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Suicidal behaviors and ideation during emerging viral disease outbreaks before the COVID-19 pandemic: a systematic rapid review

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Maeva Samuel: Methodology, Investigation, Writing original Draft

Hans Oh: Conceptualization, Methodology, Writing – Review & editing

Emmanuel Poulet: Conceptualization, Supervision, Writing – Review & editing, Validation

Jérôme Brunelin: Conceptualization, Supervision, Writing – Review & editing, Validation

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ABSTRACT

The current COVID-19 pandemic is the most severe pandemic of the 21st century, on track to having a rising death toll. Beyond causing respiratory distress, COVID-19 may also cause mortality by way of suicide. The pathways by which emerging viral disease outbreaks (EVDOs) and suicide are related are complex and not entirely understood. We aimed to systematically review the evidence on the association between EVDOs and suicidal behaviors and/or ideation.

An electronic search was conducted using five databases: Medline, Embase, Web of Science, PsycINFO and Scopus in April 2020. A rapid systematic review was carried out, which involved separately and independently extracting quantitative data of selected articles.

The electronic search yielded 2,480 articles, of which 9 met the inclusion criteria. Most of the data were collected in Hong Kong (n = 3) and the USA (n = 3). Four studies reported a slight but significant increase in deaths by suicide during EVDOs. The increase in deaths by suicide was mainly reported during the peak epidemic and in older adults. Psychosocial factors such as the fear of being infected by the virus or social isolation related to quarantine measures were the most prominent factors associated with deaths by suicide during EVDOs.

Overall, we found scarce and weak evidence for an increased risk of deaths by suicide during EVDOs. Our results inform the need to orient public health policies toward suicide prevention strategies targeting the psychosocial effects of EVDOs. High-quality research on suicide risk and prevention are warranted during the current pandemic.

64

65 **INTRODUCTION**

66 The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), also known as the
67 Corona Virus Disease 2019 (COVID-19), first appeared in Wuhan, China, in November 2019
68 (Spiteri et al., 2020). Since then, COVID-19 has spread across the world, on all continents,
69 leading The World Health Organization to officially declare the COVID-19 outbreak a
70 pandemic (Spiteri et al., 2020). Currently, there have been more than 850,000 reported deaths
71 from COVID-19 infection and more than 25,000,000 reported cases worldwide (WHO, 2020).
72 The COVID-19 pandemic is thus considered to be the most severe pandemic of the 21st
73 century, on track to having a rising death toll.

74 Beyond causing respiratory symptoms and distress that lead to death, COVID-19 may also
75 cause direct and indirect mortality by way of suicide (Chevance et al., 2020; Gunnell et al.,
76 2020; Reger, Stanley & Joiner, 2020). On March and April 2020, the first cases of COVID-
77 19-related suicides were reported in India and Bangladesh when two men who feared having
78 contracted the disease took their own lives (Goyal et al., 2020; Mamun & Griffiths, 2020).
79 Moreover, recent editorials hypothesized an increased suicide risk associated with the
80 COVID-19 pandemic (Gunnell et al., 2020; Holmes et al. 2020; Klomek, 2020) and previous
81 studies informed the putative association between viral infectious diseases and deaths by
82 suicide (Catalan et al., 2011; Lund-Sørensen et al., 2016). A nationwide Danish study for
83 example reported a significant and strong association between viral infection during
84 hospitalization and deaths by suicide, with the number of days treated for infection being
85 associated with elevated risk for suicide in a dose-response fashion (Lund-Sørensen et al.,
86 2016). However, the pathways by which emerging viral disease outbreaks (EVDOs) and
87 suicide may be related are complex and not entirely understood.

88

89 First, EVDOs are associated with psychosocial and emotional aspects (*e.g.*, fear of infection,
90 stigma of being diagnosed with infection, cancellation of “*non-emergency*” hospitalizations)
91 that may drive risk for suicidal ideation and suicide attempts (Reger, Stanley & Joiner, 2020).
92 The social distancing and quarantine measures that have been enacted to curb the spread of
93 the disease have resulted in increased loneliness, anxiety, stress, and depression in the general
94 population (Rajkumar, 2020; Wang et al., 2020). EVDOs also result in economic downturns,
95 causing unemployment and general instability that has been associated with numerous health
96 problems, including increased deaths by suicide (Oyesanya, Lopez-Morinigo & Dutta, 2015).
97 Second, viruses exhibit neurotrophic properties and can cause severe neurological damage
98 and nervous diseases (*e.g.*, toxic infectious encephalopathy) that cause mental disorders
99 (Toovey et al., 2020; Wu et al., 2020). In some cases, viral infections can cause disorientation,
100 dysphoria, confusion, and delirium, which in turn lead to suicidal ideation and behaviors
101 (Chevance et al., 2020; Reger, Stanley & Joiner; Severance et al., 2008).
102 These factors taken together likely increase risk for suicidal ideation and behaviors during
103 EVDOs; however, to our knowledge, there has been no review of literature published on the
104 topic thus far. In the current context, it is imperative to systematically review past research in
105 order to prevent the negative impacts of the emerging pandemic and do as much as possible to
106 reduce all deaths that are linked to the outbreak, including death by suicide. A rapid
107 systematic review on the topic is thus urgently needed, to immediately inform prevention
108 strategies during and beyond the COVID-19 pandemic. The aim of our study was to
109 systematically review the evidence on the association between EVDOs and suicidal ideation
110 and behaviors.

