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1 **Does the public know when a scientific controversy is over? Public perceptions of**
2 **hydroxychloroquine in France between April 2020 and June 2021**

3 Short title: Public perceptions of hydroxychloroquine in France

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15 **Abstract**

16 Objectives:

17 In the early stages of the COVID-19 pandemic, chloroquine and its derivatives such as
18 hydroxychloroquine (HC) were widely commented upon both within the scientific community and in
19 the media. This paper explores the different factors that influenced public perceptions in France of
20 the efficacy of HC as well as their evolution between April 2020 and June 2021.

21 Methods

22 This article draws on 5 surveys conducted among representative samples of the French population
23 (projects COCONEL and TRACTRUST ; quota method, N=1006 ; 1004 ; 2006 ; 1014 and 1005). We
24 asked questions on the effectiveness of chloroquine against COVID-19. We also collected
25 sociodemographic variables and attitudes toward politics and science.

26 Results

27 Between April and June 2021, the proportion of respondents who believed in the efficacy of HC
28 decreased rapidly from 35% to 14%. The proportion of respondents who believed that HC is
29 ineffective rose gradually from 6% to 21%.

30 After adjusting for the temporal effect, the logistic regression showed a very strong association
31 between political orientation and the belief in the efficacy of HC. Respondents who felt closest to the
32 more radical parties (far right and far left) were more likely to believe in the efficacy of HC than those
33 who felt closest to the political center (O.R. 2.48 [1.95-3.15] and 1.87 [1.44-2.43]).

34 The role of trust in the government and in science and of the degree of political engagement were
35 investigated in the two waves conducted after the scientific consensus was established during the
36 summer of 2020. High levels of trust in the government and in science and of politicization are
37 associated with belief of HC proven inefficacy.

38 Across the whole period, a majority of respondents were uncertain. Even in 2021, 41.5% stated that
39 the data were insufficient to decide whether or not HC is effective and 25.2% stating that they did
40 not know.

41 Conclusion

42 Because media coverage of scientific controversies is higher in times of uncertainty than after these
43 controversies have died down, the publicization of therapeutic promises can have lasting
44 consequences on attitudes towards science and medicine.

45 **Keywords:** COVID-19 ; chloroquine ; surveys ; public attitude ; sociology

46 **Introduction**

47 Of all the treatments that have raised and dashed hopes of curing COVID-19, chloroquine and its
48 derivatives, especially hydroxychloroquine (hereafter HC) occupies a special place because of the
49 intensity of the debates surrounding it. In the early stages of the pandemic, HC, were widely
50 commented upon both within the scientific community and in the media. This public debate had
51 several consequences. First, they sent research on unfruitful avenues, as evidenced by the
52 multiplication of clinical trials on HC—often of poor quality (1,2)—that yielded negative results
53 (3,4) and by the difficulties in recruiting patients for trials that tested other molecules (5). Second,
54 several people who took HC to treat COVID-19 infection, either through self-medication or
55 prescription, suffered adverse effects (6–8), and patients affected by diseases commonly treated with
56 HC (such as malaria or lupus) faced stock-outs due to an explosion of demand for the drug (9). Third,
57 the debates on hydroxychloroquine had a temporary impact on health policy in some countries,
58 where exceptional authorizations of use were enacted, and a durable one in others (10,11), such as
59 in Brazil where a “hydroxychloroquine alliance” was formed between intellectuals, physicians, and
60 politicians (12). Fourth and lastly, the confrontational nature of the debate led to insults and attacks
61 against doctors and scientists on the Internet (13,14) as well as legal actions against scientific
62 advisers to governments, such as in France, accused of mass killing for asking to respect the rules of
63 clinical research.

