0.92)       | **0.005** | 0.74 (0.60–0.91)         | **0.004** |
|                    | Age 35–44 years               | 0.68 (0.56–0.83)       | <**0.001** | 0.63 (0.51–0.78)         | <**0.001** |
|                    | Age 45–54 years               | 0.55 (0.46–0.67)       | <**0.001** | 0.50 (0.40–0.61)         | <**0.001** |
|                    | Age 55–64 years               | 0.50 (0.41–0.60)       | <**0.001** | 0.44 (0.35–0.55)         | <**0.001** |
|                    | Age 65–74 years               | 0.40 (0.33–0.49)       | <**0.001** | 0.36 (0.29–0.46)         | <**0.001** |
|                    | Age ≥75 years                 | 0.47 (0.39–0.57)       | <**0.001** | 0.45 (0.35–0.58)         | <**0.001** |
| Married            | Divorced                      | 1.29 (1.14–1.46)       | <**0.001** | 1.14 (0.97–1.34)         | 0.106   |
|                    | Widowed                       | 0.98 (0.82–1.17)       | 0.802   | 0.95 (0.76–1.19)         | 0.653   |
|                    | Unmarried                     | 1.43 (1.29–1.59)       | <**0.001** | 0.99 (0.85–1.14)         | 0.861   |
| Cohabiting         | Not cohabiting                | 1.10 (1.01–1.20)       | **0.030** | 0.97 (0.86–1.10)         | 0.665   |
| Low education level| Middle education level        | 0.90 (0.81–1.01)       | 0.060   | 0.89 (0.79–0.99)         | **0.039** |
|                    | High education level          | 0.78 (0.69–0.88)       | <**0.001** | 0.83 (0.73–0.95)         | **0.007** |
| Employed           | Unemployed                    | 1.07 (0.98–1.17)       | 0.140   | 0.95 (0.84–1.06)         | 0.322   |
| Psychiatric comorbidity | Anxiety disorder                | 1.83 (1.67–2.00)       | <**0.001** | 1.16 (1.04–1.30)         | **0.008** |
|                    | Alcohol use disorder          | 1.82 (1.57–2.10)       | <**0.001** | 1.06 (0.89–1.25)         | 0.529   |
|                    | Substance use disorder        | 2.07 (1.79–2.38)       | <**0.001** | 1.06 (0.90–1.25)         | 0.521   |
|                    | Personality disorder          | 2.71 (2.32–3.18)       | <**0.001** | 1.28 (1.06–1.55)         | **0.010** |
| Depression severity | Moderate                       | 1.07 (0.96–1.20)       | 0.250   | 1.14 (1.01–1.28)         | **0.030** |
|                    | Severe without psychotic features | 0.85 (0.74–0.97)       | **0.014** | 1.01 (0.87–1.17)         | 0.882   |
| Inpatient characteristics | Involuntarily admitted      | 0.89 (0.79–1.00)       | **0.046** | 0.88 (0.78–1.00)         | 0.051   |

(Continues)
| Reference variable                                         | Variable                        | Univariate OR (95% CI) | p-Value | Multivariate OR (95% CI) | p-Value |
|----------------------------------------------------------|---------------------------------|------------------------|---------|--------------------------|---------|
| Prior psychiatric hospitalizations                       |                                 |                        |         |                          |         |
| No prior hospitalization                                 | 1 prior hospitalization         | 1.23 (1.08–1.41)       | 0.002   | 1.16 (1.01–1.34)         | 0.040   |
|                                                          | 2–3 prior hospitalizations      | 1.55 (1.37–1.76)       | <0.001  | 1.44 (1.25–1.67)         | <0.001  |
|                                                          | 4–6 prior hospitalizations      | 2.03 (1.75–2.35)       | <0.001  | 1.81 (1.52–2.15)         | <0.001  |
|                                                          | 7–10 prior hospitalizations     | 2.34 (1.92–2.84)       | <0.001  | 2.06 (1.64–2.58)         | <0.001  |
|                                                          | >10 prior hospitalizations      | 3.43 (2.95–4.00)       | <0.001  | 2.60 (2.09–3.22)         | <0.001  |
| ATHF within 1 year before hospitalization                | A score of 0–1                  | 1.30 (1.15–1.46)       | <0.001  | 1.15 (1.01–1.32)         | 0.039   |
|                                                          | A score of 2–4                  | 1.41 (1.25–1.59)       | <0.001  | 1.12 (0.97–1.30)         | 0.120   |
|                                                          | A score of >8                   | 2.00 (1.72–2.32)       | <0.001  | 1.37 (1.14–1.64)         | 0.001   |
| Drugs collected within 100 days before admission         | No antidepressants              | 1.43 (1.19–1.71)       | <0.001  | 0.92 (0.74–1.14)         | 0.437   |
|                                                          | Antidepressants                 | 1.57 (1.42–1.73)       | <0.001  | 1.11 (0.99–1.24)         | 0.081   |
|                                                          | No antipsychotics               | 0.97 (0.86–1.09)       | 0.566   | 0.97 (0.86–1.10)         | 0.619   |
|                                                          | Antipsychotics                  | 1.16 (1.06–1.26)       | 0.001   | 1.18 (1.07–1.30)         | 0.001   |
|                                                          | No benzodiazepines              | 1.49 (1.26–1.75)       | <0.001  | 0.97 (0.81–1.16)         | 0.747   |
| Family history in first-degree relatives                 | No family history of affective disorders | 1.00 (0.90–1.11) | 0.998 | 1.04 (0.93–1.16) | 0.546 |
|                                                          | Family history of suicide       | 0.99 (0.78–1.25)       | 0.904   | 0.91 (0.71–1.16)         | 0.456   |

Note: Statistically significant results (p-value < 0.05) are presented using bold font.

Abbreviations: ATHF, Antidepressant Treatment History Form; CI, confidence interval; ECT, electroconvulsive therapy; OR, odds.