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115 **METHODS**

116 *Systematic research*

117 The review protocol was based on the PRISMA guideline for systematic reviews (Liberati et
118 al., 2009) and previous rapid reviews (Tricco et al., 2015). The search was conducted between
119 April 7th and April 11th, 2020, on the five following databases: Medline, Embase, Web of
120 Science, PsycINFO and Scopus, using the following search terms, grouped into three
121 categories as follows:

122 (a) (suicid* OR self-harm OR self-injury OR self-destruct* OR DSH OR self-poison* OR
123 self-mutilat* OR self-inflict*),

124 b) (pandemic* OR epidemic* OR outbreak), and

125 c) (coronavirus OR influenza OR infectious OR infection OR virus OR viral OR MERS-CoV
126 OR SARS OR Ebola OR Zika OR Chikungunya OR H1N1 OR H5N1 OR lockdown OR
127 quarantine).

128 To ensure the exhaustivity of the search and the relevance of the algorithm, a pilot electronic
129 search was performed between April 3rd and April 6th, 2020. The results of the pilot search
130 were reviewed and the search terms and algorithm were further refined. Moreover, the
131 electronic search was supplemented with a manual search using the reference lists of relevant
132 publications. Corresponding authors of articles were contacted if necessary.

133 *Inclusion criteria*

134 Inclusion criteria were (a) articles published in peer-review journals in the English, French or
135 German language; (b) articles published since inception until April 7th, 2020; (c) articles
136 assessing the prevalence or incidence of suicidal ideation and/or suicide attempts and/or
137 deaths by suicide; (d) articles assessing these outcomes during or in the aftermath of an
138 EVDO. No geographic or age restrictions were applied for the electronic research. Regarding

139 the methodology of articles, editorials, correspondences, systematic reviews and single case
140 reports were excluded.

141 Based on the Columbia Classification Algorithm of Suicide Assessment (C-CASA) (Posner et
142 al., 2007; Turecki & Brent, 2016), we differentiated suicidal ideation and suicidal behaviors,
143 which were defined as a) suicide attempts and b) deaths by suicide.

144 ***Selection process***

145 Two authors (EL and MS) performed the electronic search on April 7th, 2020. The studies
146 identified through the databases were then subjected to three selection filters between April
147 8th and 11th, depending on the titles, abstracts, and a comprehensive full-text reading of each
148 selected paper thereafter. At each stage, the two authors independently screened all the
149 selected articles, and identified those for which available data (title for the first stage, abstract
150 for the second and then full-text) were consistent with the inclusion criteria of the review.
151 After each stage, the two authors discussed their selections and agreed upon the articles to
152 retain. When discrepancies arose, the choice to include or exclude an article was discussed
153 with other co-authors (JB and HO).

154 ***Quality of reporting evaluation***

155 Two authors (EL and MS) assessed the quality of included studies according to the STROBE
156 statement (Strengthening the Reporting of Observational Studies in Epidemiology)(von Elm
157 et al., 2007). The level of quality was as follows: very good quality (26-32); good quality (20-
158 26); average quality (14-20); and poor quality (<14).

159 ***Data analysis***

160 A systematic review was carried out, which involved separately and independently extracting
161 quantitative data by the two first authors (EL and MS) for each of the outcomes. We extracted
162 from each article the name of the first author, the year of publication, the design of the study,
163 the country of the study, the sample and characteristics of participants and the main results

164 reported by the authors regarding the association between EVDOs and suicidal ideation and
165 behaviors (*e.g.*, prevalence or incidence during the epidemic or post-epidemic periods, risk
166 factors, at-risk populations). The extracted data were then grouped and the evidence was
167 summarized for each outcome. All discrepancies were discussed, and consensus was reached
168 across all authors on the final summary. No meta-analysis was planned as the number of
169 included studies was expected to be low and their outcomes heterogeneous.

