COVID-19 vaccination rates in hospitalized mentally ill patients compared to the general population in Germany: Results from the COVID Ψ Vac study

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Abstract
Background. Mental illness is known to come along with a large mortality gap compared to the general population and it is a risk for COVID-19 related morbidity and mortality. Achieving high vaccination rates in people with mental illness is therefore important. Reports are conflicting on whether vaccination rates comparable to those of the general population can be achieved and which variables represent risk factors for nonvaccination in people with mental illness.

Methods. The COVID Ψ Vac study collected routine data on vaccination status, diagnostic groups, sociodemographics, and setting characteristics from in- and day-clinic patients of 10 psychiatric hospitals in Germany in August 2021. Logistic regression modeling was used to determine risk factors for nonvaccination.

Results. Complete vaccination rates were 59% (n = 776) for the hospitalized patients with mental illness versus 64% for the regionally and age-matched general population. Partial vaccination rates were 68% (n = 893) for the hospitalised patients with mental illness versus 67% for the respective general population and six percentage (n = 74) of this hospitalized population were vaccinated during the hospital stay. Rates showed a large variation between hospital sites. An ICD-10 group F1, F2, or F4 main diagnosis, younger age, and coercive accommodation were further risk factors for nonvaccination in the model.

Conclusions. Vaccination rates were lower in hospitalized people with mental illness than in the general population. By targeting at-risk groups with low-threshold vaccination programs in all health institutions they get in contact with, vaccination rates comparable to those in the general population can be achieved.

Introduction
Mental illness is conceived a risk for COVID-19 related morbidity and mortality. Studies agree that patients with psychotic and to a lower degree mood disorders seem to be at risk for COVID-19 associated morbidity and mortality [1, 2] and some studies show a higher risk for addiction disorders [3]. This risk status seems to be mostly related to common somatic comorbidities like metabolic syndrome, cardiovascular, and respiratory disorders associated with mental disorders due to reduced self-care, medication side effects, more precarious social and living conditions, and insufficient somatic medicine treatment [1–4]. By these risk factors in combination with pandemic-associated reduced health-care services [5, 6] the COVID-19 pandemic has the potential to further broaden the appallingly large mortality gap for severe mental disorders [7, 8]. Therefore, high vaccination rates among the risk groups with mental illness are of high public health priority. In the initial COVID-19 vaccination campaign in 2021, in some countries like Denmark, the Netherlands, the UK, and Germany populations with severe mental illness were prioritized for vaccination [9] but it remained unclear to what degree at-risk
groups with mental illness were reached by vaccination campaigns in every-day routine health-care practice. Studies on vaccination rates of populations with mental illness in comparison to the general population showed heterogenous results: In some studies vaccination rates were comparable to or better than the general population [10–13] but in others people with mental illness showed much lower vaccination rates [14–17]. A common factor for vaccination rates similar to the general population seemed to be vaccination offerings by mental health institutions [10–12]. This corresponds to studies on reasons for nonvaccination that did not show a general vaccine hesitancy among people with mental illness but were organizational access issues appeared to be the most relevant factors [15, 17–19]. Some studies on risk groups for non-vaccination identified a younger age [12, 17] and a schizophrenia diagnosis [13, 15, 16] associated with nonvaccination while others found no such differences [11, 20].

Therefore, the first aim of the COVID-19 Vac study was to determine vaccination rates among hospitalized people with mental illness in routine health care in comparison to the age-equivalent general population in Germany at a time period in August 2021, when access to COVID-19 vaccines was widely available. The second aim was to identify risk populations for unvaccinated status by available routine data indicators in order to identify target groups for vaccination programs among populations with mental illness.

