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1
2 **Quantifying preferences around vaccination against frequent, mild disease**
3 **with risk for vulnerable persons: A discrete choice experiment among French**
4 **hospital health care workers**

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34 **Keywords:** France; Vaccination; Influenza; Pertussis; Health care workers; Stated preferences
35 discrete choice experiment; Incentives; Social conformism

36

37 **Abstract**

38 The individual determinants of vaccine acceptance among health workers (HCWs) have been
39 described in the literature, but there is little evidence regarding the impact of vaccine
40 characteristics and contextual factors (e.g., incentives, communication) on vaccination
41 intentions. We developed a discrete choice experiment (DCE) to assess the impact of seven
42 attributes on stated vaccination intention against an unnamed disease, described as frequent with
43 rapid clinical evolution and epidemic potential (similar to influenza or pertussis). Attributes
44 evaluated vaccine characteristics (effectiveness, security profile), inter-individual aspects
45 (epidemic risk, controversy, potential for indirect protection, vaccine coverage) and incentives
46 (e.g., badge, hierarchical injunction). A total of 1214 French hospital-based HCWs, recruited
47 among professional organizations, completed the online DCE questionnaire. The relative impact
48 of each attribute was estimated using random effects logit models on the whole sample and
49 among specific subgroups. Overall, 52% of included HCWs were vaccinated against influenza
50 during 2017-18 and the average vaccination acceptance rate across all scenarios was 58%.
51 Except for attitude from the management, all attributes' levels had significant impact on
52 vaccination decisions. Poor vaccine safety had the most detrimental impact on stated acceptance
53 (OR 0.04 for the level *controversy around vaccine safety*). The most motivating factor was
54 protection of family (OR 2.41) and contribution to disease control (OR 2.34). Other motivating
55 factors were improved vaccine effectiveness (OR 2.22), high uptake among colleagues (OR
56 1.89) and epidemic risk declared by health authorities (OR 1.76). Social incentives (e.g., a badge
57 *I'm vaccinated*) were dissuasive (OR 0.47). Compared to HCWs previously vaccinated against
58 influenza, unvaccinated HCWs who were favorable to vaccination in general were most sensitive
59 towards improved vaccine effectiveness. Our study suggests that vaccine safety considerations

60 dominate vaccine decision-making among French HCWs, while adapted communication on
61 indirect protection and social conformism can contribute to increase vaccination acceptance.

62

63 **1. Introduction**

64 Low uptake of recommended vaccinations is a worldwide problem for public health. Low
65 acceptance or hesitancy by the target population or specific subgroups has been identified a main
66 factor for vaccine refusal (MacDonald and SAGE Working Group on Vaccine Hesitancy, 2015).

67 A substantial body of literature has described the determinants of acceptance (and refusal) of
68 specific vaccinations, including that of health care workers, thus informing on *the characteristics*
69 *of persons* accepting vaccination. However, individuals' positions towards vaccination is now
70 understood as a continuum of vaccination hesitancy, ranging from full refusal to full acceptance,
71 on which individuals can move depending on the type of disease to be prevented, type of
72 vaccine, and several other factors, commonly structured into convenience, complacency and
73 confidence (MacDonald and SAGE Working Group on Vaccine Hesitancy, 2015).

74 Understanding the features of vaccination programs that allow hesitant individuals *to move from*
75 *refusal towards acceptance* in specific vaccine decisions are therefore of utmost importance. So
76 far, few research efforts have focused on this aspect. The perspective in this approach is to move
77 from descriptive towards interventional research, to improve communication, strategies and
78 other elements of vaccination programs.

79 Because there is little variation in public health programs (e.g., vaccination) within
80 populations, it is difficult to infer the drivers of individual decisions using observed choices (i.e.,
81 *revealed preferences*). Discrete choice experiments (DCEs) have been developed to overcome
82 this limitation (Ryan, 1999). DCEs allow exploring the determinants of individual preferences
83 for different health intervention (e.g., a treatment, a preventative or screening program) in
84 hypothetical settings. The service or intervention in question is described by different
85 characteristics or attributes. The attributes are arranged into multi-attribute alternative options