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171

172 **RESULTS**

173 The electronic search yielded a total of 2,480 articles. After removal of duplicates and the
174 application of selection filters, 9 articles (Wasserman, 1992; Smith, 1995; Huang et al., 2005;
175 Chan et al., 2006; Cheung et al., 2008; Yip et al., 2010; Okasuga et al., 2011; Keita et al.,
176 2017; Harrington et al., 2018) met the inclusion criteria (Figure 1).

177

PLEASE INSERT FIGURE 1 ABOUT HERE

178 *Characteristics of included articles*

179 Most of the data were collected in Hong Kong (n = 3)(Chan et al., 2006; Cheung et al., 2008;
180 Yip et al., 2010) and the USA (n = 3)(Wasserman, 1992; Okasuga et al., 2011; Harrington et
181 al., 2018). All studies were observational, with samples ranging from 66 to 87,486,713.
182 Publication dates ranged from 1992 to 2019. Four of the articles dealt with the 2003 Severe
183 Acute Respiratory Syndrome (2003 SARS)(Huang et al., 2005; Chan et al., 2006; Cheung et
184 al., 2008; Yip et al., 2010) outbreak, four with influenza outbreaks (Wasserman, 1992; Smith,
185 1995, Okasuga et al., 2011; Harrington et al., 2018) and one with the 2013-2016 Ebola virus
186 disease in Guinea (Keita et al., 2017). The studies assessed the prevalence of deaths by suicide
187 (n = 5)(Wasserman, 1992; Smith, 1995; Chan et al., 2006; Cheung et al., 2008; Yip et al.,
188 2010) or suicide attempts (n = 4)(Huang et al., 2005; Okasuga et al., 2011; Keita et al., 2017;

189 Harrington et al., 2018). Of them, 5 studies retrospectively assessed the prevalence of deaths
190 by suicide (Wasserman et al. 1992; Smith, 1995; Chan et al., 2006; Cheung et al., 2008) or
191 suicide attempts (Huang et al., 2005) during and/or after EVDOs (Okasuga et al., 2011;
192 Harrington et al., 2018). Yip et al. (2010) retrospectively examined the characteristics of
193 SARS-related suicides versus non-SARS-related deaths by suicide that occurred in 2003 in
194 Hong Kong. Only one study longitudinally assessed the presence of suicidal ideation and
195 suicide attempts in a post-epidemic period (Keita et al., 2017). The characteristics of the
196 included studies are displayed in Table 1.

197 PLEASE INSERT TABLE 1 ABOUT HERE

198 ***Change in rates of deaths by suicide (n= 4)***

199 The four studies (Wasserman, 1992; Smith, 1995; Chan et al., 2006; Cheung et al., 2008)
200 reported an increase in deaths by suicide during three different EVDOs (Table 1). Two studies
201 (Chan et al., 2006; Cheung et al., 2008) reported a slight but significant increase in suicide
202 rates in older adults in Hong Kong during the 2003 SARS outbreak. Wasserman (1992) and
203 Smith (1995) reported increased suicide rates in the general population during two influenza
204 outbreaks, respectively in the USA during the 1918 influenza outbreak and in Europe (United
205 Kingdom, Ireland and France) during the 1889-1894 Russian influenza outbreak.

206 ***Change in rates of suicide attempts (n =1)***

207 Huang et al. (2005) reported a non-significant increase in emergency department visits for
208 suicide attempts (drug overdoses) during the peak of the 2003 SARS epidemic in Taiwan.

209 ***Time of the outbreak***

210 ***Epidemic peak (n= 4)***

211 The increase in suicidal behaviors was mainly reported during the peak of the epidemic
212 (Wasserman, 1992; Chan et al., 2006; Cheung et al., 2008). Chan et al., 2006 and Cheung et
213 al., 2008 found an excess in older adults' suicide rates at time of the epidemic peak of the

214 2003 SARS outbreak. Wasserman (1992) reported a peak in deaths by suicide in the US
215 general population during the Great Influenza Epidemic occurring at the end of the peak of
216 the flu epidemic in 1919. Huang et al. (2005) reported a non-significant increase in emergency
217 department visits for suicide attempts (drug overdoses) during the peak of the 2003 SARS
218 epidemic in Taiwan.