64 In this article, we analyze the evolution of the French public’s perceptions of the efficacy of HC across
65 a period of more than a year (April 2020-June 2021). Although media coverage of HC is now over, the
66 efficacy of HC is still put forward in conspiracy theories, even as these develop in new directions, such
67 as resistance to vaccination or the promotion of treatments like ivermectin. The unfolding of public
68 debates in France is interesting in that it raises the question of the reception of therapeutic promises
69 in the public sphere, both in terms of public perceptions of promising treatments and of their
70 perceptions after a scientific consensus has been established. The recall of episodes from the

71 HIV/AIDS epidemic during the COVID-19 pandemic shows that controversies surrounding some
72 treatments or medical technologies more generally can have durable effects on social
73 representations (15). This phenomenon can cause problems for health authorities. A case in point is
74 that of vaccine hesitancy, which is fueled by the now discredited belief that vaccines cause autism or
75 multiple sclerosis (16). The public reception of “new” treatments has so far received little attention.
76 Indeed, in a context where disease management is performed under a medical monopoly,
77 therapeutic promises are generally seen as concerning mainly doctors and patients. The first studies
78 on attitudes towards HC have focused mainly on doctors (17). Few studies, in France or abroad, have
79 explored the factors involved in the formation of public opinion on the efficacy of HC. Although the
80 French polling institute IFOP did include a question on perceptions of the efficacy of HC in its April
81 2020 survey showing a very high of respondents believing in the efficacy of HC (59%), this has not led
82 to in-depth studies of the factors influencing these perceptions (18). Outside of France, available
83 studies on the topic were conducted on samples that were not representative of the entire
84 population (19–21). In this paper, we are particularly attentive to the effects of political orientation
85 and attitudes towards science on public perceptions of the efficacy of HC. Indeed, research on public
86 controversies surrounding science suggests that political orientation plays a role in the acceptance or
87 refusal of certain medical technologies (22,23). More generally, political orientation appears to
88 influence public perceptions of the scientific consensus (24,25). This was likely to be the case during
89 the COVID-19 pandemic in France given that many political representatives, on both sides of the
90 political spectrum, became personally involved in advocating for HC or defending Professor Didier
91 Raoult and that the debate around this treatment was a major topic in the political news (26).
92 Available studies also suggest that attitudes towards science are an important factor in the perceived
93 efficacy of certain treatments (27). Thus, numerous studies have shown that adherence to false
94 beliefs on topics ranging from the danger of vaccines to creationism is correlated with interest and
95 trust in science in general (28,29).

96 In addition to the issues raised by a pandemic that has been exceptional in its scope and impact, the
97 controversy over HC brought to the fore the issues for health democracy that can arise with the
98 unregulated media coverage of scientific issues in a context where patient autonomy and public
99 engagement in health are encouraged. In France, after a period of intense coverage, the mainstream
100 media reported the scientific consensus on the inefficacy of HC. Yet, some doctors—especially
101 Professor Didier Raoult—continued to defend the efficacy of HC on social networks and, in some
102 cases, to prescribe the drug to COVID-19 patients. Several studies have shown that the correction of
103 false information has less effect than its initial communication (30). Misinformation can even be
104 amplified by contentious groups. We can therefore expect that people who trust science, the
105 mainstream media and feel closest to the governing party have followed the scientific consensus on
106 the inefficacy of HC, and conversely, that those who do not continue to hold views that go against
107 this consensus.

108 After reviewing the evolution of public debates on HC in France, this paper explores the different
109 factors that influenced perceptions of the efficacy of HC between April 2020 and June 2021 based on
110 5 surveys conducted on representative samples of the French population. We show that public
111 perceptions of the drug were less polarized than suggested by the media at the time: not only did a
112 large proportion of respondents declare that they were uncertain about the efficacy of HC, but levels
113 of uncertainty remained high throughout the study period. We also show that political orientation
114 and trust in science or the government were continuously associated with the belief in the efficacy of
115 HC.

