

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

**Short title: COVID-19 vaccination in mentally ill**

**Current author list:**

Hauke Felix Wiegand, MD/PhD, Department of Psychiatry and Psychotherapy, University Medical Center of the Johannes Gutenberg-University Mainz  
Birgit Maicher, Department of Psychiatry and Psychotherapy, Carl Gustav Carus University Hospital, Medical Faculty, Technische Universität Dresden  
Mike Rueb, Department of Psychiatry and Psychotherapy, University Hospital, LMU Munich; Institute for Medical Information Processing, Biometry and Epidemiology, LMU Munich; Pettenkofer School of Public Health, Munich  
Paula Wessels, Department of Psychiatry, Psychosomatics and Psychotherapy, University Hospital of Würzburg  
Dr. med. Bianca Besteher, Department of Psychiatry and Psychotherapy, Jena University hospital  
Prof. Dr. med. Sabine Hellwig, Department of Psychiatry and Psychotherapy, Medical Center – University of Freiburg, Faculty of Medicine University of Freiburg, Germany  
Prof. Dr. med. Andrea Pfennig, Department of Psychiatry and Psychotherapy, Carl Gustav Carus University Hospital, Medical Faculty, Technische Universität Dresden  
Dr. med. Henrik Rohner, Department of Psychiatry and Psychotherapy, University Hospital of Bonn  
Dr. med. Stefan Unterecker, Department of Psychiatry, Psychosomatics and Psychotherapy, University Hospital of Würzburg  
Dr. phil. Lars Peer Hölzel, Department of Psychiatry and Psychotherapy, University Medical Center of the Johannes Gutenberg-University Mainz and Oberberg Parkklinik Schlangenbad, Wiesbaden Schlangenbad  
Prof. Dr. Alexandra Philipsen, Department of Psychiatry and Psychotherapy, University Hospital of Bonn  
Prof. Dr. med. Katharina Domschke, Department of Psychiatry and Psychotherapy, Medical Center – University of Freiburg, Faculty of Medicine University of Freiburg, Germany  
Prof. Dr. med. Peter Falkai, Department of Psychiatry and Psychotherapy, University Hospital, LMU Munich  
Prof. Dr. med. Klaus Lieb, Department of Psychiatry and Psychotherapy, University Medical Center of the Johannes Gutenberg-University Mainz  
Dr. med. Kristina Adorjan, Department of Psychiatry and Psychotherapy, University Hospital, LMU Munich

**Corresponding author:**

Hauke Felix Wiegand, MD/PhD  
Klinik für Psychiatrie und Psychotherapie  
Universitätsmedizin Mainz

This peer-reviewed article has been accepted for publication but not yet copyedited or typeset, and so may be subject to change during the production process. The article is considered published and may be cited using its DOI.

This is an Open Access article, distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives licence (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is unaltered and is properly cited. The written permission of Cambridge University Press must be obtained for commercial re-use or in order to create a derivative work.

44 Untere Zahlbacher Straße 8  
45 55118 Mainz  
46 Germany  
47  
48 Haukefelix.wiegand@unimedizin-mainz.de  
49  
50

**Abstract****Background**

Mental illness is a risk for COVID-19 related morbidity and mortality. Already without the COVID-19 pandemic mental illness goes along with a large mortality gap compared to the general population. Achieving high vaccination rates in people with mental illness is therefore of high priority. However, conflicting reports have been published on whether vaccination rates comparable to those of the general population can be achieved and which variables represent risk factors for non-vaccination in people with mental illness.

**Methods**

The COVID  $\Psi$  Vac study collected routine data on vaccination status, diagnostic groups, socio-demographics and setting characteristics from all in- and day-clinic patients of ten psychiatric hospitals in Germany in August 2021. Logistic regression modeling was used to determine risk factors for non-vaccination.