219 *Late and post-epidemic periods (n= 3)*

220 Cheung et al. (2008) reported the maintenance of higher suicide rates in older adults in the
221 year after the 2003 SARS outbreak. Similarly, Keita et al. (2017) reported the persistence of
222 occurrence of suicide attempts five, eleven, and twelve months after discharge from Ebola
223 Treatment Centers. On the other hand, Huang et al. (2005) found no increase in emergency
224 department visits due to suicide attempts in the late- and post-epidemic period of the 2003
225 SARS outbreak.

226 ***Sociodemographic characteristics***

227 *Age of participants (n= 2)*

228 In the study by Chan et al. (2006), the increase in the rates of suicide was significant for older
229 adults (>65) but not for people under 65 in Hong Kong. One study (Harrington et al., 2018)
230 assessed the association between influenza infection and suicide attempt in people under 18
231 and found no significant association.

232 *Gender of participants (n= 2)*

233 Chan et al. (2006) found the excess mortality by suicide to be significant for older females but
234 not for older males during the peak of the 2003 SARS outbreak, while Cheung et al. (2008)
235 did not find any gender differences in the same context.

236 *Other characteristics (n= 1)*

237 Yip et al. (2010) found no significant differences in marital (married, single, divorced, widow
238 or lived alone) or in socioeconomic status (employed, unemployed, retired, homemaker or
239 received CSSA) between SARS-related and non-SARS-related suicides.

240

241 ***Factors associated with suicidal behaviors during emerging viral disease outbreaks (n= 4)***

242 Yip et al. (2010) and Cheung et al. (2008) identified four putative factors associated with
243 SARS-related deaths by suicide: the fear of the infection, the experience of social isolation,
244 the disruption of normal social life and the burden among those with long-term illnesses. The
245 fear of contracting SARS was found to be the most significant risk factor by Yip et al. (2010
246 and Cheung et al. (2008). Regarding the fear of being infected, unusual concerns about
247 hygiene and reluctance to receive medical care were identified as two factors implicated in
248 death by suicide (Yip et al., 2010). Yip et al. (2010) also reported the role of social
249 disconnection as a risk factor for SARS-related suicides in older adults. Cheung et al. (2008)
250 also identified high severity of chronic physical illness and high dependence as risk factors for
251 suicide in older adults during the 2003 SARS outbreak. On the contrary, Yip et al. (2010)
252 found no significant correlation between the level of dependence, the severity of illness, and
253 SARS-related suicides in older adults.

254 Regarding psychiatric profiles, Cheung et al. and Yip et al. (2010) found no significant
255 association between previous psychiatric disorders and deaths by suicide in older adults
256 during the SARS 2003 outbreaks. In their case-series analysis, Keita et al. (2017) reported
257 suicidal ideation and attempts associated with post-Ebola depressive disorders.

258 Regarding antiviral treatments, Harrington et al. (2018) found no significant association
259 between oseltamivir consumption and suicide attempts in people under 18.

260 ***Type of virus***

261 ***Coronaviruses (n= 2)***

262 Two studies (Chan et al., 2006; Cheung et al., 2008) reported an increase of suicide rates
263 during the 2003 SARS outbreak in Hong Kong, while Okasuga et al. (2011) found no
264 significant association between coronavirus seropositivity and suicide attempts in the USA.

265 *Influenza viruses (n= 4)*

266 Okasuga et al. (2011) reported a significant and positive association between seropositivity for
267 influenza B and suicide attempt but not for influenza A seropositivity in depressed individuals.
268 Harrington et al. (2018) found no significant association between influenza infection and
269 suicide attempts in people under 18. Wasserman (1992) and Smith (1995) reported increased
270 suicide rates during two influenza pandemics.

271 *Ebola virus (n= 1)*

272 Keita et al. (2017) reported in a case-series analysis of 256 survivors of the Ebola virus
273 disease four cases of people experiencing suicidal ideation (n = 1) or having attempted suicide
274 (n = 3) after their discharge from Ebola Treatment Centers.

275 ***Quality or reporting***

276 The mean score at the STROBE checklist was 20.44 (SD = 4.14). Of the included studies, 8
277 were rated as good quality (Wasserman et al., 1992; Huang et al., 2005; Chan et al., 2006;
278 Cheung et al., 2008; Yip et al., 2010; Okasuga et al., 2011; Keita et al. 2017; Harrington et al.,
279 2018). The article by Smith et al. (1995) was considered as poor quality as the
280 methodological characteristics of the study (*e.g.*, population, outcome measures, statistical
281 analyses) were not accurately reported.