86 (e.g., treatments), which are presented in choice sets of two or more options. The DCE task
87 requires individuals to choose their preferred option. Econometric analysis of responses then
88
89 allows quantifying the weights individuals attach to various attributes of the health intervention
90 in order to finally predict their independent impact on decisions. DCEs have increasingly been
91 used for valuing treatments, preventative or screening interventions (Bridges et al., 2011; Clark
92 et al., 2014; Johnson et al., 2014; Ryan and Gerard, 2003). More recently, this approach has also
93 been used to elicit preferences not only for vaccines, but vaccination programs, including
94 programmatic and interindividual factors as attributes (Determann et al., 2016; Seanehia et al.,
95 2017; Verelst et al., 2018). Seanehia et al. (2017) conducted a DCE study among French students
96 and concluded that an explicitly stated potential for indirect protection, and factual information
97 on coverage in the community positively impact theoretical individual vaccine acceptance, while
98 a controversy about potential side effects may have greater negative impact than a confirmed
99 rare severe side effect. Another DCE study among Belgian parents showed that vaccine-related
100 side effects and accessibility (in terms of convenience and reimbursement) were the most
101 influential attributes, followed by vaccine effectiveness and burden of disease (Verelst et al.,
102 2018). Besides, peer influence had a greater influence on vaccine decision than free-riding on
103 herd immunity (Verelst et al., 2018).

104
105 Seasonal influenza is recommended for health care workers (HCWs) in most European
106 countries (Maltezou and Poland, 2014; Mereckiene et al., 2014), to reduce work days lost and to
107 interrupt the viral transmission to vulnerable patients (Hayward et al., 2006). However, influenza
108 vaccine coverage among HCWs in Europe remains in general below 40% (Jorgensen et al.,
109 2018). In France, seasonal influenza vaccination among HCWs was estimated at 25.6% in 2008-
110 09 (55.0%, 24.4% and 19.5% among physicians, nurses and nurse assistants, respectively)
111 (Guthmann et al., 2012), but recent estimates suggest an increasing trend in coverage, with

112 34.8% of HCWs vaccinated in 2018-19 (72,2%, 35,9% and 20,9% among physicians, nurses and
113 nurse assistants, respectively) (Santé Publique France, 2019) Mandatory vaccination has been
114
115 suggested as a solution, following the example of the US hospitals and health care organizations
116 (Greene et al., 2018). A similar situation exists for pertussis (whooping cough) vaccination,
117 which is recommended for HCWs in contact with new-born babies to avoid nosocomial infection
118 (Calugar et al., 2006), but for which coverage remains below the target in France (45% among
119 midwives, 11% among HCWs in general) (Guthmann et al., 2012).

120 The reasons for vaccination refusal by HCWs have been described as misconceptions
121 about the disease (e.g., influenza) and its vaccine (Boey et al., 2018), the perception of low or
122 inconstant vaccine effectiveness, decisional uncertainty (Visser et al., 2018), vaccine safety and
123 fear of adverse events following vaccination (Dorribo et al., 2015), and the belief that the risk of
124 disease transmission during care activities is low or can be avoided by hygienic measures
125 (Doumont and Libion, 2007; Gil et al., 2006). On the other hand, protection for oneself, the
126 family or patients has been identified as reason for acceptance (Hakim et al., 2011; Valour et al.,
127 2007). However, the relative importance of these factors, and the extent to which motivating
128 factors can compensate for low disease risk and worry about the vaccine safety profile, has not
129 been studied, yet. Moreover, the impact of external incentives on vaccination acceptance has not
130 been evaluated in this context.

131 In the present study, we aimed at evaluating preferences for vaccination program
132 characteristics - beyond vaccine access - among French HCWs practicing in hospitals. In
133 particular, we sought to evaluate communication options around specific program aspects (e.g.,
134 coverage, safety, potential for indirect protection) and the effect of incentives. The hypotheses
135 underlying this study were mainly structured according to the health belief model in vaccination
136 (Paulussen et al., 2006; Rosenstock, 1974), proposing the perceived likelihood and severity of
137 disease, the perceived benefits, risks and costs of vaccination as determinants of vaccine

138 acceptance. We assumed that disease risk perception and vaccine-related factors (safety and
139 effectiveness) would have the strongest impacts on HCWs' vaccination decisions, but that inter-
140
141 individual level factors (social conformism, potential for indirect protection) and communication
142 modalities (incentives, injunction) can offset these effects to a substantial extent. We also
143 hypothesized that these impacts may vary across groups defined by health-related behavior,
144 attitudes towards vaccination and towards health authorities.