Methods

Study design and participants

Ten psychiatric hospitals and departments in five regions of Germany took part in the study. Seven departments were part of university medical centers. They all had a regional care mandate (“Versorgungsauftrag”), what means that they were responsible for the inpatient psychiatric emergency care of a defined region and that they cannot selectively choose but have to admit all patients with an indication from this region. For achieving a rapid data collection in the evolving pandemic the choice of hospitals was a convenience sample based on participation in the NUM egePan COVID-19 research network that funded the study and willingness to participate in the study. Six of the 10 hospitals offered in-hospital COVID-19 vaccinations during inpatient mental health treatment, in those facilities all patients got weekly vaccination offerings. Between August 4, 2021 and August 19, 2021, a time period were COVID-19 vaccines were widely available for the adult population, the participating institutions selected a reference date and collected the bellow mentioned routine data of all inpatient and day-clinic patients in treatment at this day. For assessing representativity, the sample’s main diagnoses and age groups were compared to the latest version of the publicly available Germany-wide hospital statistic (“Krankenhausstatistik”) from 2019 of the German Federal Statistical Office (“Statistisches Bundesamt”) [21]. For comparing vaccination rates between the population hospitalized for mental illness and the general population, the regionally and age-matched general population vaccination rates were calculated using public data from the German Robert Koch Institute (RKI) from August 12, 2021 as a reference [22]. The RKI is Germany’s public health institute. Its vaccination statistic (“Implikationsmonitoring”) is the most reliable publicly available source based on a mandatory electronic reporting of all COVID-19 vaccinations. However, the RKI itself assumes a modest but tolerable underreporting on comparisons with vaccine delivery and accounting data.

Routine data indicators and outcomes

The following routine data variables were collected for all inpatient and day clinic services, they were chosen based on availability: Age categorical (18–39, 40–60, 60+); gender (female, male, and diverse); ICD-10 main diagnosis groups (F0: organic mental disorders, F1: addictive disorders, F2: psychoses, F3: affective disorders, F4: anxiety, obsessive-compulsive, stress-associated, dissociative, and somatoform disorders, and F6: personality disorders); presence of somatic comorbidities (adapted from the RKI’s list of risk conditions for severe SARS-CoV-2 outcomes), inpatient or day clinic setting; hospital stay >3 months; admission mode acute or elective; legal status “voluntary” or “coercive accommodation”; residential status “independent,” “assisted,” or “homeless”; and COVID-19 vaccination status “unvaccinated,” “partially vaccinated,” “fully vaccinated,” or “recovered.” The RKI list of risk conditions for severe SARS-CoV-2 outcomes comprised the following conditions: obesity with BMI >30, diabetes mellitus, disorders of the cardiovascular system (arterial hypertension, coronary heart disease, etc.) chronic lung diseases (COPD, etc.), neoplasms, chronic kidney and liver diseases, weakened immune system (by disease or medication).

Statistical analysis

To determine risk factors of the outcome “vaccination status unvaccinated,” a logistic regression with a multilevel random intercept model with “hospital site” as random effect was chosen because of categorical variables and high variation between hospital sites characteristics. To estimate the variance explained by the random effect “hospital site,” the Intraclass Correlation Coefficient was calculated. All other variables were then included in a model as fixed effects. In each case, the reference category used was the one with the highest vaccination rate (e.g., F3 for ICD-10 categories, see Table 1). To examine the goodness of fit of the model, Nakagawa’s marginal and conditional $R^2$ were used [23]. All calculations were performed in Rstudio 1.4.1717 using the “base,” “datasets,” and “lme4” packages.

Ethics, data protection, and funding

The COVID-19 Vac study was part of the BMBF-funded egePan collaborative project within the German National Network University Medicine (NUM), a network for COVID-19-related research. Positive votes from the regional ethics committees responsible for the participating institutions as well as the data protection department of the University Medicine Mainz were available. N = 88 patients had to be excluded for data protection reasons because they would have been individually identifiable based on the routine data variables.

Results

Population characteristics and sample representativity

Routine data from $n = 1,320$ patients was included in the study, 54% ($n = 711$) were female, 41% ($n = 538$) between 18 and 39 years, 33% ($n = 437$) between 40–60 and 26% ($n = 347$) above 60 years of age. Eighty-seven percentage ($n = 1,148$) were living independently, 10% ($n = 133$) in assisted living facilities and 3% ($n = 37$) were homeless. Seven percentage ($n = 95$) had an ICD-10 F0 main diagnosis, 16% ($n = 207$) an ICD-10 F1 main diagnosis, 21%
(n = 276) an F2 main diagnosis, 45% (n = 593) an F3 main diagnosis, 10% (n = 132) an F4 main diagnosis and 1% (n = 17) an F6 main diagnosis. Forty-six percentage (n = 610) had a known somatic comorbidity from the RKIs list of risk conditions for severe SARS-CoV-2 outcomes. Eighty-four percentage (n = 1,115) were in inpatient treatment, 16% (n = 207) in day-clinic treatment; 9% (n = 117) were coercively accommodated. Fifty-five percentage (n = 722) were admitted electively to inpatient or day-clinic treatment, 45% (n = 600) had an acute admission. Seven percentage (n = 93) had been in inpatient or day-clinic treatment for more than 3 months (Table 1).