**Results**

Complete vaccination rates were 59% (n=776) for the hospitalized SMI versus 64% for the regionally and age-matched general population. 3% (n=41) of the completely vaccinated SMI patients received vaccination during their hospital stay. Partial vaccination rates were 68% (n=893) for the SMI versus 67% for the respective general population. 6% (n=74) of this SMI 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 non-vaccination 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.

**82 Introduction**

83 Mental illness is conceived a risk for COVID-19 related morbidity and mortality. Studies agree  
84 that patients with psychotic and to a lower degree mood disorders seem to be at risk for  
85 COVID-19 associated morbidity and mortality [1,2] and some studies show a higher risk for  
86 addiction disorders [3]. This risk status seems to be mostly related to common somatic  
87 comorbidities like metabolic syndrome, cardiovascular and respiratory disorders associated  
88 with mental disorders due to reduced self-care, medication side effects, more precarious  
89 social and living conditions and insufficient somatic medicine treatment [1-4]. By these risk  
90 factors in combination with pandemic-associated reduced health-care services [5,6] the  
91 COVID-19 pandemic has the potential to further broaden the appallingly large mortality gap  
92 for severe mental disorders [7,8]. Therefore, high vaccination rates among the risk groups  
93 with mental illness are of high public health priority. In the initial COVID-19 vaccination  
94 campaign in 2021, in some countries like Denmark, the Netherlands, the UK, and Germany  
95 populations with severe mental illness were prioritized for vaccination [9] but it remained  
96 unclear to what degree at-risk groups with mental illness were reached by vaccination  
97 campaigns in every-day routine health-care practice. Studies on vaccination rates of  
98 populations with mental illness in comparison to the general population showed  
99 heterogenous results: In some studies vaccination rates were comparable to or better than  
100 the general population [10-13] but in others people with mental illness showed much lower  
101 vaccination rates [14-17]. A common factor for vaccination rates similar to the general  
102 population seemed to be vaccination offerings by mental health institutions [10-12]. This  
103 corresponds to studies on reasons for non-vaccination that did not show a general vaccine  
104 hesitancy among people with mental illness but where organizational access issues appeared  
105 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 non-vaccination while others found no such differences [11,20]. Therefore, the first aim of the COVID  $\Psi$  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*

10 psychiatric hospitals and departments in five regions of Germany took part in the study. 7 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. 6 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 12.08.2021 as a reference [22]. The RKI is Germany's public health institute. Its vaccination statistic ("Impfquotenmonitoring") 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 based 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, 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, F6: personality disorders); presence of somatic comorbidities (adapted from the *Robert Koch-Institute's* (RKI) 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<sup>2</sup> 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 Ψ 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=1320 patients was included in the study, 54% (n=711) were female, 41% (n=538) between 18-39 years, 33% (n=437) between 40-60 and 26% (n=347) above 60 years of age. 87% (n=1148) were living independently, 10% (n=133) in assisted living facilities and 3% (n=37) were homeless. 7% (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. 46% (n=610) had a known somatic comorbidity from the RKIs list of risk conditions for severe SARS-CoV-2 outcomes. 84% (n=1115) were in inpatient treatment, 16% (n=207) in day-clinic treatment; 9% (n=117) were coercively accommodated. 55% (n=722) were admitted electively to inpatient or day-clinic treatment, 45% (n=600) had an acute admission. 7% (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% versus 34%) and slightly less patients in the 40-59 years group (33% versus 40%).