116 **Evolution of public debates on HC in France between April 2020 and June 2021**

117 While collective mobilizations around potential treatments have occurred in other epidemic contexts
118 —such as AZT for HIV (Epstein, 1996)—the temporality and scope of the COVID-19 pandemic gave
119 exceptional and international public visibility to the therapeutic promise of HC (31). The debates
120 surrounding HC are now considered exemplary of the issues involved in the representation of science

121 in the public sphere (32). In France, these debates were particularly intense from March to June
122 2020. They touched upon a variety of issues ranging from the merits of clinical trials, the ethical
123 dilemmas facing doctors in a context of uncertainty, the risk of putting unfounded hopes into new (or
124 old)treatments and the relationship between science, pharmaceutical companies and politicians
125 (15,26). The debates over HC were also linked to France's colonial history. In the 17th century, a
126 scientific and political controversy emerged around the use of quinquina (33). More recently, HC has
127 been used massively in the fight against malaria in former French colonies including northern African
128 countries. Professor Raoult, a major advocate of HC use against COVID largely drew on this colonial
129 and postcolonial history to call into question the necessity and quality of contemporary scientific
130 norms (34).

131 *Figure 1. Evolution of attitudes toward HC in France and media coverage*

132 The mainstream media began to take an interest in this potential treatment after the regional press
133 broadcast the 25 February statement posted by Professor Raoult on the social media accounts of the
134 University Hospital Institute Méditerranée Infection (IHU) (26). With the gradual recognition of the
135 severity of the COVID-19 pandemic, President Emmanuel Macron announced the lockdown of the
136 country on 16 March, effective the day after. That same day, Professor Raoult posted a video that
137 went viral in which he presented the results of a clinical study by the IHU supporting the efficacy of
138 HC. In this context of urgency and uncertainty, the various media widely echoed the ensuing debates,
139 giving voice to a diversity of stakeholders (35). Internationally, Elon Musk and Donald Trump
140 repeated Professors Raoult's claims, thereby increasing media coverage of HC (9).

141 In France, media discussions of emerging clinical data on HC were accompanied by a political debate.
142 On 3 April, a former Minister of Health, Philippe Douste-Blazy, launched a petition to allow doctors to
143 prescribe the drug. This demand was taken up by different political figures, especially by prominent
144 members of the main conservative party « Les Républicains ». Despite the lack of evidence, the
145 acting Minister of Health Olivier Veran issued a decree on 25 March authorizing the prescription of

146 HC for serious cases in the hospital setting (2020-314). On 27 March, Professor Raoult posted the
147 results of another IHU study on social networks, and his team continued to promote HC for the early
148 management of COVID-19. This high-profile promotion prompted several intellectuals and media
149 personalities to come to the IHU to be treated and to make the case for the drug. Professor Raoult
150 and the IHU gradually entered “pop culture,” both in the form of cultural expressions (tags, paintings,
151 tattoos) and via a very active Facebook group (created on 20 March) that led to intense exchanges on
152 social networks (36). A mobilization for the generalization of the use of HC took place, despite the
153 French government’s reluctance and the COVID-19 Scientific Council’s reminder to respect the rules
154 of clinical research (37). An IFOP survey reported that at the beginning of April 2020, 98% of French
155 people knew what HC was and 59% believed that it was effective against COVID-19 (18). As more and
156 more clinical data became available, the efficacy of HC was increasingly contested by the scientific
157 community. The trajectory of public debates was nevertheless disrupted by what came to be known
158 as the “Lancet gate” scandal. Indeed, a study reporting the high toxicity of HC in the Lancet on 22
159 May was retracted on June 4 for fraudulent data, casting doubt on the growing scientific consensus.
160 While this study had led to the suspension of the WHO trials and to the publication on 27 May of a
161 French decree prohibiting the prescription of HC for the treatment of COVID-19, its retraction
162 reinforced the positions of HC promoters, who loudly denounced the quality of international
163 research. Around the same time, meta-analyses were published that pointed to the inefficacy of HC
164 against COVID-19. The intermediate results of the Recovery trial published on 5 June showed an
165 absence of effect of HC, and the WHO Solidarity trial published on 15 October confirmed this finding
166 (5). In view of these data, the WHO officially declared HC to be ineffective against COVID-19. These
167 events, however, were insufficient to stop some doctors from promoting HC in the media, and
168 Professor Raoult continued to defend HC on the social media accounts of the IHU and in scientific
169 articles. Nevertheless, the promoters of HC became increasingly marginalized, and media coverage of
170 the drug began to decrease (see Figure 1). A recent report by the CNRS ethics committee criticized
171 the behavior of HC promoters, explicitly describing it as a form of scientific populism (38).

