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Association between SARS-CoV-2 infection and self-harm: a Danish nationwide, register-based cohort study.

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21 **ABSTRACT**

22 **Background:** Case studies have linked SARS-CoV-2 infection to suicidal behaviour. However,
23 conclusive evidence is lacking.

24 **Aims:** To examine whether a history of SARS-CoV-2 infection or SARS-CoV-2 related
25 hospitalisation was associated with self-harm in the general population and in high-risk groups.

26 **Method:** A cohort design was applied to nationwide data on all people aged 15+ years and living in
27 Denmark between Feb 27, 2020 and Oct 15, 2021. Exposure was identified as a positive SARS-
28 CoV-2 PCR-test, and further assessed as SARS-CoV-2-related hospitalisation. Rates of probable
29 self-harm were examined using adjusted incidence rate ratios (aIRRs). The following subgroups
30 were identified: (1) lower educational level, (2) chronic medical conditions, (3) disability pension,
31 (4) mental disorders, (5) substance misuse disorders, and (6) history of homelessness and (7)
32 imprisonment.

33 **Results:** Among 4,412,248 included individuals, 260,663 (5.9%) had tested positive for SARS-
34 CoV-2. Out of 5,453 individuals presenting with self-harm, 131 (2.4%) had been infected.
35 Individuals with a history of a positive SARS-CoV-2 test result had an aIRR for self-harm of 0.86
36 (95% CI: 0.72-1.03) when compared to those without. High rates were found after a SARS-CoV-2
37 related hospitalisation (aIRR: 7.68; 95% CI: 5.61-10.51) or a non-SARS-CoV-2 related
38 hospitalisation (aIRR: 10.27; 95% CI: 9.65-10.93) versus non-infected and not hospitalised. In
39 sensitivity analyses, a positive PCR-test was associated with lower rates of self-harm.

40 **Conclusions:** Individuals with a PCR-confirmed SARS-CoV-2 infection did not have higher rates
41 of self-harm than those without. Hospitalisation in general seemed to be linked to elevated rates of
42 self-harm, rather than being SARS-CoV-2 positive.

43

44 **RELEVANCE**

45 The absence of elevated risks of self-harm among individuals with PCR-confirmed SARS-CoV-2
46 infection will help clinicians to evaluate patient's safety in the context of the recent pandemic and
47 its on-going consequences. Evidence regarding no excess rates of self-harm in relation to SARS-
48 CoV-2 infection in high-risk groups, such as individuals with severe mental disorders and substance
49 misuse, might bring confidence to risk assessments when conducted, for instance via online tools
50 and in unusual settings.

51

52 **INTRODUCTION**

53 According to case reports, being infected with SARS-CoV-2 might be associated with suicidal
54 ideation or self-harm (intentional non-fatal self-poisoning or self-injury).¹⁻³ Although large-scale
55 studies of SARS-CoV-2 infection and self-harm are lacking, general infections have previously
56 been linked with increased suicide risk.⁴ Suicidal ideation could also arise during periods of SARS-
57 CoV-2 infection-related distress, for instance, after isolation, quarantine or experiences of trauma,
58 which have been reported frequently by SARS-CoV-2 positive individuals.^{1,5} Moreover, infections,
59 and the activation of the immune system and systemic inflammation, related to SARS-CoV-2 have
60 been associated with increased risk of mental disorders,^{6,7} Also, individuals with hospital contacts
61 for SARS-CoV-2 have been found to have higher risks of mental disorders, such as mood and
62 anxiety disorders, in comparison to individuals hospitalised for other reasons, for instance, skin
63 infection and fracture of large bones.⁸

64

65

66 *High risk groups*

67 Individuals with chronic medical conditions and mental disorders and also homeless or incarcerated
68 people, who are all known to have higher rates of suicide.⁹⁻¹² A lower SARS-CoV-2 vaccination
69 rates have found among these groups, implying an increased probability of a complicated course of
70 any SARS-CoV-2 infection.¹³ Indeed, higher occurrences of SARS-CoV-2-related morbidity and
71 mortality have been reported for all of these groups when compared to the general population.¹⁴
72 During the pandemic, higher levels of psychological distress have been found for several of these
73 groups as well as individuals of lower educational.¹⁵ In addition to people suffering from chronic or
74 mental disorders and those belonging to socially marginalised groups, older adults may be
75 disproportionately affected by psychological distress when infected with SARS-CoV-2.¹⁶ It remains

76 to be examined whether the outcome of SARS-CoV-2 infection may be more amplified in these
77 high-risk groups, for instance, due to limited and interrupted access to on-going and new treatment
78 as well as general support for other issues, such as social welfare.

79
80 The aim of the current study was to examine whether individuals who tested positive for SARS-
81 CoV-2 had higher rates of self-harm than individuals with no such history. Furthermore, we aimed
82 to analyse whether people with (1) lower educational level, (2) chronic medical conditions, (3)
83 disability pension, (4) mental disorders, (5) substance misuse, or a history of either (6)
84 homelessness or (7) imprisonment and who had tested positive for SARS-CoV-2 had higher rates of
85 self-harm when compared to peers with no history of a SARS-CoV-2 infection. Until the end of
86 2021, Denmark had one of the highest rates of PCR-tests for SARS-CoV-2 in the world.¹⁷ It also
87 has national administrative registries, which enable excellent individual-level linkage of data
88 records.¹⁸ Linking information on individual PCR-tests with other national individual-level data
89 records provides a unique opportunity for conducting studies with high validity.