### *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%. 3% (n=41) were vaccinated during the hospital stay. 2% (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% [22]. 68% (n=893) of the hospitalized SMI patients were vaccinated at least once. 6% (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 (59% versus 64%) but a higher partial vaccination rate (68% versus 67%). This effect was largely due to in-hospital vaccination programs in some of the participating institutions, where patients hospitalized for mental illness got weekly vaccination offerings. Thereby, these routine care results confirm studies, which attributed lower vaccination rates in those with mental illness mainly to access barriers and not to a generally higher vaccination unwillingness [10-12,17-19,24]. They highlight the need to offer people with mental disorders repeatedly and actively COVID-19 vaccinations at all those health care providers, where they are in trusting and stigmatization-free contact with the

health care system, thus psychiatric hospitals, outpatient clinics, and office-based psychiatrists and not only at centralized vaccination facilities or somatic medicine providers. Second, the study identified risk factors for non-vaccination, namely a younger age, a principal diagnosis of addictive disorder, psychosis or F4 group disorder (anxiety, obsessive-compulsive, stress-related, dissociative and somatoform disorders) and coercive accommodation status. Psychoses have been identified as a risk factor for non-vaccination in other studies [15,16] and addiction has been associated with poorer COVID-19 outcomes [25]. The results of lower vaccination rates despite a higher risk correspond to findings of a poorer quality of physical health care in general in exactly these severely mentally ill populations despite a high burden of physical disorders and an alarmingly huge mortality gap compared to the general population [26]. Therefore, for preventing a further widening of the preexisting mortality gap in severely mentally ill people by the COVID-19 pandemic, mental health care and somatic medicine, including vaccination offerings, need to be better integrated in the future and mental health care facilities should routinely offer basic somatic medical care.

Third, despite Germany being a high-income country with universal health insurance coverage and during the data collection period in August 2021 widely available COVID-19 vaccines, vaccination rates were (and are still) quite low in comparison to e.g. in France or Denmark. Furthermore, a remarkably high regional variation was observable both in the population of hospitalized people with mental illness and in the general population. This fits other studies results that highlight the importance of regionally variable attitudes towards vaccinations.

This study has several limitations: The convenience sample of hospital sites with a large share of university hospitals was a compromise for gaining a large enough sample rapidly in

the light of the rapidly evolving pandemic in a country with unfortunately no routinely available access to routine data for research purposes and strict data protection laws. The use of quite coarse routine data variables collected for other purposes can give information about vaccination rates and diagnostic groups but not about subjective factors for non-vaccination. Therefore, further qualitative research on these factors is very important for identifying, understanding and addressing these factors in order to further boost vaccination rates. A further limitation is the exclusion of 6% (n=88) of the hospitals' patients, a compromise that had to be made for balancing needs for on the one hand data protection and on the other hand rapid study implementation. This exclusion might have led to bias or obscuration of smaller risk groups. However, regarding gender, age and ICD-10 diagnostic groups the studies sample can be regarded as representative for hospitalized patients with mental illness in Germany and the findings concerning vaccination rates, risk groups and the effect of in-hospital vaccination strategies should be fairly valid.

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.

**Acknowledgements**

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 (Netzwerk 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”).

**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**

Conflicts of Interest: Hauke Felix Wiegand, Birgit Maicher, Mike Rüb, Paula Wessels, Bianca Besteher, Sabine Hellwig, Henrik Rohner, Stefan Unterecker, Lars Hölzel, Alexandra Philipsen, Klaus Lieb and Kristina Adorjan declare none. Peter Falkai 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, e.g. from the "German Science Foundation", the "German Ministry of Science" and the "German Ministry of Health". Katharina Domschke is a member of the Steering Committee Neurosciences, Janssen-Cilag GmbH