172 **Methods**

173 Data collection

174 This study draws on data from five surveys conducted between 7 April 2020 and 9 June 2021 as part
175 of two research projects: COCONEL (dir. Patrick Peretti-Wattel) and TRACTRUST (dir. Laetitia Atlani-
176 Duault). The COCONEL survey was approved by the ethics committee of the IHU (#2020-018) and the
177 TRACTRUST survey by the IRB of the Biomedical Research Institute INSERM CEEI (#20-722). The
178 surveys consisted of self-administered online questionnaires and were conducted on representative
179 samples of the French population. Quota sampling was used to match the French general population
180 with regards to gender, age and population density in the region of residence (as per official census
181 data). The characteristics of the five surveys are presented in Table 1.

182 Because public debates on HC evolved quite rapidly, we reformulated the main questions and
183 included new variables in the surveys throughout the study. While this limited the comparability of
184 the data, our study nevertheless offers a unique look at the evolution of public perceptions of the
185 efficacy of HC in France over more than a year.

186 In the first two surveys in April, a filter question asked respondents whether or not they knew the
187 chloroquine-based protocol, and a second question asked those who knew this protocol: "In your
188 opinion, is this chloroquine protocol an effective or ineffective treatment against Coronavirus?"
189 Responses options were: "Yes," "No," and "I don't know." In the last three surveys (June 2020,
190 November 2020 and June 2021), the filter question was no longer asked because the overwhelming
191 majority of French people had heard about HC by June 2020. In view of the fact that public debates
192 increasingly focused on the developing scientific consensus, the second question was changed to: "In
193 your opinion, is the current state of knowledge sufficient to settle the scientific debate on the
194 efficacy of chloroquine and its derivatives against the coronavirus?" Response options were: "Yes,
195 and I think chloroquine and its derivatives are a good treatment against coronavirus," "Yes, and I

196 think chloroquine and its derivatives are not a good treatment against coronavirus,” “No, I think data
197 are still insufficient” and “I don’t know.”

198 In accordance with the above questions, public perceptions of the efficacy of HC were recoded in the
199 first two surveys into the following three modalities: “belief that HC is effective,” “belief that HC is
200 ineffective,” and “uncertainty.” In the last three surveys, these perceptions were recoded into the
201 following four modalities: “belief that HC is effective,” “belief that HC is ineffective,” “uncertainty due
202 to insufficient data,” and “uncertainty due to not knowing.”

203 The following variables were collected in all five surveys: gender, age, education level, income and
204 political orientation. Given the increasing focus on the developing scientific consensus in public
205 debates, the following variables were collected in the last three surveys: level of politicization,
206 interest and trust in science, and trust in the government.

Name of the survey	Date of administration	Number of respondents
COCONEL1	7-9 April 2020	1,006
COCONEL2	23-27 April 2020	1,004
COCONEL3	19-24 June 2020	2,006
TRACTRUST1	13-16 November 2020	1,014
TRACTRUST2	8-9 June 2021	1,005

207

208 *Table 1 - Characteristics of the five surveys*

209 Statistical analysis.

210 Several variables were recoded to ensure comparability and interpretability: “Educational level” was
211 recoded into three groups and “age” was recoded into four groups.

212 The association between variables was measured using Pearson’s correlation coefficient for numeric
213 variables and the chi-square test for categorical variables. Estimated proportions were interpreted
214 based on the margins of error provided by pooling institutes, which ranged from 1.4 to 3.1 points.

215 The factors associated with perceptions of the efficacy of HC were explored using binomial logistic
216 regression analyses. A theory-driven variable selection was performed. Statistical analyses were
217 conducted using Python (Pandas–Scipy–Statsmodel).