145

146 **2. Methods**

147 **2.1. Study design and participant inclusion**

148 We conducted a cross-sectional study among French HCWs using a self-administered
149 online questionnaire containing a single profile discrete choice experiment (DCE). The study
150 invitation was addressed to any HCW practicing in France, including students and HCWs in
151 French overseas departments. Respondents indicating that they worked independently, i.e.,
152 outside the hospital, a nursing home or a comparable institution, received a different version of
153 the questionnaire and were excluded from the present analysis. The invitation was distributed by
154 e-mail to a professional registry (18,120 entries) and to two professional organizations: the
155 Research Group for the Prevention of Occupational Infections in Healthcare Workers (GERES)
156 and the National College of Nurses (approximately 300,000 members in total), without any
157 reminder message. Due to the 'snowball' sampling technique (investigators recruited HCWs
158 from their acquaintances) used by one professional organization (the GERES) to reach HCW
159 outside the organization, the number of HCW having received the invitation - and thus the
160 response rate and representativeness - could not be estimated. The National College of Nurses
161 included the invitation inside their monthly newsletter, which was sent to 230,000 French nurses
162 and nursing managers. The e-mail contained some basic information about the study's objectives

163 and methods, the anticipated time required for participation (i.e., 15-20 minutes) and a link to the
164 anonymous questionnaire on the Sphinx® online survey platform. No informed consent was
165
166
167 required for this anonymous survey. We obtained approval from a French ethics committee (CPP
168 Sud-Est V). The survey platform was open during June 18 through September 06, 2018.

169
170 The questionnaire contained three parts. The first part asked general background
171 information (e.g., profession and socio-demographic characteristics). The second part contained
172 the DCE tool. The third part collected information on vaccine behaviors and attitudes, including
173 sources of vaccine information, vaccine hesitancy on a four levels scale (Verger, 2017) and
174 health-related behavior (e.g., use of alternative medicine, smoking).

175

176 **2.2. Design of the DCE tool**

177 *Attributes and levels*

178 The attributes and levels included in the DCE were identified following a review of the
179 literature on determinants of acceptance and refusal of vaccination among HCWs (Boey et al.,
180 2018; Dorribo et al., 2015; Hakim et al., 2011; Visser et al., 2018), with a focus on influenza and
181 pertussis vaccination, and through discussion between eight experts and stakeholders (social
182 scientist, epidemiologist, professional organizations, and occupational health). Given an
183 abundant (grey) literature including from France, we refrained from additional qualitative work
184 to identify attributes and levels. We established a list of possible attributes and levels and
185 eliminated items stepwise in discussion between co-authors, until consensus on the most
186 important items was reached. We considered essential to include items corresponding to the
187 above-mentioned health belief model, as well as the 3C-concept of vaccine hesitancy
188 (convenience, complacency and confidence) (McDonald et al., 2015), along with social

189 conformism and indirect protection (Seanehia et al., 2017). Convenience was fixed in the frame,
190 defined as the hypothetical situation of a meeting organized by the occupational health service,
191 with the objective to provide information about the vaccine and to offer *immediate free*
192
193 vaccination. The targeted vaccine-preventable disease was not named but described according to
194 characteristics of influenza and whooping cough: high incidence and seasonal patterns, easily
195 transmitted during close contacts, with a low risk of complications, except for specific vulnerable
196 groups (infants, elderly, chronic disease patients). A total of seven attributes were included in the
197 hypothetical vaccination scenarios (**Table 1**).

- 198 - The attribute EPI (4 levels) referred to the epidemic situation and was designed to test
199 how disease risk perception influenced vaccination acceptance. We assumed that the
200 level “*cases among colleagues*” would have the highest positive impact on vaccine
201 acceptance. Indeed, disease risk perception is a main reason for vaccination (Setbon and
202 Raude, 2010), and colleagues are the most reliable information and also the most
203 immediate threat.
- 204 - The SAFETY attribute (4 levels) described various situations of vaccine-related side
205 effects. It was developed to test whether a public controversy or a recent vaccine with
206 uncertain safety profile impacted vaccine acceptance as negatively as a confirmed severe
207 side effect, as already observed among French students (Seanehia et al., 2017).
- 208 - The attribute EFFECTIVENESS (4 levels) evaluated whether an improved vaccine (90%
209 vaccine effectiveness instead of the regularly observed 30% against influenza (Bonmarin
210 et al., 2015)), and larger intervals (every 3-5 years instead of annual vaccination) could
211 stimulate vaccine acceptance.
- 212 - The COVERAGE attribute (5 levels) was designed to test the impact of social
213 conformism and free-riding on vaccination acceptance, and whether social conformism
214 was stronger towards colleagues or the general HCW population (Hastings et al., 2004).

215 The reference level “insufficient coverage” represented a commonly used communication
216 formula, which we hypothesized to have no positive impact on vaccine acceptance,

217

218

219 contrary to factual communication of low coverage (30%) or occasional uptake (“a few
220 colleagues”).