Table 2 shows the sample’s gender, age groups and ICD-10 main diagnoses compared to the Federal Statistics Office’s statistic on all German mental health inpatient facilities in 2019. The two samples were largely comparable, except for the COVID \( \Psi \) Vac sample having slightly more patients in the 18–39 years group (41 vs. 34%) and slightly less patients in the 40–59 years group (33 vs. 40%).
Table 2. Comparison of Study Sample and Hospital Statistic 2019 Sample

| Variable                  | COVID Ψ Vac sample (n) | Hospital statistic 2019 of the federal statistics office sample* (n) |
|---------------------------|------------------------|---------------------------------------------------------------|
| Gender                    |                        |                                                               |
| F                         | 54                     | 53                                                            |
| M                         | 46                     | 47                                                            |
| Age group                 |                        |                                                               |
| 18–39                     | 41                     | 34                                                            |
| 40–60                     | 33                     | 40                                                            |
| 60+                       | 26                     | 26                                                            |
| Main diagnosis            |                        |                                                               |
| F0                        | 7                      | 8                                                             |
| F1                        | 16                     | 16                                                            |
| F2                        | 21                     | 19                                                            |
| F3                        | 45                     | 42                                                            |
| F4                        | 10                     | 10                                                            |
| F6                        | 1                      | 5                                                             |

*The hospital diagnosis statistics is an annual census of patients who were discharged from inpatient treatment in a hospital in Germany in the reporting year. It contains data of all hospitalized patients in Germany. The table shows the results filtered for the ICD-10 groups selected in the COVID Ψ Vac study.

Vaccination rates

The overall complete vaccination rate among hospitalized patients with mental illness was 59% (n = 776) with a large range between hospital sites of 32–71%. Three percentage (n = 41) were vaccinated during the hospital stay. Two percentage (n = 21) were recovered from a SARS-CoV-2 infection within the last 6 month and thus not eligible for vaccination. The regionally and age-matched general population complete vaccination rate was 64% and thus not eligible for vaccination. The regionally and age-matched general population complete vaccination rate was 64% [22]. Sixty-eight percentage (n = 893) of the hospitalized SMI patients were vaccinated at least once. Six percentage (n = 74) with partial vaccination were vaccinated during the hospital stay. In the regionally and age-matched general population 67% were vaccinated at least once.

Comparing main diagnosis groups, complete vaccination rates were highest with 71 and 67% for patients with an F6 (but very low n) and an F3 main diagnosis respectively and with 46% lowest for patients with an F2 main diagnosis.

In the age group 60+ vaccination rates were the highest with 65% (n = 227) completely vaccinated and 71% (n = 249) at least partially vaccinated. In the 40–60 years age group 63% (n = 274) were completely vaccinated, 71% (n = 313) at least partially vaccinated. In the 18–39 age group 51% (n = 275) were completely vaccinated, 61% (n = 331) at least partially vaccinated (Table 1).

Risk factors for being unvaccinated

To determine risk factors of the outcome “vaccination status unvaccinated,” a logistic regression with a multilevel random intercept model with “hospital site” as random effect was chosen. Patients with the gender “diverse,” “ICD-10 group F6,” and residence status “homeless” were excluded from regression because of too small group sizes. All other variables were then included in a model as fixed effects. In each case, the reference category used was the one with the highest vaccination rate. The ICD-10 categories F1, F2, and F4, age category 18–39, absence of somatic comorbidities, and legal status “coercive accommodation” showed significant effects (Table 3). Nakagawa’s marginal $R^2$ was 0.12, the conditional $R^2$ 0.22. The Intraclass Correlation Coefficient was calculated and 11.4% of the variance was explained by the random effect “hospital site.”

Because of the inevitable collinearity between the variables “age group” and “ICD-10 diagnostic group” we calculated the same model again just for the age group 40–60, in which all ICD-10 diagnostic groups were represented in significant numbers. For the ICD-10 categories F1 (odds ratio OR 2.92 [1.44–5.90], p = 0.003), F2 (OR 2.15 [1.07–4.32], p = 0.03), and F4 (OR 10.55 [3.97–28.02], p < 0.001) absence of somatic comorbidities (OR 1.73 [1.03–2.90], p = 0.04) and legal status “coercive accommodation” (OR 7.50 [2.43–23.11], p < 0.001) effects remained significant. Additionally, residential status “assisted” (OR 0.28 [0.10–0.83], p < 0.001) showed a significant effect.