218 **Results**

219 A declining belief in the efficacy of hydroxychloroquine with high levels of uncertainty

220 Following peak media exposure in March 2020 (Figure 1), almost all respondents had heard about
221 hydroxychloroquine, with only 7% declaring that they had never heard about it in early April. The
222 majority of respondents were uncertain about the efficacy of HC, either due to insufficient data or
223 due to not knowing. Moreover, 35% of respondents believed that HC is effective against COVID-19,
224 and 6% believed that it is ineffective (Table 1).

225 Table 2. Distribution of attitudes toward HC socio-demographic characteristics and political affiliation

226 The proportion of respondents who believed in the efficacy of HC decreased rapidly from 35% to 20%
227 between April and June 2020. It remained low until June 2021, when 14% of respondents stated that
228 they believed HC to be effective. The proportion of respondents who believed that HC is ineffective
229 rose gradually from 6% in April 2020 to 21% in June 2021. These findings contrast with the large
230 proportion of respondents who were uncertain about the efficacy of HC (either due to insufficient
231 data or due to not knowing), a figure that increased slightly from 60% in April 2020 to 64% in June
232 2021.

233 Factors associated with the belief in the efficacy of hydroxychloroquine and their evolution

234 To account for the main factors associated with the belief in the efficacy of HC, we performed a
235 logistic regression on the entire dataset. The dates of each survey were included in the model as
236 covariates (Table 2).

237 Table 3. Binomial logistic regressions of the answers regarding HC (over the 5 surveys)

238 The model showed a strong effect of time on public perceptions of the efficacy of HC. After adjusting
239 for this effect, we observed a very strong association between political orientation and the belief in
240 the efficacy of HC. All other things being equal, respondents who were close to the more radical
241 parties (far right and far left) were more likely to believe in the efficacy of HC than those who were
242 close to the political center (2.48 [1.95-3.15] and 1.87 [1.44-2.43]). Likewise, respondents who were
243 close to the right were more likely to hold this belief than those who were close to the political
244 center (1.43 [1.10-1.85]). Respondents who were not close to any political party were less likely to
245 believe in the efficacy of HC compared to those who were close to the political center (0.38 [0.29-
246 0.49]).

247 Older respondents (above 70 years) were more likely to believe in the efficacy of HC than younger
248 ones (below 35 years) (1.36 [1.10-1.69]). Respondents with a high level of education were more likely
249 to believe that HC is ineffective than those with a low level of education (1.47 [1.20-1.79]).

250 The models per survey (Supplementary A and B) show that respondents with a high level of
251 education were more likely than those with a low level to believe that HC is effective at the beginning
252 of the study period (1.77 [1.27-2.49] for April 2020 survey), but more likely to believe that it is
253 ineffective at the end of this period (1.64 [1.12-2.40] for the June 2021 survey). The effect of political
254 orientation on the belief in the efficacy of HC was very strong. Thus, respondents who feel close to
255 far right parties were more likely than those close to the political center to believe that HC is
256 effective at the beginning of the study period (3.33 [1.93-5.73] for the April 2020 survey) and all the
257 way until the end (2.89 [1.43-5.84] for the June 2021 survey). Respondents close to far left parties
258 were also more likely than those close to the political center to hold this belief from June 2020
259 onwards (2.44 [1.10-5.37] for the June 2020 survey).

260 Factors associated with the belief in the efficacy of hydroxychloroquine after the scientific consensus
261 was reached

262 *Table 4. Binomial logistic regressions of the answers regarding HC (over the survey of November 2020*
263 *and June 2021)*

264 In June 2020, a scientific consensus on the inefficacy of HC began to form (see section on the
265 evolution of public debates). In view of this, specific questions on politicization, interest and trust in
266 science, and trust in the government were included in the November 2020 and June 2021 surveys.

267 The data collected in these two surveys were combined in the binomial logistic model (Table 3).

268 After the consensus was established, women were less likely than men to believe that HC is
269 ineffective (0.63 [0.49-0.82]). Respondents with a high level of education were more likely to believe
270 that HC is ineffective (1.62 [1.19-2.21] compared to respondents with a low level of education), as
271 were high-income earners (2.16 [1.13-4.14] compared to low-income earners).

