

*SUPPLEMENTARY MATERIAL*

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*Short Communication*

**COVID-19 vaccine willingness among patients with mental illness  
compared with the general population**

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# Supplementary methods

## Survey of patients with mental illness

### *Participants*

To investigate vaccine willingness among patients with mental illness, we conducted a follow-up to a previous survey, which is described in detail elsewhere (Kølbæk et al., 2021). In brief, the first survey was a questionnaire-based online survey, which was fielded from June 30 to July 20, 2020. The survey data were coupled with sociodemographic and clinical data from the electronic medical records of all invitees, enabling analysis of attrition and weighting of results. A random sample of 6,000 patients from the psychiatric services of the Central Denmark Region were invited to participate in the survey via the electronic mailing system (e-Boks) used by the Danish authorities (The Agency for Digitisation, 2020). Of these invitees, 541 did not use e-Boks and were consequently excluded. Subsequently, in order to target a population with established mental illness prior to the pandemic lockdown in Denmark, we excluded 877 patients who were not registered with a psychiatric diagnosis before the lockdown. Of the remaining 4,582 patients, 992 responded (response rate of 21.6%)(Kølbæk et al., 2021). For the present survey regarding vaccine willingness, we invited all 992 respondents from the initial survey to participate in the follow-up.

### *Procedure and questionnaire – survey on vaccine willingness*

We distributed survey invitations via e-Boks. We repeated most of the questions used in the initial survey, while adding questions regarding vaccine willingness. Specifically, we asked all participants the following questions: “Have you been offered vaccination against coronavirus?”. The response options were: “Yes”, “No”, and “Do not wish to answer”. Participants who responded “Yes” were then asked “Have you accepted this offer?”. Conversely, participants who responded “No” or “Do not wish to answer” were asked “Will you accept vaccination against coronavirus, once it is offered to you?”. The response options for both of these questions were: “Yes”, “No”, and “Do not wish to answer”. The participants could not skip the questions regarding vaccine willingness but could leave the survey prior to these questions (and were then considered as non-respondents). Participants who responded “No” to having accepted/being willing to accept coronavirus vaccination were then asked “Why have you not accepted to be vaccinated against coronavirus?” or “Why will you not accept the offer to be vaccinated against coronavirus?”, respectively, and were invited to respond with text input. The survey was fielded from February 9 to February 22, 2021.

### *Supplementary data used for weighting of vaccine willingness*

Supplementary sociodemographic and clinical data employed for weighting (see below) were derived from the initial survey (Kølbæk et al., 2021). For the present study, data on hospital admissions and outpatient contacts were updated (data were included up to February 8, 2021, i.e., the day prior to fielding the survey).

### *Weighting of vaccine willingness*

To render the sample representative of the population of patients with mental illness on a number of sociodemographic and clinical parameters, we weighted estimates of vaccine willingness using the inverse propensity weighted (IPW) estimation method (Cole and Hernán, 2008) For the IPW estimation, we used the demographic and clinical variables on which the respondents and non-respondents differed with statistical significance as weights, namely, sex, age, relationship status, municipality, psychiatric diagnosis and the number of outpatient visits in the pre-pandemic and pandemic period, respectively (see Kølbaek et al., 2021 for further details on these variables).

### *Legal and ethical considerations*

The survey was approved by the Danish Patient Safety Authority, the Legal Office of the Central Denmark Region, and the medical directors of the hospitals in the Central Denmark Region. All data were processed and stored in accordance with the European Union General Data Protection Regulation. Ethical review board approval is not required for survey-based studies in Denmark.

## **Survey of the general population**

### *Participants*

To investigate vaccine willingness in the general Danish population, we conducted a follow-up to a previous panel survey, which is described in detail elsewhere (Sønderskov et al., 2020a). In brief, the first round of this survey was conducted by the survey agency Epinion from March 31 to April 6, 2020 and had 2,458 respondents sampled from Epinion's respondent pool. This was followed by two subsequent survey rounds (also conducted by Epinion) targeting the 2,458 respondents from the first survey. The two follow-up surveys were fielded from April 22 to April 30, 2020 (Sønderskov et al., 2020b), and from November 20 to December 8, 2020 (Sønderskov et al., 2021), respectively. For the present survey on vaccine willingness, we invited all 2,458 respondents from the initial survey to participate.