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287 **DISCUSSION**

288 *Summary of findings*

289 We performed the first systematic review on the impact of EVDOs on suicidal ideation and
290 behaviors before the SARS-CoV-2 pandemic. First, we found the literature on the topic to be
291 scarce but we found some weak evidence to suggest a significant increase in deaths by suicide
292 during EVDOs. Second, older adults were reported to be particularly vulnerable to death by
293 suicide during the 2003 SARS outbreak. Third, psychosocial factors such as the fear of being
294 infected by the virus or social isolation related to quarantine measures were the most
295 prominent factors associated with death by suicide during EVDOs. Fourth, on the contrary,
296 we found only weak evidence to support the hypothesis that the neuropsychiatric symptoms
297 induced by infection may explain the increased rates of suicidal behaviors during EVDOs.

298

299 We found scarce and weak evidence that suicidal behaviors increase during EVDOs
300 (Wasserman, 1992; Smith, 1995; Huang et al., 2005; Chan et al., 2006; Cheung et al., 2008;
301 Yip et al., 2010; Keita et al., 2017). However, there has been few studies conducted on the
302 topic, especially regarding suicide attempts. Moreover, the strength of the association is
303 relatively low. Indeed, several included studies reported non-significant results (*e.g.*, Huang et
304 al., 2005; Chan et al., 2006, Harrington et al., 2018), and the studies that reported positive
305 results showed relatively small effects. For instance, the estimate IRRs reported by Cheung et
306 al. (2008) and Chan et al. (2006) among older adults ranged from 1.18 to 1.32, which may fall
307 short of being clinically meaningful. However, the findings were consistent across studies and
308 suicide prevention strategies are thus warranted during EVDOs.

309

310 *Potential pathways*

311 Psychosocial effects of EVDOs may be regarded as the main risk factors for an increase in
312 suicidal behaviors according to our results. The fear of being infected by the virus was indeed
313 reported in our review to be the most salient reason for suicide attempt during EVDOs (Goyal
314 et al., 2020; Cheung et al., 2008; Yip et al., 2010), especially among older adults (Cheung et
315 al., 2008; Yip et al., 2010). This result is consistent with previous studies on emerging
316 infectious diseases, such as HIV (Vuorio, Aärelä & Lehtinen, 1990; Aro et al., 1994,1995;
317 Kausch, 2004) or syphilis (Savage, 2014) for which the fear of being infected was also found
318 to be correlated with suicide ideation or attempts. Recently, deaths by suicide associated with
319 the fear of being infected with the virus were reported during the current COVID-19
320 pandemic (Goyal et al., 2020; Mamun & Griffiths, 2020).

321

322 Social isolation was also found in our review to be a significant risk factors for deaths by
323 suicide during the 2003 SARS outbreak. Although none of the included articles directly
324 assessed the impact of lockdown measures on suicidal behaviors, social isolation and
325 loneliness may foster suicidal ideation and attempts in the general population (Calati et al.,
326 2019; Brooks et al., 2020). In a recent narrative review of 40 articles, Calati et al. (2019)
327 reported that objective social isolation and subjective feelings of loneliness are associated
328 with higher suicidal ideation and behaviors. In the same vein, Brooks et al. (2020) reported
329 that quarantine and lockdown measures are associated with poorer mental health status in the
330 general population. However, the effects of social isolation observed in previous EVDOs may
331 be different than the effects of the current pandemic. Indeed, technologies, such as
332 videoconferencing, are now more widely available. Moreover, the quarantine measures are
333 applied to the whole population during the COVID-19 pandemic, while they were only
334 applied to vulnerable groups (*e.g.*, older adults, people with poor health conditions) during the

335 2003 SARS epidemic (Cheung et al., 2008), which may have been stigmatizing and isolating
336 for those who were forced into quarantine.

337

338 Unexpectedly, we found no evidence for an increased risk of deaths by suicide in people with
339 previous psychiatric disorders during EVDOs (Cheung et al., 2008; Yip et al., 2010).
340 However, this result has to be interpreted with caution as only three studies (Cheung et al.,
341 2008; Yip et al., 2010; Keita et al., 2017) evaluated the effect of previous psychiatric
342 disorders. People with mental disorders are indeed considered as a vulnerable population
343 during the COVID-19 pandemic (Chevance et al., 2020; Reger, Stanley & Joiner, 2020), and
344 may still require preventive interventions during lockdown (Chevance et al., 2020; Yao, Chen
345 & Xu, 2020).