221 - The attribute INDIRECT PROTECTION (4 levels) was designed to assess the extent to
222 which communication on supra-individual benefits from vaccination can improve vaccine
223 acceptance (Shim et al., 2012). Indirect protection conferred by a vaccine leads to the
224 effect of herd protection in the population, meaning that the average disease risk is
225 reduced due to reduced pathogen transmission. The risk reduction or the disease control
226 becomes more important as vaccine coverage increases and eventually can reach the level
227 of herd immunity, at which the pathogen does not circulate and thus the disease is
228 eliminated from the population (Fine et al., 2011). We hypothesized that reference to a
229 collective goal (disease control) not involving personal altruism (protection of family,
230 patients) had the highest positive impact, in line with previous results among French
231 university students (Seanehia et al., 2017).

232 - The attribute INCENTIVES (4 levels) tested whether announced incentives or
233 punishment had any positive impact on vaccine acceptance (Lugo, 2007). We had no a
234 priori assumption, because the effect may depend on the complementarity /
235 substitutability between intrinsic motivation (or altruistic motives) towards vaccination
236 and external incentives (Frey, 1994; Janus, 2010).

237 - The MANAGEMENT attribute (2 levels) tested whether a pro-vaccine message of the
238 hospital management team (chief officer), representing a hierarchical injunction with a
239 health-related utility (avoiding work days lost), had positive impact on vaccine
240 acceptance (Canning et al., 2005; Lugo, 2007).

241
242 We performed a pilot study by having six health professionals in our environment
243 (one nurse, two physicians, two medical students and one pharmacist) self-administering the
244
245 questionnaire and providing feedback that helped us simplify the introduction text of every
246 scenario, and clarify the formulation of some levels.

247
248 *Experimental design*

249 This list of attributes would theoretically allow constructing 10,240 hypothetical
250 vaccination profiles (i.e., scenarios with only one vignette) in a full factorial design. We used
251 SAS® software to generate a 32-profile orthogonal design with non-informative priors and
252 allowing estimation of all main effects. We constrained the final design to incorporate two
253 specific attributes' combinations corresponding to contexts that aimed to closely mimic 1) the
254 influenza vaccination situation and 2) the pertussis vaccination situation (see **Figures A1 and**
255 **A2**, supplementary file A). Moreover, several constraints were added to avoid implausible
256 combinations of attributes. These constraints automatically generated some correlations between
257 attributes, but these correlations were low as the final design was 90.5% D-efficient compared to
258 the best possible orthogonal design (see **Table A1** for detailed model constraints). This initial
259 choice set was 'blocked' into two versions of the survey each with 16 profiles (the 'blocking'
260 procedure allowing minimizing the correlation between the attributes in each version) (Reed
261 Johnson et al., 2013).

262 In each choice task, we presented one hypothetical vaccination profile to participants and
263 asked whether or not they would accept immediate vaccination (single profile DCE format, see
264 Figure 1 for an example choice task). In the vaccination context, individuals are used to make
265 binary choices such as to vaccinate or not to vaccinate, rather than choosing between several
266 alternative vaccines. We hypothesized that a single profile choice design would increase the

267 realism of the choice task and thus survey engagement, such that any potential loss in statistical
 268 efficiency (only one profile per choice task) would be compensated by an increase in data
 269 quality.

270
 271 If vaccination was accepted, *willingness to accept* pain associated with vaccination was
 272 evaluated by asking for which maximum level of pain the respondent was willing to be
 273 vaccinated (**Figure 1**). Four ordinal levels were presented to respondents: minor pain during the
 274 injection; redness / swelling at the injection site for one day; minor arm pain during three days;
 275 one day with fever while you need to stay in bed. We included a briefing on how to complete the
 276 choice tasks before the beginning of the DCE (see supplementary file **B**).

277

278 **2.3. Statistical analyses**

279 We estimated the determinants of vaccination acceptance using a random intercept logit
 280 model, detailed in Eq. (1):

$$\begin{aligned} \text{logit}[P(\text{Accept}_{nj})] = & \beta_0 + \beta_{1-3}EPI_{nj} + \beta_{4-6}SAFETY_{nj} + \beta_{7-9}EFFECTIVENESS_{nj} \\ & + \beta_{10-13}COVERAGE_{nj} + \beta_{14-16}INDIRECT\ PROTECTION_{nj} + \beta_{17-19}INCENTIVE_{nj} \\ & + \beta_{20}MANAGEMENT_{nj} + u_n \quad (1) \end{aligned}$$

281

282 In Eq. (1), Accept_{nj} is a binary indicator coded 1 if respondent n accepts the hypothetical
 283 vaccination profile j ; $EPI_{nj}, \dots, MANAGEMENT_{nj}$ represent the levels of the attributes
 284 displayed in scenario j ; β_{x-y} is a vector of corresponding part-worth utility coefficients for all
 285 levels $x-y$ of attribute k ; and u_n is a subject-specific random error term, assumed normally
 286 distributed and representing respondent' n propensity to accept / not accept the hypothetical
 287 vaccines. Note that the logit specification in equation (1) further assumes that all other
 288 unobserved factors and idiosyncrasies influencing $P(\text{Accept}_{nj})$ follow a type 1 extreme value
 289 distribution. Because all respondents (in a same survey block) faced the same vaccination
 290 profiles or scenarios (and thus were exposed to the same attributes' levels combinations), the

291 explanatory variables were exogenous such that fixed effects and random effects estimators for
292 panel data collapse (Wooldridge, 2002, chapter 10). The random intercept model was estimated
293 by Gauss-Hermite quadrature.