### *Procedure and questionnaire – survey of vaccine willingness*

We again commissioned Epinion to conduct the survey, which also contained questions regarding political attitudes and psychological well-being for other research purposes. The questions regarding vaccine willingness and the response options were identical to those described above for the survey of patients with mental illness. However, the open-ended questions regarding reasons for not accepting/not intending to accept COVID-19 vaccination (conditioned on a “no” response to the questions regarding vaccine willingness) were not included. The survey was fielded from February 4 to February 21, 2021.

#### *Supplementary data used for weighting of vaccine willingness*

Supplementary sociodemographic and behavioral data used for weighting (see below) was available in the present survey (and for the general Danish population as a whole).

#### *Weighting of vaccine willingness*

To minimize the impact of attrition bias, we weighted estimates of vaccine willingness using the inverse propensity weighted (IPW) estimation method constructed by the survey company (Cole and Hernán, 2008). For the IPW estimation, sex, age, level of education, region, and political party choice at last general election (June 5, 2019) was used.

#### *Legal and ethical considerations*

All data were processed and stored in accordance with the European Union General Data Protection Regulation. Participation in the survey was based on consent. Ethical review board approval is not required for survey-based studies in Denmark.

**Supplementary Table 1.** Sociodemographic and clinical characteristics of the respondents from the patient sample.

Characteristics	Respondents (n = 608)	
	Unweighted	Weighted
<b>Sex, n (%)</b>		
Female	425 (69.9)	369 (61.5)
<b>Age</b>		
1 <sup>st</sup> ; 2 <sup>nd</sup> ; 3 <sup>rd</sup> quartile	27; 37; 51	26; 36; 50
<b>Civil status, n (%)</b>		
Single	346 (56.9)	391 (65.1)
Married or reg. partnership	170 (28.0)	113 (18.8)
Divorced or repeal of reg. partnership	82 (13.5)	86 (14.3)
Widow/widower	10 (1.6)	11 (1.8)
<b>Municipality, n (%)</b>		
Inhabitants 150,000-350,000	232 (38.2)	196 (32.6)
Inhabitants 50,000-150,000	235 (38.7)	276 (45.9)
Inhabitants < 50,000 + unknown <sup>b</sup>	141 (23.2)	129 (21.5)
<b>Diagnosis, n (%)</b>		
F10-F19 <sup>a</sup>	< 5	6 (0.9)
F20-F29	119 (19.6)	170 (28.3)
F30-F31	112 (18.4)	95 (15.7)
F32-F33	217 (35.7)	165 (27.5)
F40-F48	89 (14.6)	91 (15.2)
F50-F59	7 (1.2)	6 (1.0)
F60-F69	38 (6.2)	32 (5.3)
F90-F98	21 (3.5)	30 (5.0)
Other <sup>a,c</sup>	< 5	6 (0.9)
<b>Psychiatric inpatient days, median (IQR)</b>		
Pre-corona (01.01.2015-10.03.2020)	0 (0;17)	0 (0;17)
Corona (11.03.2020-08.02.2021)	0 (0;0)	0 (0;0)
<b>Psychiatric outpatient visits<sup>d</sup>, median (IQR)</b>		
Pre-corona (01.01.2015-10.03.2020)	44 (17;87)	41 (16;77)
Corona (11.03.2020-08.02.2021)	20 (12;32)	18 (10;28)
<b>Adults living in your household besides yourself?</b>		
Yes <sup>d</sup>	370 (61.1)	334 (55.8)
<b>Children living in your household?</b>		
Yes <sup>d</sup>	166 (27.4)	140 (23.4)
<b>Were you born in Denmark?</b>		
Yes <sup>e</sup>	558 (92.7)	552 (92.6)
<b>Where were you born? (condition: previous question = No)<sup>e</sup></b>		
Asia	5 (11.4)	5 (11.2)
Europe	20 (45.5)	19 (41.5)
Middle East	8 (18.2)	8 (18.2)
North America + South America	5 (11.4)	5 (10.8)
Africa + Oceania + missings	6 (13.6)	8 (18.3)
<b>What is your highest attained educational level?<sup>f</sup></b>		
Primary and lower secondary school	105 (17.4)	124 (20.8)
Upper secondary education	160 (26.5)	156 (26.2)
Skilled worker/craftsman	38 (6.3)	43 (7.2)
Short-cycle higher education	97 (16.1)	98 (16.4)
Medium-cycle higher education including bachelor	131 (21.7)	108 (18.1)
Long-cycle higher education	73 (12.1)	67 (11.3)