321

322 **Data availability statement**

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

326

## References

- [1] Vai B, Mazza MG, Colli CD, Foiselle M, Allen B, Benedetti F, et al. Mental disorders and risk of COVID-19-related mortality, hospitalisation, and intensive care unit admission: a systematic review and meta-analysis. *The Lancet Psychiatry* 2021;1–16. doi:10.1016/S2215-0366(21)00232-7.
- [2] Toubasi AA, AbuAnzeh RB, Tawileh HBA, Aldebei RH, Alryalat SAS. A meta-analysis: The mortality and severity of COVID-19 among patients with mental disorders. *Psychiatry Res* 2021;299:113856. doi:10.1016/j.psychres.2021.113856.
- [3] Wang QQ, Kaelber DC, Xu R, Volkow ND. COVID-19 risk and outcomes in patients with substance use disorders: analyses from electronic health records in the United States. *Mol Psychiatry* 2021;1–10. doi:10.1038/s41380-020-00880-7.
- [4] Wang Q, Xu R, Volkow ND. Increased risk of COVID-19 infection and mortality in people with mental disorders: analysis from electronic health records in the United States. *World Psychiatry* 2021;20:124–30. doi:10.1002/wps.20806.
- [5] Adorjan K, Pogarell O, Pröbstl L, Rüb M, Wiegand HF, Tüscher O, et al. [Impact of the COVID-19 pandemic on the care situation in psychiatric hospitals in Germany]. *Nervenarzt* 2021;92:562–70. doi:10.1007/s00115-021-01129-6.
- [6] Busch AB, Huskamp HA, Raja P, Rose S, Mehrotra A. Disruptions in Care for Medicare Beneficiaries With Severe Mental Illness During the COVID-19 Pandemic. *JAMA Netw Open* 2022;5:e2145677–7. doi:10.1001/jamanetworkopen.2021.45677.
- [7] De Hert M, Correll CU, Bobes J, Cetkovich-Bakmas M, Cohen D, Asai I, et al. Physical illness in patients with severe mental disorders. I. Prevalence, impact of medications and disparities in health care. *World Psychiatry* 2011;10:52–77. doi:10.1002/j.2051-5545.2011.tb00014.x.
- [8] De Hert M, Cohen D, Bobes J, Cetkovich-Bakmas M, Leucht S, Ndeti DM, et al. Physical illness in patients with severe mental disorders. II. Barriers to care, monitoring and treatment guidelines, plus recommendations at the system and individual level. *World Psychiatry* 2011;10:138–51. doi:10.1002/j.2051-5545.2011.tb00036.x.
- [9] De Picker LJ. Closing COVID-19 mortality, vaccination, and evidence gaps for those with severe mental illness Comment. *The Lancet Psychiatry* 2021;1–2. doi:10.1016/S2215-0366(21)00291-1.
- [10] Mazereel V, Van Assche K, Detraux J, De Hert M. COVID-19 vaccination for people with severe mental illness: why, what, and how? *The Lancet Psychiatry* 2021;8. doi:https://doi.org/10.1016/S2215-0366(20)30564-2.
- [11] Mazereel V, Vanbrabant T, Desplenter F, Detraux J, De Picker L, Thys E, et al. COVID-19 Vaccination Rates in a Cohort Study of Patients With Mental Illness in Residential and Community Care. *Front Psychiatry* 2021;12:805528. doi:10.3389/fpsyt.2021.805528.
- [12] Peritogiannis V, Drakatos I, Gioti P, Garbi A. Vaccination rates against COVID-19 in patients with severe mental illness attending community mental health services in rural Greece. *Int J Soc Psychiatry* 2022;207640221081801. doi:10.1177/00207640221081801.
- [13] Hassan L, Sawyer C, Peek N, Lovell K, Carvalho AF, Solmi M, et al. COVID-19 vaccination uptake in people with severe mental illness: a UK-based cohort study. *World Psychiatry* 2022;21:153–4. doi:10.1002/wps.20945.