294
295 We computed the overall significance of the attributes using likelihood ratio tests - that is,
296 by considering the difference in models log likelihoods for an attribute (with all its levels) in and
297 out of a model (Lancsar et al., 2007) – and measured the relative importance of the attributes by
298 the logworth statistic, i.e. $-\log_{10}(\chi^2)$ of the LR test).

299 We explored the impact of individual characteristics on preference weights (observed
300 preference heterogeneity) in several steps. First, we re-estimated Eq. (1) by adding interactions
301 between all attributes' levels and individual characteristics including background information
302 (e.g., gender, age, profession), attitudes towards vaccination, and vaccine information from
303 media and health authorities (in total: 26 attribute levels * nine personal characteristics = 234
304 interactions tested). Next, we included only the significant interaction effects (at the 5% level) in
305 a joint model. In addition, we assessed the structural differences in preferences using stratified
306 (subgroup) analysis. A significance threshold of 5% was used to assess statistically significant
307 differences.

308 For the ordinal outcome 'willingness to accept pain', we used an ordered panel logit
309 model, assuming proportionality of odds between outcome levels. The levels weights were
310 expressed as odds ratios (OR) with 95% confidence intervals.

311

312 **3. Results**

313 **3.1. Descriptive statistics**

314 A total of 1827 HCW responded to the online survey, of which 18 did not meet the
315 inclusion criteria. One third (N=595, 32.9%) indicated working outside the institutional setting
316 and were thus excluded from the present analysis. Among the remaining 1214 HCWs, 72.5%

317 were nurses, 10.5% doctors, 9.1% nursing managers and 7.9% other professional groups
318 (including nurse assistants and midwives) (**Table 2**). Forty percent of respondents were younger
319 than 40 years, 81.8% were female, 51.7% were vaccinated against influenza during the 2017-18
320
321 season (78.1%, 48.0%, 60.9% and 18.4%, respectively, among doctors, nurses, nursing managers
322 and other groups) and 83.6% were up-to-date for pertussis vaccination. Most HCWs (83.5%)
323 declared trusting health authorities for vaccine information, while only 17.0% declared trusting
324 information from the mass media. Most HCWs were favorable towards vaccination in general
325 (93.2%), and 83.5% towards influenza vaccination. A low, medium and high level of vaccine
326 hesitancy was found for 25.0%, 6.1% and 23.1% of participants, respectively. Use of alternative
327 medicine was reported by 47.2%, and daily smoking, by 16.1% of participants. Only 11 (0.91%)
328 participants were students, therefore their responses were not analyzed separately.

329

330 **3.2. Stated preferences**

331 Overall, the participating HCWs accepted 58.0% of vaccination scenarios (range: 25.4%
332 to 83.6%). Between- and within-individual heterogeneity in vaccination acceptance was of the
333 same magnitude (0.36 and 0.33, respectively) (**Table 3**). The scenario representing realistic
334 influenza and pertussis vaccination situation was accepted by 74.2% and 81.4% of HCWs,
335 respectively. The most commonly accepted maximal level of mild side effects was one day of
336 redness and swelling at the injection site (46.0%).

337

338 **3.2.1. Determinants of vaccine acceptance**

339 The overall importance of attributes is displayed in **Figure 2**. Safety issues had greatest
340 influence on vaccination acceptance (normalized logworth = 100%, reference) while attitude
341 from the management did not have any significant impact. The attributes EFFECTIVENESS,

342 INCENTIVE, INDIRECT PROTECTION, and COVERAGE had approximately equal influence
343 (normalized logworth= 63%, 62%, 61%, and 57%, respectively).