<b>What describes your current employment status?<sup>g</sup></b>		
Full-time student	46 (7.6)	45 (7.5)
Part-time student	14 (2.3)	13 (2.2)
Full-time employed	50 (8.3)	52 (8.7)
Part-time employed	24 (4.0)	24 (4.0)
Subsidized employment	51 (8.5)	50 (8.3)
Absent owing to illness	211 (35.0)	197 (33.0)
Unemployed	67 (11.1)	75 (12.5)
Retired	140 (23.2)	142 (23.8)
<b>WHO-5, median (IQR)</b>	36 (20;52)	36 (20;56)
<b>BSI-18, median (IQR)</b>	27 (16;38)	27 (16;37)

<sup>a</sup> To reduce risk of identifying individual respondents.

<sup>b</sup> Undisclosed municipality.

<sup>c</sup> F34 + F38 + F39 + F80-F89.

<sup>d</sup> Proportion is taken of 606.

<sup>e</sup> Proportion is taken of 602.

<sup>f</sup> Proportion is taken of 604.

<sup>g</sup> Proportion is taken of 603.

**Supplementary Table 2:** Sociodemographic characteristics of the respondents from the general population sample.

Characteristics	Respondents(n = 1654)	
	Unweighted	Weighted
<b>Sex, n (%)</b>		
Female	806 (48.7)	842 (50.9)
<b>Age</b>		
1 <sup>st</sup> ; 2 <sup>nd</sup> ; 3 <sup>rd</sup> quartile	37; 54; 67	34; 51; 65
<b>Children living in your household? (%)</b>		
Yes	250 (15.1)	1372 (82.9)
<b>Were you born in Denmark? (%)</b>		
Yes	1500 (95.4)	1503 (90.8)
No	69 (4.2)	69 (4.2)
No information	85 (5.1)	83 (5.0)
<b>What is your highest attained educational level? (%)</b>		
Primary and lower secondary school	242 (14.6)	260 (15.7)
Upper secondary education	794 (48.0)	845 (51.0)
Short-cycle higher education	117 (7.1)	103 (6.2)
Medium-cycle higher education including bachelor	340 (20.6)	296 (17.9)
Long-cycle higher education	161 (9.7)	151 (9.1)
<b>What describes your current employment status? (%)</b>		
Student	139 (8.4)	161 (9.7)
Working	749 (45.3)	795 (48.5)
Absent owing to illness	31 (1.9)	35 (2.1)
Unemployed	91 (5.5)	97 (5.9)
Retired	581 (35.1)	501 (30.3)
Other	63 (3.8)	65 (4.0)
<b>WHO-5; median (IQR)</b>	68 (52;76)	64 (48;76)

**Supplementary Table 3.** Responses regarding COVID-19 vaccine willingness among patients with mental illness and the general population.

Survey questions	Patients with mental illness (n = 608)			General population (n = 1654)		
	Yes	No	Do not wish to answer	Yes	No	Do not wish to answer
Have you been offered vaccination against coronavirus?	20 (3.3)	583 (95.9)	5 (0.8)	79 (4.8)	1575 (95.2)	0 (0.0)
(if yes) Have you accepted this offer?	16 (80.0)	4 (20) <sup>a</sup>		67 (84.8)	12 (15.2) <sup>a</sup>	
(if no) Will you accept vaccination against coronavirus, once it is offered to you?	505 (85.9)	36 (6.1)	47 (8.0)	1430 (90.8)	87 (5.5)	58 (3.7)

<sup>a</sup> Cells are merged to reduce risk of identifying individual respondents.

**Supplementary Table 4.** Weighted estimates of COVID-19 vaccine willingness among patients with mental illness and the general population.

Weighted COVID-19 vaccine willingness	Patients with mental illness	General population	P-value for comparison
Proportion of participants accepting vaccination, among those offered vaccination, %	76.4	83.8	$P = .437^a$ $P = .465^b$
Proportion of participants accepting vaccination, among those not yet offered vaccination, %	85.1	89.8	$P = .001^a$
Proportion of participants accepting vaccination, among those offered and those not yet offered vaccination (overall vaccine willingness), %	84.8	89.5	$P < .001^a$

<sup>a</sup> Two-sample test of proportions with one-sided  $P$ -value.