90
91 **METHODS**

92 *Study design and data sources*

93 A cohort design was applied to longitudinal, nationwide, register-based data on all people who were
94 living in Denmark between Feb 27, 2020 and Oct 15, 2021. The start date marked the first
95 confirmed SARS-CoV-2 case in Denmark,¹⁹ while the end of follow-up was defined by the recency
96 of data. Information on all residents living in Denmark was obtained from the Danish Civil
97 Registration System.²⁰ Using the unique personal identification number assigned to all individuals,
98 a linkage to data from the following registers was facilitated: the Danish Microbiology Database,²¹
99 the Population Education Register,²² the National Patient Register,²³ the Psychiatric Central

100 Research Register,²⁴ the National Prescription Registry,²⁵ the Homeless Register,¹¹ and the Central
101 Criminal Register.²⁶ The National Patient Register and the Psychiatric Central Research Register
102 provided dates and diagnoses from for all somatic inpatient contacts since 1994 and all psychiatric
103 inpatient contacts since 1969, respectively. Outpatient and emergency department contacts were
104 recorded since 1995 in both registers. Socio-demographic information, including socio-economic
105 status, was obtained from Statistics Denmark.

106

107 *Study population*

108 All individuals who lived in Denmark and were 15 years or older, i.e., born on 15th October 2006 or
109 earlier, were included. The following sub-groups, which have been suggested as being vulnerable to
110 SARS-CoV-2 infection, were identified: people who attended/had: (1) primary school or less
111 education, (2) chronic medical conditions, (3) disability pension, (4) a history of mental disorders,
112 including severe mental disorders, (5) substance misuse disorders, (6) history of homelessness, and
113 (7) history of imprisonment. Information on highest obtained education was collected from the
114 Population Education Register and based on the status in September 2019 (Supplementary Table 1).
115 Persons who had been approved for disability pension prior to 2020 were identified through their
116 socio-economic status. People with chronic medical conditions were identified using diagnoses for
117 31 medical conditions recorded according to the 10th revision of the International Classification of
118 Disease (ICD) in the National Patient Register,²⁷ and which had been diagnosed prior to Feb 27,
119 2020. In addition, records of medication prescribed for chronic medical conditions were obtained
120 from the National Prescription Registry (Supplementary Table 2).^{24, 28} Severe mental illness was
121 defined as having been diagnosed with schizophrenia, bipolar disorder, or depressive disorder at
122 some point after 1969 and recorded in the Psychiatric Central Research Register. Persons with
123 substance use disorders were identified using the same data source as for mental disorders, as well

124 as data on treatment from the Registry of Drug Abusers Undergoing Treatment for the period of
125 1996-2018 and supplemented with information from the National Registry of Alcohol Treatment
126 during 2006-2018. In addition, we applied information on drugs used to treat addictive disorders
127 from the National Prescription Registry since 2015 to identify people with substance misuse.
128 Homeless people were identified using a previously developed algorithm, which primarily was
129 based on the Homeless Register with nationwide information on homeless shelter contacts in
130 Denmark during 1999-2020.¹³ Persons who at some point during 1991-2020 had been imprisoned
131 were identified in the Central Criminal Register.

132

133 *Ascertainment of infection with SARS-CoV-2*

134 Individuals with a SARS-CoV-2 infection were identified as having had a positive PCR-confirmed
135 SARS-CoV-2 infection. PCR-tests were conducted as throat swabs in any of the free-of-charge test
136 stations in Denmark and retrieved from the national Danish Microbiology Database with the last
137 update on Oct 15, 2021.^{19, 21} Individuals were considered as infected from the date of a first record
138 of being SARS-CoV-2 positive until the end of the follow-up. In addition, we considered people
139 who had been admitted to somatic hospital for more than 12 hours and within 14 days from the date
140 of a positive PCR-test as having a SARS-CoV-2 infection-related hospitalisation.¹⁴

141

142 *Outcome*

143 Due to the fact that self-harm events are under-recorded in Danish registries,²⁹ we opted to examine
144 a broader algorithm of hospital contacts, which might be considered probable self-harm. This
145 category covers self-harm regardless of intent, and included poisoning by drugs and, biological and
146 nonmedical substances, as well as lesions to the hand and forearm. Self-harm episodes were
147 identified as presentations to either psychiatric or somatic hospitals, includes emergency

148 departments and recorded in the National Patient Registry with one of the following ICD diagnoses:
149 ICD-10: X60-X84, or where the reason for contact was coded as being suicide attempt (ALCC04)
150 or non-suicidal self-harm (ALCC05). In addition, the following combinations of ICD diagnoses
151 were included: a main diagnosis of a mental disorder (ICD-10: F00-F99) together with one of the
152 following sub-diagnoses: S51, S55, S59, S61, S65, S69 (cutting by sharp objects), T36–T50
153 (poisoning by pharmaceuticals), T52–T60 (poisoning by non-pharmaceuticals) as well as all
154 admissions with a main diagnosis of T39, T40 (poisoning by mild analgesics; except T40.1), T42,
155 T43, and T58 (poisoning by opioids, psychotropics, and by carbon monoxide). Individuals who died
156 on the same or subsequent day as the record of the self-harm were considered as having died by
157 suicide and excluded. The same measure has been used previously.²⁹

158

159 As a sensitivity analysis, we restricted the outcome to only consist of self-harm episodes, which
160 were exclusively identified as diagnoses (ICD-10: X60-X84) or where the reason for contact was
161 coded as being a suicide attempt (ALCC04).

162

163 *Follow-up*

164 Participants were followed from Feb 27, 2020 to date of first upcoming self-harm episode,
165 migration out of the country, death, or Oct 15, 2021, whichever occurred first.