344 The impact of each attribute's levels are details in **Table 4**. The level "epidemic risk
345 estimated by health authorities" had higher effect than "cases among colleagues" (OR= 1.89 vs.
346 OR= 1.23, 95% confidence intervals not overlapping). Vaccine acceptance was positively
347 impacted by higher vaccine effectiveness (level "90% for 3-5 y": OR= 2.22) and, to a lesser
348 extent, by longer duration of protection ("30% for 3-5y": OR= 1.39). The attribute SAFETY
349 included the levels with the highest absolute impact on vaccination acceptance, which were all
350 negative. The strongest, negative impact (disutility) was observed for controversy (OR= 0.04)
351 and a confirmed severe side effect (OR= 0.05), followed by "recent vaccine, no side effect
352 known" (OR= 0.30). Among inter-individual factors, the communication of "most colleagues
353 vaccinated" and "80% coverage" had positive impacts (OR= 1.89 and OR= 1.45, respectively),
354 and the communication of "30% coverage" had a small positive effect compared to "insufficient
355 coverage" (OR= 1.19). The potential for indirect protection showed the highest positive effects,
356 with OR =2.41 for "protection of family" and OR= 2.34 for "disease control". Incentives through
357 badge or certificate, and threat had negative impacts (OR= 0.47, OR= 0.57 and OR= 0.79,
358 respectively). A "message from management" was the only attribute level that did not show any
359 significant impact on vaccination acceptance (OR= 1.02). The results were robust to the
360 exclusion of "straight-liners", that is, those always refusing or accepting the hypothetical
361 vaccines, thus not contributing to the likelihood of the model (supplementary **Table C1**).

363

364 **3.2.2. Analysis of preference heterogeneity: interaction effects and subgroup analyses**

365 Results of interaction models (**Table 5**) and subgroup analyses (supplementary material
366 **C, Tables C2 to C9**) showed little variation in preferences according to HCW's background
367 characteristics (e.g., gender, age, profession), but more pronounced differences according to

368 vaccination attitudes. Preferences were not significantly different across gender and age
369 accounted for only minor differences in preferences. Significant differences were found
370 regarding vaccine effectiveness (lower utility of improved effectiveness among older HCWs)
371 and vaccine safety profile (e.g., lower disutility from a so far safe but recent vaccine among 50-
372
373 65-year-old HCWs) (**Table 5**). Regarding profession, some differences were found such as a
374 lower negative effect of “recent vaccine, no side effect” among nursing health managers (OR=
375 0.58, 95%-CI [0.37-0.93]; vs. OR= 0.26 [0.22-0.31] among nurses) and a significantly positive
376 impact of “message from the management” among nursing health managers (Table 5) and among
377 doctors (OR= 1.52, 95%-CI [1.00-2.32]; vs. OR=0.96 [0.84-1.09] among nurses, **Table C2**).
378 HCWs using, advising and / or consulting (for) alternative medicine experienced increased
379 disutility from the levels “controversy” and “known, neuro effect” of the SAFETY attribute
380 (**Table 5**).

381 Participants vaccinated against seasonal influenza during 2017-18 (N=628), those not
382 vaccinated but vaccine-favorable in general (N=502), and those not vaccinated and vaccine-
383 unfavorable (N=76) accepted vaccination in 76.5%, 42.8% and 8.3% of scenarios, respectively.
384 These results show strong consistence between revealed preferences (i.e., reported vaccination
385 uptake) and stated preferences (i.e., hypothetical uptake). Not vaccinated and unfavorable
386 participants tended to be younger, with higher prevalence of women and nurse assistants, while
387 doctors, men and older participants were overrepresented in the vaccinated group. Table 5 show
388 that this composite variable combining vaccine attitudes and practices account for largest
389 variations in preferences. Stratified analyses according to this variable are displayed in
390 supplementary **Table C9 / Figure C1**. Compared to vaccinated participants, those who were *not*
391 *vaccinated but vaccine-favorable* were significantly more sensitive to improved and longer
392 vaccine effectiveness (“90% for 3-5y”: OR=2.84 vs. OR=1.59), but experienced less disutility
393 from controversy (OR=0.05 vs. OR=0.03), confirmed side effect (OR=0.07 vs. OR=0.04) and

394 incentive through badge (OR= 0.54 vs. OR=0.35) (**Table C9**). By contrast, compared to the
395 unvaccinated but vaccine-favorable group, participants who were *not vaccinated and vaccine-*
396 *unfavorable* showed substantially greater sensitivity to vaccine safety (OR= 0.01 for “confirmed
397 side effects” and OR= 0.12 for “recent vaccine, no side effect”). They tended to be more
398
399 sensitive to the epidemic situation (OR= 4.67 [1.04-20.99] for “cases among patients”) and to
400 social conformism (OR=3.68 [0.87-15.60] for the level “80% of French HCWs vaccinated”), less
401 sensitive to potential for indirect protection for patients and family except for disease control
402 (OR= 2.13 [0.39-11.72]), and experience greater disutility from incentives (OR = 0.27 [0.07-
403 1.08] for the level “badge”).