346

347 *Implications for suicide prevention strategies during EVDOs*

348 Our results indicate the need to design adaptive suicide prevention during EVDOs, focusing
349 on their psychosocial impacts. First, our results may give the impression that practitioners
350 should routinely assess for fear of infection during EVDOs to detect people with higher
351 suicide risk. For example, Ahorsu et al. (2020) recently developed and validated the 7-item
352 Fear of COVID-19 Scale in a sample of 717 Iranian participants. However, there is
353 insufficient evidence to support the clinical utility of such screenings to reduce mental health
354 symptoms (Gilbody, Sheldon & Wessely, 2006; Gilbody, Sheldon & House, 2008; Keshavarz
355 et al., 2013) or prevent suicides (Oyama et al., 2008; Belsher et al., 2019). Thus, it would be
356 premature to integrate these screenings into clinical practice at this point. Second, as
357 emphasized by Reger, Stanley & Joiner (2020), social connection plays a key role in suicide
358 prevention, so that the prevention of loneliness induced by quarantine measures should be
359 included in public health policies during the COVID-19 pandemic. Notably, brief contact

360 interventions, through phone calls or postcards, appear to be a promising strategy to reduce
361 suicide risk by providing social support and promoting distance-based access to mental health
362 care (Milner et al., 2016). Third, during the 2003 SARS outbreak, older adults were reported
363 as being particularly vulnerable to suicide (Chan et al., 2006; Cheung et al., 2008; Yip et al.,
364 2010). Thus, mitigating the impact of social isolation and of the fear of infection in older
365 adults are two specific objectives that must be properly addressed during the COVID-19
366 pandemic. However, two recent systematic reviews reported that the literature on suicide
367 prevention in older adults (Zeppegno et al., 2019) and in nursing homes (Chauliac et al., 2019)
368 is scarce. Psychotherapies for suicide prevention have been tailored for older adults and have
369 been demonstrated to be effective in reducing suicidal behaviors (Zeppegno et al., 2019).
370 Interestingly, telephone helplines providing brief counselling and emotional support have
371 been reported to be effective in preventing suicidal behaviors in older adults in Italy (De Leo
372 et al., 1995,2002) and in Hong Kong (Chan et al., 2006). Fourth, regarding the results from
373 Cheung et al. (2008) and Keita et al. (2017) on suicidal behaviors in the post-epidemic periods,
374 prevention strategies must be designed in a long-term fashion and also target people infected
375 by the SARS-CoV-2 as they may exhibit high level of post-traumatic, anxiety and depressive
376 symptoms in the aftermath of the infection (Duan & Zhu, 2020).

377

378 *Limitations*

379 Our review has several limitations. First, the number of included articles is low and their
380 quality is heterogeneous. This highlights the scarcity of literature on the topic and the urgent
381 need to collect nationwide and worldwide data on the psychological impact of the current
382 COVID-19 pandemic. In agreement with recent editorials (Gunnell et al., 2020; Holmes et al.,
383 2020), our results stress the need to perform high quality research on suicide risk and
384 prevention in the current pandemic context. Second, the included studies were performed in a

385 small number of countries. Suicidal behaviors are known to be shaped by cultural and social
386 contexts, so the generalizability of our conclusions may be hampered. For example, the
387 suicide rate in older adults in Hong Kong was known to be high compared to other countries
388 at the period preceding the 2003 SARS outbreak (Chi et al., 1998). Third, only two studies
389 assessed the long term impact of EVDOs on suicidal ideation and behaviors, so that the
390 evidence on the long-term impact of EVDOs remains poorly understood. Thus, our results
391 only weakly inform what the long-term impact of the current COVID-19 pandemic might be
392 on suicidal behaviors. Fourth, the review did not examine other specific high-risk groups than
393 older adults, so that our results fail to inform targeted suicide prevention strategies. Finally,
394 the between-studies heterogeneity was high regarding quality, design, population, and
395 outcomes and may thus limit the relevance of our results.

396

397 **CONCLUSION**

398 While the literature on the impact of EVDOs on suicidal ideation and behaviors was found to
399 be scarce, the existing literature shows weak evidence for an increased risk of deaths by
400 suicide during viral outbreaks, especially during the peak epidemics. The pathways by which
401 EVDOs and suicide are related remain not entirely understood, but their psychosocial effects
402 may be regarded as the main risk factors. Public health and suicide prevention strategies must
403 target the most vulnerable populations that struggle the most to adapt to EVDOs.