166

167 *Statistical Analyses*

168 Poisson regression analysis was used to calculate Incidence Rate Ratios (IRRs) with 95%
169 confidence intervals (CIs) per 100,000 person-years where rates of self-harm for individuals with a
170 positive PCR-test for SARS-CoV-2 infection were calculated relative to individuals not recorded
171 with a positive test. The outcome was defined as a first incident of a self-harm episode since onset

172 of the pandemic. When assessing rates in relation to SARS-CoV-2 infection-related hospitalisation,
173 models were further stratified by history of mental disorders and other hospitalisations (somatic and
174 psychiatric combined). In addition, self-harm rates of high-risk groups were analysed in models
175 with status of high-risk and PCR-confirmed SARS-CoV-2 infection. Analyses were adjusted for
176 calendar time (months), age (5-year groups), sex (female, male), and country of origin (Denmark,
177 other high-income countries, and low- and middle-income countries). Homelessness and
178 imprisonment were handled as time-dependent variables whereas all other covariates were fixed as
179 of Feb 27, 2020. The association between SARS-CoV-2 and self-harm was tested in a sensitivity
180 analysis where the outcome was restricted to a more conservative definition of self-harm, as
181 described above.

182

183 Cumulative incidences of self-harm were estimated for individuals followed from the date of a first
184 PCR-confirmed SARS-CoV-2 infection and for the subsequent nine months in a sub-sample where
185 each case was matched on age and sex to two individuals from the general population who had not
186 been recorded with a positive test on the date of matching. Using the Aalen-Johansson estimator,
187 we calculated the cumulative incidence of self-harm, while accounting for competing risks from
188 death and emigration.

189

190 The statistical analyses were performed using SAS software (version 9.4.).

191

192 *Ethical considerations*

193 The project was approved by the Danish Data Protection Agency (Capital Region of Denmark: P-
194 2020-439), Statistics Denmark, and the Danish Health Data Authority. Informed consent was not
195 required for this study according to Danish regulations.

196

197 **RESULTS**

198 A total of 4,412,248 individuals (50.6% females) were observed over 7,069,961 person-years (mean
199 follow-up: 1.6 person-year). During Feb 27th, 2020 – October 31st, 2021, 260,663 (5.9%)
200 individuals tested positive for SARS-CoV-2 infection with a PCR-test at a median age of 40.3 years
201 (5th percentile: 16.7 year; 95th percentile: 75.5 years).

202

203 Of 5,453 first records of a self-harm episode, 131 (2.4%) were among individuals who had
204 previously tested positive for SARS-CoV-2 infection, resulting in an incidence rate of 74.7 (95%
205 CI: 61.9-87.5) per 100,000 person-years compared to a rate of 77.2 (95% CI: 75.1-79.3) per
206 100,000 person-years in the remaining population (Supplementary Table 3). When adjusted for
207 calendar time, age, sex, and country of origin, individuals with SARS-CoV-2 infection had an aIRR
208 for self-harm of 0.86 (95% CI: 0.72-1.03; p=0.09) when compared to the remaining part of the
209 general population.

210

211 *SARS-CoV-2 infection-related hospitalisation*

212 We identified 12,834 individuals who had a SARS-CoV-2 infection-related hospitalisation to
213 somatic hospital (median age: 68.2 years; 5th percentile: 30.9 year; 95th percentile: 90.0 years).
214 Individuals with a SARS-CoV-2 infection-related hospitalisation had a self-harm rate of 178.2 per
215 100,000 person-years, while those with a SARS-CoV-2 infection, which did not result in hospital
216 admission had a rate of 68.0 (Table 1). The self-harm rate among individuals with no SARS-CoV-2
217 positive PCR-test and no record of being hospitalised during follow-up was 55.1 per 100,000
218 person-years, while those admitted to somatic hospital for other reasons had a rate of 363.0.
219 Compared to people not infected and not hospitalised, individuals with a SARS-CoV-2 infection-

related hospitalisation had an IRR of 6.45 (95% CI: 4.10-10.15), which was comparable to those with no positive test and a hospitalisation for other reasons who had an IRR of 10.27 (95% CI: 9.65-10.93).

When stratifying this group by history of mental disorders, we found that rates of self-harm among SARS-Cov-2 positive with no history of mental disorders were comparable, irrespective of whether hospitalisation has been SARS-CoV-2 related or not (SARS-CoV-2 hospitalisation: IRR: 2.52; 95% CI: 1.05-6.09; other hospitalisation: IRR: 5.34; 95% CI: 3.25-8.76) and when compared to those with no SARS-CoV-2 infection nor hospitalisation (IRR: 4.81; 95% CI: 4.29-5.39). Among individuals with a history of mental disorders and a positive test, rates of self-harm were also comparable with respect to SARS-CoV-2 related or other hospitalisation (SARS-CoV-2 hospitalisation: IRR: 7.14; 95% CI: 4.21-12.11; other hospitalisation: IRR: 7.15; 95% CI: 4.76-10.72). Individuals with SARS-CoV-2 but no hospitalisation records had comparable rates of self-harm to individuals with no SARS-CoV-2. In a model where presence of mental disorders and hospitalisations were examined jointly, a higher rate of self-harm was noted among individuals with mental disorders and SARS-CoV-2 related hospitalisation (IRR: 36.67; 95% CI: 21.63-62.16) but also for individuals with mental disorders and hospitalisation not related to SARS-CoV-2 (IRR: 39.65; 95% CI: 26.45-59.44) when compared to those with neither.