272 After adjusting for level of politicization, the effect of political orientation disappeared, except for
273 respondents close to the far right, who were less likely than those close to the political center to
274 believe that HC is ineffective (0.38 [0.22-0.66]). By contrast, trust in the government had a strong
275 effect on the belief in the efficacy of HC. Thus, respondents with a low level of trust in the
276 government were twice as likely to believe that HC is effective (2.02 [1.46-2.79]) and twice less likely
277 to believe that it is ineffective (0.51 [0.39-0.67]) than those with a high level of trust. The level of
278 politicization also had an effect on the belief in the efficacy of HC, as respondents with a high level of
279 politicization were twice as likely to believe in the efficacy of HC than those with a low level of
280 politicization (1.85 [1.32-2.59]).

281 Trust in science also appeared to have an effect, as those with a low level of trust were twice as likely
282 to believe that HC is effective than those with a high level of trust (2.20 [1.61-3.02]). Respondents
283 who had no interest in science were twice less likely to accept the scientific consensus that HC is
284 ineffective than those who did (0.62 [0.47-0.81]).

285 The importance of uncertainty

286 By the end of 2020 and during 2021, the majority of respondents were uncertain about the efficacy
287 of HC, with 41.5% stating that the data were insufficient to decide whether or not HC is effective and
288 25.2% stating that they did not know. While political orientation, level of politicization, trust in
289 science, and trust in the government determined the ratio between the belief that HC is effective and
290 the belief that it is ineffective, uncertainty consistently remained the majority option (Figure 2).

291 *Figure 2. Distribution of attitude toward HC regarding political identification and trust in science and*
292 *government.*

293 The factors associated with uncertainty due to insufficient data were not the same as those
294 associated with uncertainty due to not knowing (Table 3). Indeed, the factors that distinguished
295 respondents who stated that they were uncertain due to insufficient data were a high level of trust in
296 science (0.68 [0.52-0.90] compared to respondents with a low level of trust in science) and a high
297 income (1.75 [1.20-2.55] compared to low-income earners). By contrast, several factors were
298 associated with uncertainty due to not knowing: being a woman (1.45 [1.14-1.83] compared to men),
299 having a low level of education (0.61 [0.45-0.81] compared to respondents with a low level of
300 education), feeling close to no party (1.87 [1.18-2.96] compared to respondents close to the political
301 center), and having a low level of politicization (0.61 [0.46-0.82] compared to respondents with a
302 high level of politicization). Having no interest in science (1.96 [1.08-3.57] compared to respondents
303 with an interest in science) and answering “don’t know” to the question on trust in the government
304 (1.96 [1.08-3.57]) or trust in science (5.51 [3.20-9.50]) were also associated with uncertainty due to
305 not knowing.

306 **Discussion**

307 The controversy over HC will long remain a cautionary tale for researchers (31), as it brought to the
308 fore the limits of pre-publications, the dangers of publicizing certain studies, and the importance of
309 conducting high-quality clinical trials. The treatment of the scientific controversy by journalists,
310 intellectuals, scientists, and political representatives is also a case study on how to publicly discuss

311 medical treatments, and more generally scientific research, in a context of uncertainty (26). Within
312 the scientific community, the handling of the controversy reignited a number of debates on
313 questions of publication and citation and more generally on public perceptions of medical research
314 (32). While it is necessary to draw lessons from this episode for the conduct of research, whose
315 temporality does not correspond to that of the media (39), the scope and intensity of the debates on
316 HC also highlight the importance of better understanding their public reception. It would be a
317 mistake to consider this episode as belonging entirely to the past. Beyond the fact that certain actors,
318 in particular doctors, have continued to advocate HC for the treatment of COVID-19, this controversy
319 could have long-term consequences felt in the years to come in the areas of medicine, science, and
320 politics. The continued centrality of HC in conspiracy theories promoted by far-right organizations is a
321 case in point (36).