404

405 **Figure 1. Flow chart diagram of study selection according to the PRISMA guidelines**

406 **Table 1. Characteristics, designs and results of the studies included in the systematic**
407 **review**

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Tableau 3 : Facteurs de risque d'ARCF post-rupture (spontanée et artificielle)

Facteurs de risque	RCF normal post rupture N=129	RCF pathologique post rupture N=104	P
ARCF avant rupture	4 (3,1%)	33 (31,7%)	<0,001
Groupe			0,29
RAM	68 (52,7%)	62 (59,6%)	
RSM	61 (47,3%)	42 (40,4%)	
Âge maternel	29,3 ±5,5	30,0 ±5,7	0,35
LAM	21 (16,3%)	19 (18,3%)	0,69
Ocytocine lors de la rupture	7 (5,4%)	7 (6,7%)	0,68
Nulliparité	66 (51,2%)	46 (44,2%)	0,29
Post-terme	29 (22,5%)	12 (11,5%)	0,029
PAG	9 (7%)	14 (13,5%)	0,099
IMC>25 kg/m2	45(34,9%)	39(37,5%)	0,68
Durée rupture-accouchement	4,5(2,3 ;7,0)	3(1,3 ;4,8)	<0,001
Dilatation lors de la rupture	4(3,0 ;7,0)	4 (3,0. 7,0)	0,84

Résultats exprimés en N (%) ou en moyenne ± écart-type et médiane (Quartile 1, Quartile 3).

AG= Age gestationnel

IMC = Indice de masse corporelle

LAM= Liquide amniotique méconial.

RAM = Rupture artificielle des membranes

RSM = Rupture spontanée des membranes.

RCF= Rythme cardiaque fœtal

Author (year)	Country	Outbreak	Study design	Population	Sample (n)	Outcome	Main results	Quality*
Wasserman (1992)	USA	1918 Influenza	Cross-sectional Naturalistic observational study Estimate of suicide rates using the US Bureau of the Census and the Death Registration Area data	Population of the USA	87,486,713	Prevalence of deaths by suicide	<ul style="list-style-type: none"> Increased suicide rate during the first phase of the peak-epidemic Peak in suicide rate at the end of the peak of the flu epidemic Significant association between suicide rate and mortality rate ($p < 0.05$) 	22
Smith (1995)	UK, Ireland, France	1889-1893 "Russian" Influenza	Cross-sectional Data aggregation cited in papers from others authors	Population of the UK, Ireland and France	NA	Prevalence of deaths by suicide	<ul style="list-style-type: none"> 25% increased suicide rate in the UK between 1889 and 1893. 12% increased suicide rate in Ireland in 1892-1893. 17% increased rate of SA among women and 7% increased among men in the UK. 23% increased suicide rate in Paris in 1889-90 	9
Huang et al. (2005)	Taiwan	2003 SARS	Cross-sectional Retrospective chart review of medical records (demographic and clinical characteristics) of emergency department patients, before, during and after the SARS epidemic, in a SARS-dedicated hospital	Visitors aged over 14 of the Emergency Department of the Taipei Veterans General Hospital	17,586	Prevalence of SA by drug overdose	<ul style="list-style-type: none"> Non-significant increase of visits for SA from drug overdose during the peak-epidemic stage: peak-epidemic: 3.3 ± 1.8 (2.8 ± 1.5) visits per day vs pre-epidemic: 2.5 ± 1.8 (1.2 ± 1.0) visits per day ($p > 0.05$). No increase of attendance for SA from drug overdose in the late and post-epidemic periods (late epidemic: 2.4 ± 1.5 (2.4 ± 1.4); and post epidemic: 2.3 ± 1.4 (1.4 ± 1.0)) 	22

Chan et al. (2006)	Hong Kong (China)	2003 SARS	<p>Cross-sectional</p> <p>Naturalistic observational study</p> <p>Comparison of suicide rates between 2003 and the 17 years preceding the SARS epidemic</p> <p>Data comes from the Census and Statistics Department of the Hong Kong Government</p>	Population of Hong Kong	NA	Prevalence of deaths by suicide	<ul style="list-style-type: none"> Increased suicide rates for people over 65 (IRR = 1.32, 95% CI 1.11-1.57; p = 0.002 compared to 2002). Increased suicide rates for female elders (IRR = 1.42; p= 0.014). Non-significant increased suicide rates for male elders (IRR = 1.22; p = 0.09). No increase in suicide rates for people under 65 (IRR = 0.97; p = 0.47). Excess in elderly suicide rates in April 2003 (peak of the outbreak) 	21
Cheung et al. (2008)	Hong Kong (China)	2003 SARS	<p>Cross-sectional</p> <p>Naturalistic observational study</p> <p>Comparison of suicide rates between 2003, the 10 years preceding the SARS epidemic and the year just after the SARS epidemic</p> <p>Comparison of socio-demographic, medical and psycho-social data of the people aged over 65 who committed suicide in 2003 in Hong Kong</p> <p>Data based on Coroner's death records</p>	Population of Hong Kong aged over 65 and people aged over 65 who died by suicide in 2003 in Hong Kong	321	Prevalence of deaths by suicide	<ul style="list-style-type: none"> Increased suicide rate in older adults in 2003 (IRR = 1.18, 95% CI 1.01-1.39 compared to 2004). Peak of suicide rate in older adults during the peak-epidemic in April 2003 Increased suicide rate in 2004 (post-epidemic period) compared to the pre-epidemic period (IRR = 0.83, 95% CI 0.70-0.99; p=0.045 in April 2002 compared to 2004). Differences in medical profile among the older adult in the pre-SARS, peri-SARS and post-SARS periods: significant impact of the severity of illness (p < 0.001), the level of dependency (p = 0.013) and the fear of being infected (p = 0.021) during the peri-SARS period 	21