High-risk groups

No significant difference in self-harm rates was found for persons who had completed primary school or less with respect to SARS-CoV-2 infection (N= 1,272,657; SARS-CoV-2 infection: IRR: 2.66, CI-95%: 2.11-3.36 versus no SARS-CoV-2 infection: IRR: 2.91, CI-95%: 2.74-3.10; p=0.67) when compared to people with higher educational attainment and no positive test (Table 2).

244 Comparable IRRs were also found for individuals with chronic medical conditions (N= 2,213,834;
245 SARS-CoV-2 infection: IRR: 1.58, CI-95%: 1.22-2.05 vs. no SARS-CoV-2 infection: IRR: 2.15,
246 CI-95%: 2.03-2.29; p=0.084) and disability pension (N= 188,654; SARS-CoV-2 infection: IRR:
247 3.59, CI-95%: 1.79-7.20 vs. no SARS-CoV-2 infection: IRR: 6.57, CI-95%: 6.06-7.13;
248 p=0.10) when compared to non-exposed individuals.

249

250 Self-harm rates of persons with a history of mental disorders did not vary with respect to whether
251 these individuals had a confirmed SARS-CoV-2 infection or not (N= 634,104; SARS-CoV-2
252 infection: IRR: 7.16, CI-95%: 5.55-9.23 vs. no SARS-CoV-2 infection: IRR: 8.93, CI-95%: 8.45-
253 9.44; p=0.06) when compared to those with neither. Similar rates of self-harm were also observed
254 among individuals with severe mental disorders whether or not exposed to SARS-CoV-2 infection.
255 Individuals with a substance use disorders in combination with SARS-CoV-2 infection had lower
256 rates of self-harm than those with a substance use disorder and no positive SARS-CoV-2 test (N=
257 311,332; SARS-CoV-2 infection: IRR: 5.55, CI-95%: 3.53-8.72 vs. no SARS-CoV-2 infection:
258 IRR: 9.86, CI-95%: 9.30-10.47; p=0.008). Among individuals with a history of homelessness or
259 imprisonment, those with a positive SARS-CoV-2 test and those with no such record were found to
260 have comparable self-harm rates.

261

262 *Cumulative incidence rates*

263 After nine months of follow-up, the cumulative incidence rate for self-harm was 0.05% (95% CI
264 0.04-0.06) for those who tested positive with a PCR-test for SARS-CoV-2 infection, while a self-
265 harm episode was recorded for 0.07% (95% CI 0.06-0.08) of the sex- and age-matched comparisons
266 without a PCR-confirmed SARS-CoV-2 infection (Figure 1). At the end of follow-up, the
267 corresponding figures were 0.08 (0.06-0.12) for those with SARS-CoV-2 infection and 0.12 (0.10-

0.15) for those without (Supplementary Table 4). The highest cumulative incidences of self-harm were found among individuals who tested positive for SARS-CoV-2 infection and with severe mental disorders (cumulative incidence: 0.50%; 95% CI 0.29-0.81), a history of homelessness (cumulative incidence: 0.48%; 95% CI 0.18-1.12), and substance misuse disorders (cumulative incidence: 0.42%; 95% CI 0.15-0.99). As seen in Figure 2, individuals with chronic medical conditions had the lowest cumulative incidence. The probability of self-harm during the study period for the entire population and by sex are shown in Supplementary Figure 1.

Overall, when restricting the outcome to individuals recorded with an actual definite self-harm episode, (i.e. excluding those with only a suggestive marker for self-harm), a positive PCR- test for SARS-CoV-2 infection was associated with reduced risk of self-harm (IRR 0.63, 95% CI 0.43-0.91) compared with those with no positive test when adjusting for sex, age, calendar time, and country of origin.

DISCUSSION

Having nationwide and individual-level data on all tests conducted in Denmark allowed us to identify all individuals with a PCR-confirmed SARS-CoV-2 infection. SARS-CoV-2 infection was not found to be associated with self-harm in adjusted analyses. In fact, a lower rate was found among those with SARS-CoV-2 infection when further restricting the definition of self-harm. Individuals hospitalised for SARS-CoV-2 infection-related disorders had an elevated rate of self-harm when compared to those with no confirmed SARS-CoV-2 infection nor hospitalisation. However, their rate was comparable to the one of those with SARS-CoV-2 who were hospitalised for other reasons. Among individuals with a history of mental disorders, we found elevated self-harm rates for those with a SARS-CoV-2 infection-related hospitalisation as well as those for

292 hospitalised with other physical or mental conditions. Although higher rates of self-harm were
293 found among people with a SARS-CoV-2 and lower educational attainment, medical chronic
294 conditions, history of mental disorders, history of homelessness or imprisonment when compared to
295 the rest of the general population, these rates were comparable to peers who had not had a
296 confirmed SARS-CoV-2 infection. For substance misuse, the rate of self-harm was higher in those
297 without than those with a PCR-confirmed SARS-CoV-2 infection.

298

299 A high level of trust in the authorities, free-of charge tests, and easily available test-sites are
300 believed to have contributed to the high SARS-CoV-2 testing rate in Denmark.^{13, 30} There was,
301 however, also a high compliance with SARS-CoV-2 vaccination and 87% of the population
302 received two doses of SARS-CoV-2 vaccination during this follow-up period,¹³ which might have
303 lessened the burden of the disease.