- [14] Huang H, Zhu X-M, Liang P-W, Fang Z-M, Luo W, Ma Y-M, et al. COVID-19 Vaccine Uptake, Acceptance, and Hesitancy Among Persons With Mental Disorders During the Second Stage of China's Nationwide Vaccine Rollout. *Front Med* 2021;8:761601. doi:10.3389/fmed.2021.761601.
- [15] Tzur Bitan D. Patients with schizophrenia are under-vaccinated for COVID-19: a report from Israel. *World Psychiatry* 2021;20:300–1. doi:10.1002/wps.20874.
- [16] Tzur Bitan D, Kridin K, Cohen AD, Weinstein O. COVID-19 hospitalisation, mortality, vaccination, and postvaccination trends among people with schizophrenia in Israel: a longitudinal cohort study. *The Lancet Psychiatry* 2021;8:901–8. doi:10.1016/S2215-0366(21)00256-X.
- [17] Arumuham A, O'Brien O, Ahmad Z, Nikbin K, Howes OD. Low COVID-19 vaccination rates in people with severe mental illness and reasons for this: An out-patient study. *Acta Psychiatr Scand* 2022;145:416–8. doi:10.1111/acps.13400.
- [18] Jefsen OH, Kølbaek P, Gil Y, Speed M, Dinesen PT, Sønderskov KM, et al. COVID-19 vaccine willingness amongst patients with mental illness compared with the general population. *Acta Neuropsychiatr* 2021;33:273–6. doi:10.1017/neu.2021.15.
- [19] Miles LW, Williams N, Luthy KE, Eden L. Adult Vaccination Rates in the Mentally Ill Population: An Outpatient Improvement Project. *J Am Psychiatr Nurses Assoc* 2020;26:172–80. doi:10.1177/1078390319831763.
- [20] Mazereel V, Vanbrabant T, Desplenter F, De Hert M. COVID-19 vaccine uptake in patients with psychiatric disorders admitted to or residing in a university psychiatric hospital. *The Lancet Psychiatry* 2021;8:860–1. doi:10.1016/S2215-0366(21)00301-1.
- [21] Statistisches Bundesamt. Krankenhausstatistik 2019. Downloaded from [https://www.gbe-bund.de/gbe/!pkg\\_olap\\_tables.prc\\_set\\_page?p\\_uid=gast&p\\_aid=29861792&p\\_sprache=D&p\\_help=2&p\\_indnr=544&p\\_ansnr=56616785&p\\_version=24&D.000=3741&D.001=1000001&D.002=1000002&D.003=1000004&D.972=28285](https://www.gbe-bund.de/gbe/!pkg_olap_tables.prc_set_page?p_uid=gast&p_aid=29861792&p_sprache=D&p_help=2&p_indnr=544&p_ansnr=56616785&p_version=24&D.000=3741&D.001=1000001&D.002=1000002&D.003=1000004&D.972=28285). Last accessed on 02.03.2022
- [22] Robert Koch Institut. Calculation of general populations vaccination rates based on the file “Deutschland Landkreise Impfungen 2021-11-08.csv”, publicly available from: [https://github.com/robert-koch-institut/COVID-19-Impfungen\\_in\\_Deutschland](https://github.com/robert-koch-institut/COVID-19-Impfungen_in_Deutschland). Last accessed on 05.12.2021
- [23] Nakagawa S, Johnson PCD, Schielzeth H. The coefficient of determination R<sup>2</sup> and intra-class correlation coefficient from generalized linear mixed-effects models revisited and expanded. *J R Soc Interface* 2017;14. doi:10.1098/rsif.2017.0213.
- [24] Danenberg R, Shemesh S, Bitan DT, Maoz H, Saker T, Dror C, et al. Attitudes of patients with severe mental illness towards COVID-19 vaccinations: A preliminary report from a public psychiatric hospital. *Journal of Psychiatric Research* 2021;143:16–20. doi:10.1016/j.jpsychires.2021.08.020.
- [25] Wang L, Wang Q, Davis PB, Volkow ND, Xu R. Increased risk for COVID-19 breakthrough infection in fully vaccinated patients with substance use disorders in the United States between December 2020 and August 2021. *World Psychiatry* 2021. doi:10.1002/wps.20921.
- [26] Liu NH, Daumit GL, Dua T, Aquila R, Charlson F, Cuijpers P, et al. Excess mortality in persons with severe mental disorders: a multilevel intervention framework and priorities for clinical practice, policy and research agendas. *World Psychiatry* 2017;16:30–40. doi:10.1002/wps.20384.