322 Have the urgency of the COVID-19 pandemic and the desire to believe in a cure resulted in a
323 polarization between promoters and opponents of HC? The IFOP survey published on April 6, 2020,
324 found that 59% of French people believed in the efficacy of HC, which suggested that the enthusiasm
325 for this treatment was strong in the early stages of the pandemic (with 21% that answered “don’t
326 know”) (18). The survey that we conducted one week later showed that only one third of
327 respondents (35%) considered HC effective against COVID-19, reflecting a rapid decline in this
328 enthusiasm. Yet, peaks in demand for HC and in internet searches do not mean that everyone was
329 carried away by hope, even though many may have initially been seduced by this therapeutic
330 promise. Indeed, while our April 2020 survey found a low proportion of respondents who believed
331 that HC is ineffective, it also found a high proportion of respondents who were uncertain about the
332 efficacy of the drug. Moreover, perceptions of HC evolved rapidly over the study period. The
333 proportion of respondents who believed HC to be effective decreased gradually, and conversely the
334 proportion of those who believed it to be ineffective rose over time. However, the total number of
335 respondents who believed HC to be effective or ineffective remained small compared to that of

336 respondents who were uncertain. These findings indicate that public perceptions of HC were less
337 polarized than suggested by the media.

338 Perceptions of the efficacy of HC were socially distributed. From the beginning of the study period,
339 there was a very strong association between political orientation and the belief that HC is effective.
340 Respondents close to the far right, and later those close to the right or the far left, were more likely
341 to hold this belief than those close to the political center. This could be an effect of the political
342 opposition to the governmental policies, especially for respondents from the far left who criticized
343 the lockdown strategy for its effects on social inequalities. This finding may also be explained by the
344 fact that political figures of the right and far right defended HC (26) as part of their criticism of the
345 government's handling of the crisis and its refusal to authorize this promising treatment. Another
346 possible explanation is that HC was largely promoted on social media accounts associated with the
347 right and the far right (36). Conversely, respondents close to the political center, who tend to adhere
348 to the recommendations of health agencies, were more likely to believe that HC is ineffective. The
349 politicization of HC is also reflected in the fact that respondents with no political orientation were
350 more likely to state that they were unsure about its efficacy.

351

352 The results of the November 2020 and June 2021 surveys (Table 3) shed light on the effects of
353 politicization and attitudes towards science. The association between level of politicization and the
354 belief that HC is effective suggests that perceptions of the drug were largely rooted in a political
355 reading of the government's handling of the crisis. Trust in science diminished the likelihood of
356 believing that HC is effective and, conversely, increased the likelihood of believing that it is
357 ineffective. This is consistent with the existing literature, particularly on vaccination, which shows
358 that attitudes towards science, and more generally towards institutions, has an effect on the
359 perception of new medical technologies (16,40). Yet, while the effect of trust in science was strong in
360 our study (at a factor of nearly 2), it does not fully explain perceptions of HC among the French
361 public.

363 Public debates on the efficacy of HC are at the crossroads of different temporalities: that of the
364 pandemic, marked among other things by the implementation of governmental measures like the
365 lockdown, that of the media, which put certain issues on the agenda but not others, that of scientific
366 research, in particular the conduct of clinical trials, and then that of exchanges between individuals,
367 whether in the family circle or in digital spaces. The statements of public authorities were cautious at
368 first, but eventually made it clear that HC is ineffective against COVID-19. The media initially reported
369 on the promises of this treatment, then on the lack of evidence for its efficacy, and finally on the
370 negative results of clinical trials. Learned societies such as the French Society of Pharmacology and
371 Therapeutics issued statements mentioning that HC is ineffective. Our five surveys reflect these
372 temporalities. They show a gradual decline in the number of respondents who believed in the
373 efficacy of HC and an increase in the number of respondents who believed in its inefficacy. Those
374 who continued to defend this treatment even after the scientific consensus was reached had the
375 lowest levels of trust in institutions and the government, and were unsurprisingly largely associated
376 with the political parties most opposed to the government. Thus, in June 2021, 45% of respondents
377 who were close to the political center believed that HC is ineffective, while only 11% of those who
378 were close to the far right held this belief. This difference may be explained by differentiated uses of
379 information sources, with alternative media and social networks pursuing the campaign in support of
380 HC and Professor Raoult. Another possible explanation is the persistence of the memory of the
381 controversy among respondents with the lowest levels of trust in institutions and the government.
382 Importantly, the proportion of respondents who believed in the efficacy or the inefficacy of HC (i.e.
383 respondents who had an opinion on the drug) and that of respondents who were uncertain about its
384 efficacy remained stable throughout the study period. Indeed, levels of uncertainty remained high
385 even after the scientific consensus was reached. It should be noted, however, that respondents who
386 were uncertain due to not knowing were not the same as those who were uncertain due to
387 insufficient data. Uncertainty due to not knowing was in fact associated with not having an opinion