304

305 We did not find indications that a history of PCR-confirmed SARS-CoV-2 infection was associated
306 with self-harm. When assessing self-harm using the more restrictive definition, we found a lower
307 rate of self-harm. Individuals with a positive PCR-test may only have been affected by the SARS-
308 CoV-2 infection during a limited period of time. Due to the short study period, we opted to consider
309 individuals exposed for a longer period although this could have underestimated a possible effect.
310 Analog to clinical reports of excess prevalence of depressive symptoms and anxiety among
311 individuals in hospital treatment for SARS-CoV-2,³¹ we found a substantially higher rate of self-
312 harm among individuals with a SARS-CoV-2 infection-related hospitalisation than for those not
313 hospitalised. However, a higher rate of self-harm was also found among those with a positive PCR
314 test and a later hospitalisation, which was assumed not to be related to SARS-CoV-2. Mental and
315 physical disorders have previously been linked to self-harm,³² and it is possible that the increased

316 risk relates to the level of distress experienced by individuals with any disorder, which necessitates
317 hospitalisation, rather than SARS-CoV-2 itself. Still, individuals with mental disorders who were
318 hospitalised due to SARS-CoV-2 were found to have higher rates of self-harm than individuals with
319 no mental disorders who were hospitalised due to SARS-CoV-2; suggesting there may have been an
320 extra vulnerability for those with mental disorders. Although it was beyond the scope of the present
321 study, it is possible that people suffering from long-term consequences of a SARS-CoV-2 infection
322 may experience an excess risk of self-harm.

323
324 High rates of suicidal behaviour have previously been shown for vulnerable groups, such as
325 individuals with chronic medical conditions, severe mental disorders, and homelessness.⁹⁻¹²
326 Contrary to our expectation, an excess risk of self-harm was not found for these individuals when
327 they had a confirmed SARS-CoV-2 infection. It is possible that specific subgroups, such as those
328 with chronic medical conditions or SARS-CoV-2 infection in general, received an increased level of
329 informal support from their social network during the pandemic and when infected. On the other
330 hand, access to on-going treatments and other form of formal support was likely interrupted or
331 compromised during periods when individuals had a SARS-CoV-2 infection.³³ Previous findings
332 from Denmark showed that individuals with mental disorders, substance abuse or experiences of
333 homelessness or imprisonment were less likely to be PCR-tested than those without these
334 characteristics,¹³ which could introduce selection bias.

335
336 We cannot exclude that the lower rate found among individuals with SARS-CoV-2 infection in the
337 sensitivity analysis might be due to an under-diagnosis of self-harm in select subgroups, for
338 instance, individuals with substance misuse. Nevertheless, the result supports the interpretation that
339 SARS-CoV-2 infection was not associated with a higher risk of self-harm.

340

341 *Strengths and limitations*

342 Strengths of our study include the use of national, administrative registers, thus minimizing the risk
343 for potential selection bias. These included complete and individual-level PCR-test results, which
344 were free of charge, resulting in high test rates.³⁴ Having longitudinal data, only self-harm episodes
345 which took place after the date of a positive PCR-test were considered as having occurred after
346 exposure to a SARS-CoV-2 infections. In addition, we were able to obtain data for high-risk groups,
347 such as socially marginalized people with a history of homelessness and imprisonment. Having
348 complete data on all hospitalizations, allowed us to identify of cases with severe SARS-CoV-2
349 infections. Using a cohort design and a long follow-up enabled us to generate nationally
350 representative findings. By adjusting for relevant confounders, we minimized bias.

351

352 Limitations of our study include the fact that it is possible that not all individuals were tested when
353 experiencing symptoms or used rapid tests instead of going to testing stations, which is likely to
354 make our estimates conservative. Yet, it was only at the end of 2021 that self-testing kits became
355 widely available in Denmark, and therefore we consider this issue to be of minor importance. Given
356 that the follow-up ended before the massive wave of SARS-CoV-2 infections caused by the
357 transition to the Omicron variant of concern,³⁵ our findings are not representative for this period.
358 Individuals with substance misuse or homeless persons might have been less inclined to go for
359 testing, which could imply some bias of those estimates. Although the wider definition of self-harm,
360 which has previously been used in other investigations²⁹ is likely to capture more episodes, some
361 may have been accidents. Also, the pandemic might have deterred individuals from seeking
362 hospital-care after self-harm, resulting in an under-recording of self-harm episodes. It is possible that
363 members of the examined study subgroups were more (or less) inclined to seek hospital care for

364 self-harm than others or might have re, which could bias our estimates, e.g. if they died. It is also
365 possible that they received more social support during the pandemic. We did not have confirmative
366 information that a subsequent somatic hospitalisation was due to SARS-CoV-2. Small numbers
367 prevented us from examining people who were currently experiencing homelessness or
368 imprisonment. Potentially relevant but not included factors, such as level of informal support or
369 previous self-harm, might have acted as confounders.

370

371 **CONCLUSION**

372 In a national setting with complete data on all individuals PCR-tested for SARS-CoV-2 infections,
373 self-harm rates of individuals with PCR-confirmed SARS-CoV-2 infection were not found to be
374 higher but rather at level of those with no positive tests. We did find higher rates of self-harm
375 among high-risk individuals with a hospitalisation but this was irrespective of whether it in relation
376 to a SARS-CoV-2 infection or not.

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437 **Author contributions**

438 Study concept and design: AE, PQ, TM, KH, MO, CH, MEB, TML, MN, SFN.

439 Acquisition, analysis, or interpretation of data: CH, TML, MO, SE, KM, SFN.

440 Drafting of the manuscript: AE, SFN.

441 Critical revision of the manuscript for important intellectual content: All authors.

442 Statistical analysis: AE, CH, TML, SFN.

443 Administrative, technical, or material support: SE, KM, MN.

444 Supervision: PQ, KH, MN.

445

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449

450 **Declaration of interest**

451 KH is a member of the Department of Health and Social Care's National Suicide Prevention
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453 As a governmental institution, Statens Serum Institut is involved in the national vaccine distribution
454 chain; receiving, storing and distributing vaccines to doctors and vaccine centres within Denmark.