404

405 **3.5. Determinants of willingness to accept pain (ordinal outcome)**

406 Regarding the ordinal outcome *maximal acceptable minor side effect* (willingness to
407 accept pain), most attributes’ levels were not significantly associated with vaccination
408 acceptance and the associated OR were in general close to 1 (**Table 4**). However, significant
409 effects were found for “high epidemic risk” (OR= 1.49), “controversy” (OR= 0.76), “90%
410 effectiveness for 3-5 years” (OR= 1.24), “30% coverage” (OR= 0.82) and “protection of the
411 family” (OR= 1.43).

412

413

414 **4. Discussion**

415 **4.1. Summary of results and interpretation**

416 We used a DCE to quantify the weights that French HCWs attach to known factors of
417 vaccine decision. For a disease comparable to influenza or pertussis, we found impacts from –
418 listed in decreasing order of importance – issues around vaccine safety (negative), improved
419 vaccine effectiveness, incentives (negative), potential for indirect protection, vaccine coverage,

420 and information on epidemic risk. Hierarchical injunction had a positive impact only among
421 nursing health managers and doctors. While the average frequency of acceptance substantially
422 varied between subgroups, preference weights were relatively homogeneous. Among HCWs
423 who were not vaccinated against seasonal influenza, those favorable vs. those unfavorable to
424
425 vaccination in general could be distinguished by a preference for higher vaccine effectiveness
426 among the first group vs. a particularly strong sensitivity for safety-related issues among the
427 second group.

428 Our main hypothesis was that disease risks and vaccination safety were the most
429 important predictors of vaccination decisions. Our results confirm this a priori for issues around
430 vaccine safety, with OR well below 0.5 and down to 0.04, which is close to systematic refusal of
431 vaccination. While such a strong impact from a confirmed side effect can easily be understood
432 and confirm previous results in different contexts (Luyten et al., 2019; Verelst et al., 2018), the
433 even more negative impact from a controversy is surprising. It is theoretically possible that
434 participants imagined that the controversy carried on something worse than a marginally
435 increased risk of a lifelong neurological disease, but it is also possible that controversy aversion
436 *per se* came into play. Controversies have played a crucial role in the public perception of
437 vaccination over the last few decades in France, spanning from vaccines against hepatitis B and
438 pandemic influenza to HPV and more generally vaccines containing aluminium adjuvants. From
439 an economic standpoint, disutility experienced from the absence of reliable and credible
440 information about risk is related to ambiguity aversion (Berger et al., 2013), a concept that has
441 been shown to negatively affect prevention behaviors (Han et al., 2009) or treatment decisions
442 (Berger et al., 2013). Identifying interventions that can moderate this negative impact of
443 controversies should be of high priority for public health. This is a challenge, as simple delivery
444 of counter-information has been found to aggravate vaccine safety concerns (Pluviano et al.,
445 2017). The substantial negative impact from the information that the vaccine is recent (albeit so

446 far safe) may appear surprising, but corresponds to the ranking between old, well-known and
447 newly recommended vaccines, recently described in France (Humez et al., 2017). As described
448 by Slovic in a seminal paper (Slovic, 1987), tolerance of new hypothetical risks is usually lower
449 than that of old, well-known ones. In addition, lack of trust in health authorities and
450
451 pharmacovigilance, previously described among European healthcare workers (Karafillakis et
452 al., 2016), may contribute to explain the result. Overall, these results reflect an impressively
453 negative perception of uncertainty around safety, which has also been described among French
454 university students (Seanehia et al., 2017). Whether this is a specificity of the French population,
455 as suggested by an international comparison of the consent to the simplistic affirmation
456 “vaccines are safe” (Larson et al., 2016) requires further investigation.

457 The occurrence of disease cases among patients and colleagues, or the estimation of a
458 higher epidemic risk by health authorities had a relatively low impact on vaccination acceptance
459 (OR <2), which may be explained by the fact that the hypothetical disease was presented as mild,
460 with complications being limited to vulnerable persons. However, the announcement of an
461 epidemic risk tended to have strong impact among vaccine-unfavorable participants, suggesting
462 that communication on an exceptional epidemic risk can be an external cue for vaccination,
463 despite hesitancy (Chang, 2016).

464 The third vaccine-related attribute, improved (duration of) vaccine effectiveness, showed
465 a substantial impact (OR > 2) on vaccine acceptance. This factor is often neglected in the debate
466 around vaccine hesitancy among health care workers, although disease risk perception is
467 necessarily modulated by perception of benefits from vaccination (Becker, 1974) and low
468 effectiveness has been described as a barrier to vaccine uptake (Doumont and Libion, 2007;
469 Hakim et al., 2011). Our results suggest that influenza vaccine acceptance among HCWs could
470 increase, once vaccines with an effectiveness that is less impacted by strain variations will be
471 available.