Discussion

The results show mediocre vaccination rates of 59% in the fairly representative sample of hospitalized patients with mental illness and of 64% in the regionally and age-matched general population in Germany. Three observations are especially of interest when discussing vaccination rates and strategies for risk groups among mentally ill people.

First, the results show a lower full-vaccination rate for the hospitalized mentally ill compared to the general population.

Table 3. Logistic Regression Model for “Vaccination Status Unvaccinated”

| Variable               | Odds-ratio | p-value |
|------------------------|------------|---------|
| Intercept              | 0.12       | <0.001***|
| ICD-10 F0              | 1.22       | 0.53    |
| ICD-10 F1              | 2.43       | <0.001***|
| ICD-10 F2              | 1.65       | <0.01** |
| ICD-10 F4              | 1.81       | <0.01** |
| Age 18–39              | 1.88       | <0.01** |
| Age 40–60              | 1.12       | 0.60    |
| Sex male               | 0.96       | 0.76    |
| Somatic comorbidities  | 1.55       | <0.01** |
| Acute admission        | 1.31       | 0.12    |
| Coercive accommodation | 3.46       | <0.001***|
| Inpatient setting      | 1.37       | 0.14    |
| Assisted living        | 0.99       | 0.95    |
| Length of stay >3 month| 1.16       | 0.58    |
Currently, all over Europe COVID-19 infection protection and prevention measures are lifted. However, the COVID-19 pandemic is not over, incidences are still high and infections can still be deadly in unvaccinated risk groups. Therefore, especially in countries with a low general population vaccination rate like Germany, it must remain a continuous top public health priority to systematically protect vulnerable and stigmatized risk groups like people with severe mental illness. As people with mental illness often engage more readily with mental health than with somatic medicine providers, psychiatric hospitals, outpatient clinics, and office-based psychiatrists should be enabled systematically to provide vaccinations in order to prevent the mortality and morbidity gap of mentally ill populations to further widen by the pandemic.

Data Availability Statement. The data that support the findings of this study are available on request from the corresponding author (H.F.W.) within the limits of data protection. The data are not publicly available due to data protection requirements regarding individual patient routine data.

Acknowledgments. We would like to thank all participating institutions for providing the routine data used in this article. This project was realized within the German National Network University Medicines (Nutzer Universitätsmedizin [NUM]) collaborative project egePan Unimed ("Development, Testing and Implementation of regionally adaptive health care structures and processes for pandemic management guided by evidence and led by university clinics").

Author Contributions. Conceptualization: B.B., An.P., H.R., S.U., K.A., H.F.W., L.P.H.; Data curation: B.M., M.R., P.W., B.B., S.H., H.R., K.A., H.F.W.; Funding acquisition: A.P., K.D., P.F., K.L., H.F.W.; Investigation: B.M., M.R., P.W., B.B., S.H., K.A., H.F.W., L.P.H.; Methodology: B.B., An.P., H.R., S.U., K.A., H.F.W., L.P.H.; Project administration: B.B., K.A., H.F.W.; Resources: An.P., A.P., K.D., P.F., K.L., K.A., H.F.W., L.P.H.; Supervision: B.B., An.P., S.U., K.D., P.F., K.L., K.A., H.F.W., L.P.H.; Validation: An.P., A.P., K.A., H.F.W., L.P.H.; Writing—original draft: B.M., M.R., P.W., B.B.S.H., An.P., H.R., S.U., A.P., K.D., P.F., K.L., K.A., H.F.W., L.P.H.

Financial Support. egePan Unimed is funded by the German Federal Ministry of Education and Research (BMBF) as part of the Netzwerk Universitätsmedizin (NUM) initiative (Grant-No: 01KX2021).

Conflicts of Interest. H.F.W., B.M., M.R., P.W., B.B., S.H., H.R., S.U., L.P.H., A.P., K.D., and K.A. declare none. P.F. received research support/honoraria for lectures or advisory activities from: Abbott, Boehringer-Ingelheim, Janssen, Essex, Lundbeck, Otsuka, Recordati, Richter, Servier, and Takeda. He holds a paid position as chairman of the Psychiatric Department of the University Munich; is full professor at the Psychiatric Department of the University Munich. He has received and is currently receiving grants from several national and international foundations and institutions, for example, from the "German Science Foundation," the "German Ministry of Science," and the "German Ministry of Health." K.D. is a member of the Steering Committee Neurosciences, Janssen-Cilag GmbH.

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