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456

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460 present study.

461

462 **Data statement:**

463 The data that support the findings of this study are available from Statistics Denmark. The data
464 access requires the completion of a detailed application form from the Danish Data Protection
465 Agency, the Danish National Board of Health and Statistics Denmark. For more information on
466 accessing the data, see <https://www.dst.dk/en> .

467

468 **Ethics approval and consent to participate**

469 The study was approved by the Danish Data Protection Agency, and data access was agreed by
470 Statistics Denmark and the Danish Health Data Authority. Approval by the Ethics Committee and
471 written informed consent were not required for register-based projects. All data were de-identified
472 and not recognizable at an individual level.

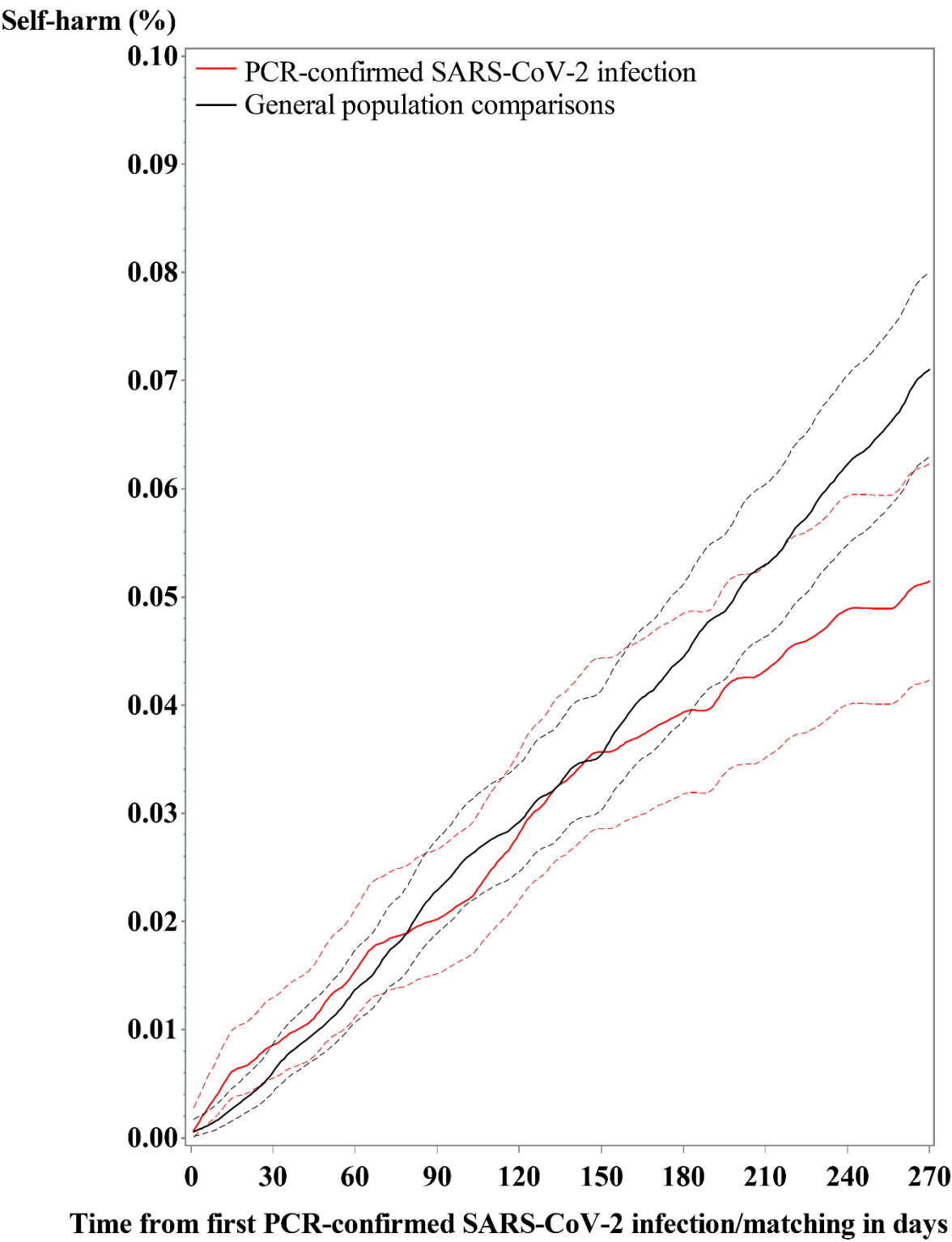
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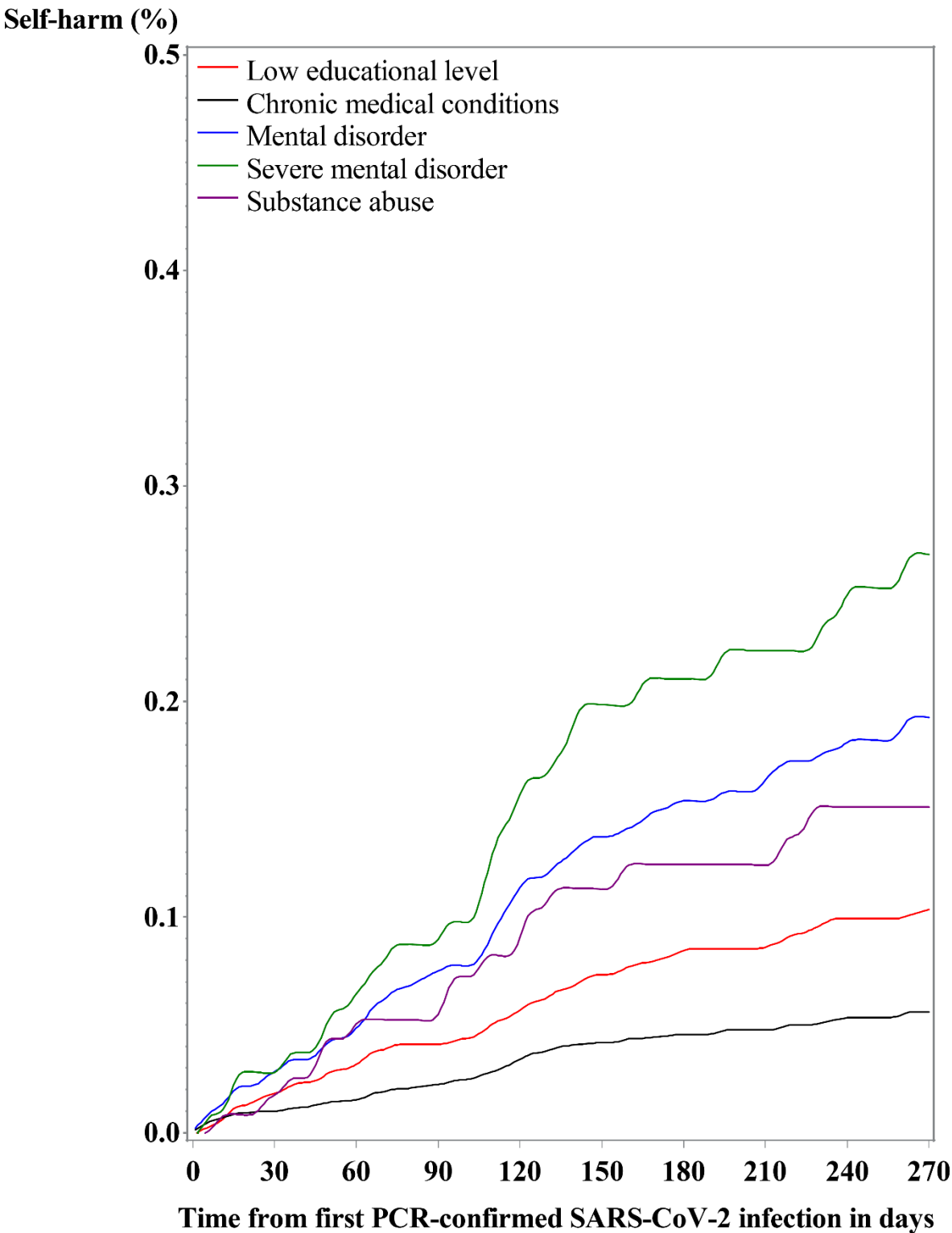
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566 Figure 1. Cumulative incidence of self-harm in people with PCR-confirmed SARS-CoV-2 infection
567 compared to matched controls from the general population without.
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571 Figure 2. Cumulative incidences of self-harm status for subgroups.*