<sup>b</sup> One-sided Fisher's exact test

**Supplementary Table 5.** Multivariate logistic regression on patients with mental illness with weighted vaccination hesitancy as outcome (participants responding either ‘No’ or ‘Do not wish to answer’ to the vaccine willingness versus ‘Yes’ (reference). Significant p-values are marked in bold.

	OR	CI <sub>95%</sub> (OR)	z-value	P-value
<b>Clinical and demographic variables</b>				
<b>Sex (reference: male)</b>				
Female	1.14	(0.62;2.13)	0.41	0.683
<b>Age (reference: &gt;3<sup>rd</sup> quantile of age)</b>				
≤ 1 <sup>st</sup> quantile	5.80	(1.63;22.39)	2.64	<b>0.008</b>
> 1 <sup>st</sup> ; ≤ 2 <sup>nd</sup> quantile	5.89	(1.99;19.04)	3.09	<b>0.002</b>
> 2 <sup>nd</sup> ; ≤ 3 <sup>rd</sup> quantile	1.39	(0.49;4.16)	0.61	0.539
<b>Civil status (reference: married &amp; registered partnership)</b>				
Single	1.11	(0.41;3.08)	0.20	0.842
Divorced, Repeal of registered partnership	4.14	(1.50;11.94)	2.70	<b>0.007</b>
Widow/widower	1.60	(0.05;14.67)	0.36	0.722
<b>Municipality (reference: Inhabitants &lt; 50,000)</b>				
Inhabitants 150,000-350,000)	0.49	(0.22;1.11)	-1.72	0.086
Inhabitants 50,000-150,000	0.92	(0.47;1.84)	-0.24	0.812
<b>Diagnosis (reference: F32-F33)</b>				
F20-F29	0.83	(0.35;1.93)	-0.43	0.666
F30-F31	1.89	(0.80;4.45)	1.46	0.143
F40-F49	0.67	(0.27;1.62)	-0.87	0.385
F50-F59	3.28	(0.17;27.40)	0.99	0.321
F60-F69	0.57	(0.13;1.95)	-0.83	0.406
F90-F98	1.06	(0.30;3.40)	0.09	0.929
Other <sup>a</sup>	1.40	(0.12;10.17)	0.31	0.758
<b>Psychiatric admission pre-corona (reference: no admission)</b>				
Admission	0.69	(0.35;1.36)	-1.05	0.293
<b>Psychiatric admission corona (reference: no admission)</b>				
Admission	1.05	(0.46;2.31)	0.12	0.904
<b>Psychiatric outpatient visits pre-corona (reference: 1<sup>st</sup> quantile)</b>				
1 <sup>st</sup> -2 <sup>nd</sup> quantile	0.86	(0.40;1.82)	-0.40	0.686
2 <sup>nd</sup> -3 <sup>rd</sup> quantile	0.93	(0.42;2.04)	-0.19	0.849
>3 <sup>rd</sup> quantile	0.82	(0.33;2.02)	-0.43	0.666
<b>Psychiatric outpatient visits corona (reference: 1<sup>st</sup> quantile)</b>				
1 <sup>st</sup> -2 <sup>nd</sup> quantile	0.79	(0.37;1.63)	-0.65	0.518
2 <sup>nd</sup> -3 <sup>rd</sup> quantile	1.26	(0.60;2.64)	0.61	0.542
>3 <sup>rd</sup> quantile	0.68	(0.27;1.64)	-0.84	0.404
<b>What is your highest attained educational level? (reference: long-cycle higher education)</b>				
Primary and lower secondary school	1.30	(0.45;3.92)	0.48	0.630
Upper secondary education	0.78	(0.28;2.28)	-0.47	0.639
Skilled worker/craftsman	1.40	(0.39;5.00)	0.52	0.602
Short-cycle higher education	0.66	(0.21;2.10)	-0.70	0.482
Medium-cycle higher education including bachelor	0.69	(0.23;2.16)	-0.64	0.523
<b>What describes your current employment status? (reference: full-time employed)</b>				
Full-time student	2.56	(0.65;10.58)	1.34	0.181
Part-time student	2.37	(0.20;18.41)	0.78	0.433