							<ul style="list-style-type: none"> No impact of psychiatric problems ($p = 0.23$) or feeling of burden ($p = 0.45$) 	
Yip et al. (2010)	Hong Kong (China)	2003 SARS	Case-control Retrospective chart review of the characteristics attributed to SARS-related suicide deaths, based on the Coroner's court reports	People aged over 65 who died by suicide in 2003 in Hong Kong	66 (22 cases – 44 controls)	Characteristics of SARS-related versus non-SARS-related deaths by suicide	<ul style="list-style-type: none"> More fear of contracting SARS ($p < 0.001$) and more social disconnection ($p = 0.02$) in older adult SARS-related suicides compared to the non-SARS-related suicides victims. No impact of the level of dependence ($p = 0.52$), severity of illness ($p = 0.704$), psychiatric problems ($p = 0.29$), feeling of burden ($p = 0.19$), employment ($p = 0.67$) or marital status ($p = 0.78$) on SARS-related suicides 	24
Okusaga et al. (2011)	USA	Influenza and coronavirus epidemics	Case-control Examination of influenza A, influenza B or coronavirus seropositivity, in adults with histories of mood disorders, suicidal attempts or healthy adults Participants were recruited into two primary studies about mood disorders and suicidal behavior	Cases: adults with exacerbation of mood disorders and SA - Controls: healthy adults	257 (218 cases - 39 controls)	Prevalence of seropositivity for viruses in people who attempted suicide	<ul style="list-style-type: none"> Significant association between SA and seropositivity for influenza B (OR= 2.53; 95%CI 1.33-4.80; $p = 0.005$). No significant association between SA and seropositivity for influenza A (OR= 1.09; 95% CI 0.77-1.51; $p = 0.65$) No significant association between SA and coronavirus seropositivity (OR= 1.25; 95%CI 0.90-1.73; $p = 0.21$) 	22
Keita et al. (2017)	Guinea	2013-2016 Ebola virus disease	Cohort	People aged over 20 discharged from	256	Incidence of SA and	<ul style="list-style-type: none"> 33 people (12.9%) met the psychiatrist 11 (4.3%) presented a severe depression, including 1 with 	22

			Examination of depressive symptoms among survivors of Ebola virus disease Psychological status was investigated through the Center for Epidemiologic Studies Depression Scale and clinical observations	Ebola Treatment Centers		suicidal ideation	suicidal ideation (0.4%) and 3 (1.1%) with SA occurring 5, 11 and 12 months after discharge from Ebola Treatment Centers	
Harrington et al. (2018)	USA	2009-2013 influenza epidemics	Case-controlRetrospective examination of exposure to oseltamivir or exposure to influenza only in people under 18 with SA Data come from an administrative claims database consisting of 50 million beneficiaries	Cases: individuals under 18 who attempted suicide and were infected by influenza virus – Controls: healthy individuals under 18	251 (17 cases – 156 controls)	Prevalence of influenza diagnosis in people who attempted suicide	<ul style="list-style-type: none"> No significant association between SA and influenza diagnosis (OR = 0.63; 95% CI, 0.34-1.08; p = 0.10). No significant association between SA and oseltamivir exposure (OR = 0.64; 95% CI, 0.39-1.00; p = 0.05). 	21

UK = United Kingdom; 2003 SARS = 2003 Severe Acute Respiratory Syndrome; SA = suicide attempt

*The quality of studies was assessed with the 32-item STROBE statement, a score of 1 (presence) or 0 (absence) was coded for each item (total score on 32)

Table 1. Characteristics, designs and results of the studies included in the systematic review