*Curves are not shown for disability pension, homelessness, and imprisonment as there were too few cases.

Table 1: Incidence rates and incidence rate ratios of self-harm by population groups in combination with SARS-CoV-2 infection-related hospital admission.*

	n/N	IR per 100,000 PY	aIRR (95% CI) †
Total	5453//4,412,248	77.1	
General population			
No SARS-CoV-2 infection, no hospitalisation	3,529/3,602,350	55.1	1 (ref.)
No SARS-CoV-2 infection, hospitalisation	1,793/549,235	363.0	10.27 (9.65-10.93)
SARS-CoV-2 infection, no hospitalisation	72/224,624	47.2	0.84 (0.67-1.07)
SARS-CoV-2 infection, hospitalisation	40/23,205	332.4	7.68 (5.61-10.51)
SARS-CoV-2 infection-related hospitalisation	19/12,834	178.2	6.45 (4.10-10.15)
No history of mental disorders			
No SARS-CoV-2 infection, no hospitalisation	1,639/3,121,328	29.7	1 (ref.)
No SARS-CoV-2 infection, hospitalisation	446/430,096	116.6	4.81 (4.29-5.39)
SARS-CoV-2 infection, no hospitalisation	48/198,295	35.7	0.90 (0.67-1.21)
SARS-CoV-2 infection, hospitalisation	16/18,435	169.1	5.34 (3.25-8.76)
SARS-CoV-2 infection-related hospitalisation	5/9,990	60.0	2.52 (1.05-6.09)
History of mental disorders			
No SARS-CoV-2 infection, no hospitalisation	1,890/481,022	213.3	1 (ref.)
No SARS-CoV-2 infection, hospitalisation	1,347/119,139	1,207.5	9.16 (8.50-9.88)
SARS-CoV-2 infection, no hospitalisation	24/26,329	131.8	0.81 (0.54-1.22)
SARS-CoV-2 infection, hospitalisation	24/4770	933.9	7.15 (4.76-10.72)
SARS-CoV-2 infection-related hospitalisation	14/2844	600.3	7.14 (4.21-12.11)
SARS-CoV-2, hospitalisation, history of mental disorders‡			
No SARS-CoV-2 infection, no hospitalisation, no mental disorder	1639/3,121,328	29.7	1 (ref.)
No SARS-CoV-2 infection, no hospitalisation, mental disorder	1890/481,022	213.3	6.91 (6.46-7.38)