Part-time employed	2.90	(0.57;14.02)	1.32	0.185
Subsidized employment	1.91	(0.44;8.42)	0.88	0.380
Absent owing to illness	2.29	(0.79;7.67)	1.44	0.149
Unemployed	2.95	(0.88;11.04)	1.69	0.091
Retired	2.22	(0.59;9.24)	1.15	0.251
<b>Adults living in your household besides yourself? (reference: yes)</b>				
No	0.70	(0.37;1.31)	-1.10	0.269
<b>Children living in your household? (reference: no)</b>				
Yes	1.44	(0.67;3.11)	0.94	0.349
<b>Were you born in Denmark? (reference: yes)</b>				
No	4.51	(1.84;11.04)	3.31	<b>0.001</b>
<b>WHO-5 (reference: ≤1<sup>st</sup> quantile of WHO-5)</b>				
1 <sup>st</sup> -2 <sup>nd</sup> quantile	1.02	(0.48;2.15)	0.06	0.956
2 <sup>nd</sup> -3 <sup>rd</sup> quantile	0.67	(0.27;1.61)	-0.87	0.382
>3 <sup>rd</sup> quantile	1.37	(0.48;3.91)	0.60	0.550
<b>BSI-18 (reference: ≤1<sup>st</sup> quantile of BSI-18)</b>				
1 <sup>st</sup> -2 <sup>nd</sup> quantile	0.71	(0.27;1.85)	-0.70	0.483
2 <sup>nd</sup> -3 <sup>rd</sup> quantile	1.71	(0.65;4.65)	1.08	0.282
>3 <sup>rd</sup> quantile	1.24	(0.42;3.77)	0.39	0.697
<b>Observations</b>	594			

**Supplementary Table 6.** Multivariate logistic regression on the general population with weighted vaccination hesitancy as outcome (participants responding either ‘No’ or ‘Do not wish to answer’ to the vaccine willingness versus ‘Yes’ (reference). Significant p-values are marked in bold.

<b>Clinical and demographic variables</b>	<b>OR</b>	<b>CI<sub>95%</sub> (OR)</b>	<b>z-value</b>	<b>P-value</b>
<b>Sex (reference: male)</b>				
Female	1.26	0.88,1.80	1.25	0.208
<b>Age (reference: &gt;3<sup>rd</sup> quantile of age)</b>				
≤ 1 <sup>st</sup> quantile	3.41	1.48;7.84	2.88	<b>0.004</b>
> 1 <sup>st</sup> ; ≤ 2 <sup>nd</sup> quantile	2.95	1.38;6.33	2.78	<b>0.005</b>
> 2 <sup>nd</sup> ; ≤ 3 <sup>rd</sup> quantile	0.89	0.40;1.98	-0.29	0.769
<b>Highest obtained educational level (reference: long-cycle higher education)</b>				
Primary and lower secondary school	3.36	1.49,7.56	2.92	<b>0.003</b>
Upper secondary education	2.55	1.21,5.39	2.45	<b>0.014</b>
Short-cycle higher education	2.70	1.02,7.13	2.00	<b>0.045</b>
Medium-cycle higher education including bachelor	1.50	0.66,3.40	0.96	0.336
<b>Current employment status (reference: employed)</b>				
Student	1.06	0.57;1.98	0.18	0.859
Absent owing to illness	3.87	1.60;9.38	3.00	<b>0.003</b>
Unemployed	1.68	0.88;3.22	1.57	0.117
Retired	1.06	0.57;1.98	0.20	0.843
Other	1.16	0.48;2.79	0.33	0.745
<b>Children living in household (reference: no)</b>				
Yes	1.60	1.03;2.51	2.08	<b>0.038</b>
<b>Born in Denmark (reference: yes)</b>				
No	1.66	0.78,3.56	1.31	0.189
No information	0.49	0.17,1.43	-1.30	0.192
<b>WHO-5 (reference: ≤1st quantile of WHO-5)</b>				
1st-2nd quantile	0.67	0.42,1.07	-1.69	0.091
2nd-3rd quantile	0.91	0.54,1.51	-0.37	0.708
>3rd quantile	0.99	0.59,1.67	-0.04	0.968
Observations	1654			

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