388 on other aspects of the pandemic. These findings indicate that perceptions of the drug were not
389 overly polarized, and therefore highlight the importance of measuring uncertainty to avoid artificially
390 polarizing analyses. Research in the field of agnotology, which has developed over the last decade as
391 part of the history and sociology of science, can help to make sense of these findings. This research
392 examines how certain actors work to maintain false beliefs or keep controversies alive even after a
393 scientific consensus has been reached (41). Some of the most notable examples are the tobacco
394 industry's creation of uncertainty about the effects of smoking, the oil industry's efforts to cast doubt
395 on the human origins of global warming, and the sugar industry's attempts to orient research
396 towards the hypothesis that fat rather than sugar is the cause of obesity. This research has shown
397 that public controversies allow for the instrumentalization of scientific knowledge (42,43) and that
398 moments of intense public debate have lasting effects since doubts about their actual outcome can
399 be remobilized later to defend certain positions—as illustrated by the case of vaccine hesitancy (16).
400 Insofar as the debates on HC gave visibility to different conceptions of science and to the problems of
401 knowledge production in biomedical research—as evidenced by the “Lancet gate” scandal, which
402 seems to have been a turning point, and by the multiplication of working papers of varying quality—
403 the high levels of uncertainty observed in our study can easily be instrumentalized towards a critique
404 of institutions. More generally, uncertainty can encourage distrust in the efficacy (or inefficacy) of
405 certain treatments and can push part of the public towards the most radical forms of complementary
406 and alternative medicine. This is a major concern given that alternative treatments can also
407 contribute to the propagation of conspiracy theories (21).

408 Lastly, our analysis of public perceptions of HC call into question the idea that belief in fallacious
409 ideas is the product of low levels of education. While having a high level of education was associated
410 in our study with having an opinion on HC (as opposed to being uncertain), this opinion was not
411 necessarily in line with the developing scientific consensus, especially in the early stages of the
412 pandemic. Conversely, a low level of education was associated not so much with the belief in the
413 efficacy of HC, but with not knowing whether or not HC is effective. When studying public

414 perceptions of controversies, it is important to take into consideration the fact that different social
415 groups have very different levels of engagement with media debates. As studies on ordinary relations
416 to politics have shown (44), one of the main social divides in France is that between, on the one
417 hand, people whose cultural practices connect them to the public sphere and who have positive
418 attitudes towards institutions, and, on the other hand, people who are not connected to the public
419 sphere and who display much lower levels of trust in the state and its actors (45).

420 **Conclusion**

421 While the controversy over HC is not the first nor the last to emerge surrounding a new but
422 ultimately disappointing treatment (46,47), it received enormous media coverage in the early stages
423 of the COVID-19 pandemic in France. After the scientific consensus on the inefficacy of HC was
424 reached, public health authorities issued statements that were clear and readily available, but that
425 received little attention in public debates. Because media coverage of scientific controversies is
426 typically higher in times of uncertainty than after these controversies have died down, the
427 publicization of therapeutic promises can have lasting consequences on attitudes towards science
428 and medicine (48), and this despite the existence of fact-checking activity. Researchers should take
429 into consideration this asymmetry when publicly discussing medical treatments or vaccines (49), and
430 more generally scientific research, in a context of uncertainty.

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