No SARS-CoV-2 infection, hospitalization, no mental disorder	446/430,096	116.6	6.06 (5.44-6.76)
No SARS-CoV-2 infection, hospitalization, mental disorder	1347/119,139	1,207.5	55.95 (51.88-60.34)
SARS-CoV-2 infection, no hospitalization, no mental disorder	48/198,295	35.7	1.15 (0.86-1.53)
SARS-CoV-2 infection, no hospitalization, mental disorder	24/26,329	131.8	4.59 (3.06-6.88)
SARS-CoV-2 infection, hospitalization, no mental disorder	16/18,435	169.1	7.04 (4.30-11.54)
SARS-CoV-2 infection, hospitalization, mental disorder	24/4770	934.0	39.65 (26.45-59.44)
SARS-CoV-2 infection-related hospitalisation, no mental disorder	5/9999	600.0	3.72 (1.54-8.95)
SARS-CoV-2 infection-related hospitalisation, mental disorder	14/2844	600.3	36.67 (21.63-62.16)

Abbreviations: IR: Incidence Rate, PY: Person-years, IRR: Incidence Rate Ratio.

*SARS-CoV-2 infection-related hospitalization defined as a hospitalization with a somatic disorder with duration of more than 12 hours within 14 days from a PCR-confirmed SARS-CoV-2 infection. Hospitalisation was defined as any hospitalisation during follow-up [†]Model is adjusted for: calendar time (months), age (5-years age groups), sex, and country of origin. [‡]P-value for the interaction was 0.55.

Table 2: Incidence rates and incidence rate ratios of self-harm by population groups in combination with PCR-confirmed SARS-CoV-2 infection status.

	n/N	IR per 100,000 PY	Adjusted IRR [¶] (95% CI)	p-value**
Total	5453/4,412,248	77.1		
SARS-CoV-2 infection				
None	5,322/4,151,585	77.2	1 (ref.)	0.09
Yes	131/260,663	74.7	0.86 (0.72-1.03)	
Educational level				
None (higher educational level)	2,305/2,886,129	47.6	1 (ref.)	0.83
SARS-CoV-2 infection	54/172,664	43.4	0.85 (0.65-1.11)	
Lower educational level	3,017/1,265,456	147.0	3.04 (2.86-3.24)	
SARS-CoV-2 infection and lower educational level	79/87,999	142.1	2.76 (2.19-3.47)	
Chronic medical condition*				
None	2,158/2,046,135	63.7	1 (ref.)	0.08
SARS-CoV-2 infection	71/152,279	72.0	1.00 (0.79-1.26)	
Chronic medical condition	3,164/2,105,450	90.2	2.15 (2.03-2.29)	
Both	60/108,384	78.2	1.58 (1.22-2.05)	
Disability pension				
None	4,455/3,970,796	67.6	1 (ref.)	0.10
SARS-CoV-2 infection	123/252,798	72.4	0.95 (0.79-1.14)	
Disability pension	867/180,789	287.9	6.57 (6.06-7.13)	
Both	8/7,865	146.7	3.59 (1.79-7.20)	
Mental disorder				
None	2,085/3,551,424	35.4	1 (ref.)	0.06
SARS-CoV-2 infection	69/226,720	45.3	1.12 (0.88-1.43)	
Mental disorder	3,237/600,161	324.4	8.93 (8.45-9.44)	
Both	62/33,943	268.4	7.16 (5.55-9.23)	

Severe mental disorders [†]					
None	3,452/3,927,009	52.9	1 (ref.)	0.26	
SARS-CoV-2 infection	101/249,601	60.2	0.97 (0.80-1.19)		
Severe mental disorder	1,870/224,576	499.9	10.98 (10.36-11.64)		
Both	30/11,062	390.7	8.47 (5.90-12.14)		
Substance misuse [‡]					
None	3,421/3,852,406	53.5	1 (ref.)	0.0076	
SARS-CoV-2 infection	112/248,510	67.0	1.05 (0.87-1.27)		
Substance misuse	1,901/299,179	382.4	9.86 (9.30-10.47)		
Both	19/12,153	233.1	5.55 (3.53-8.72)		
Homelessness [§]					
None	4,891/4,117,969	71.5	1 (ref.)	0.333	
SARS-CoV-2 infection	126/259,053	72.3	0.91 (0.76-1.08)		
Homelessness	431/33,616	774.9	14.54 (13.14-16.10)		
Both	5/1,610	472.1	8.68 (3.60-20.89)		
Imprisonment [§]					
None	4,884/4,067,935	72.3	1 (ref.)	0.58	
SARS-CoV-2 infection	125/256,402	72.4	0.89 (0.74-1.07)		
Imprisonment	438/83,650	313.9	7.09 (6.39-7.87)		
Both	6/4,261	226.2	5.03 (2.26-11.23)		

Abbreviations: IR: Incidence Rate, PY: Person-years, IRR: Incidence Rate Ratio.

*Defined as any pre-existing chronic medical condition diagnosed prior to Feb 27, 2020. [†]Severe mental disorders defined as any pre-existing severe mental illness (schizophrenia diagnosis, bipolar disorder, or depressive disorder) diagnosed prior to Feb 27, 2020.

[‡]Substance misuse defined as any pre-existing alcohol or drug misuse diagnosed prior to Feb 27, 2020. [§]Defined as any history of homeless shelter contact/imprisonment. [¶]Model is adjusted for: calendar time (months), age (5-years age groups), sex, and country of origin. Some of the 95% confidence intervals are not visible on the plot due their narrow range. ^{**}P-value to test for interaction between SARS-CoV-2 infection and examined subgroup, except for the first model, which examined rates of self-harm in relation to SARS-CoV-2 infection only.