472 The inter-individual attributes were found to have a substantial impact on HCWs' vaccine
473 acceptance. The strong impact from a potential indirect protection suggests that such an
474 argument may partially compensate for the low perceived risk related to the disease (Seanehia et
475 al., 2017). Moreover, directly mentioning patients as a group to protect tended to have less
476
477 impact than referring to collective disease control, in particular among vaccine-unfavorable
478 HCWs. While altruism has been described as a motivating factor for vaccination (Prematunge et
479 al., 2012; Shim et al., 2012), it may not be appropriate to request or incite it and the offer to
480 participate in a collective effort of disease control may more easily be heard. Further research is
481 needed regarding the development of targeted communication content about indirect protection.
482 We found that doctors' relative weight for indirect protection was lower compared to nurses,
483 which may reflect the fact that the reference level "protect one-self" already is a greater
484 motivator in this group.

485 Our results suggest that most participating HCWs might be prone to normative social
486 influence, with the information about colleagues being vaccinated or a high coverage among
487 HCWs motivating vaccination acceptance. A similar impact was observed among French
488 university students (Seanehia et al., 2017). Social conformism is part of heuristics that are
489 increasingly recognized as determinants of health-related decisions (Gigerenzer, 2008). It is
490 important to note that we could not identify any subgroup in which a "high coverage" attribute
491 level had negative impact on acceptance, thus rejecting free-riding motives among HCWs, in line
492 with results found in previous DCEs among US parents (Gidengil et al., 2012), the Belgian
493 general population (Verelst et al., 2018), and South African adult population (Verelst et al.,
494 2019). Social benefits of vaccination were explicitly addressed in our experiment, which –
495 following Betsch et al. (2013) - may have prevented free-riding. Finally, as hypothesized, the
496 commonly used formulation of "insufficient coverage" was the least attractive for hospital

497 HCWs. This could point to an aversion against an unsuccessful vaccination program
498 (Prematunge et al., 2012).

499 Our study allowed pretesting interventions to increase vaccine acceptance. While a
500 message from the management did not have any impact except among doctors, any form of
501 incentive event had a substantial negative impact on vaccine acceptance (OR <0.6). This sheds
502
503 light on the motivation of care professionals. Protecting the patient is one primary goal of the
504 profession - also referred as an 'intrinsic motivation' (Deci, 1972) - and any additional incentive
505 suggesting HCW needs to be rewarded for expected behavior may undermine this intrinsic
506 motivation and thus be negatively perceived (Frey, 1994). For instance, a badge that would allow
507 distinguishing oneself from colleagues may be seen as overjustified (Tang and Hall, 1995), under
508 the assumption that intrinsic and/or social motivations towards vaccination prevail initially. In
509 this respect, our results do not support the assumption that external (non-monetary) incentives
510 could complement intrinsic motivation or altruistic motives (Sicsic et al., 2012). Note that we
511 have limited our tool to incentives currently used in France. Others, such as financial incentives,
512 would require additional analysis.

513 The use of an ordinal outcome representing the maximal acceptable minor side effect
514 allowed us some insight into willingness to accept (WTA) pain/discomfort for vaccination, thus
515 reflecting how far different attributes go beyond personal utility. Most attribute levels showed
516 low or no impact on WTA increasing pain, which suggest that they were part of the personal
517 utility function. However, high epidemic risk according to health authorities, controversy,
518 improved vaccine performance, and protection of the family had a significant impact on WTA
519 side effects, thus suggesting that a motivation beyond personal utility may be at play. This refers
520 to the distinction made by A. Sen between sympathy (within personal utility) and commitment
521 (beyond personal utility) and suggests that altruism can partially be captured by willingness-to-
522 pay studies (Shiell and Rush, 2003).

523

524 **4.2. Study limitations**

525 Our study has several limitations. First of all, our study sample was not a representative
526 sample of the French hospital HCW population and it is likely that persons with specific vaccine-
527 related characteristics, such as particularly positive or negative opinion on vaccination, were
528
529 overrepresented. For example, physicians and nursing managers, who are more favorable
530 towards vaccination than other professional groups in our sample, were overrepresented.
531 Prevalence estimates from our study (e.g., average stated vaccination intentions) therefore cannot
532 be interpreted as prevalence among French HCWs. A second issue is that we cannot exclude that
533 stated preferences substantially vary across classes of some unobserved variables, implying that
534 our combined estimates would not be valid. If study participation was correlated to these
535 theoretically unobserved variables, the stated preferences could even be substantially over- or
536 underestimated. To explore this risk, we used a wide range of personal characteristics in
537 interaction analyses. We found substantial variation only for a combination of two variables of
538 vaccine status and perception: vaccinated, unvaccinated but favorable and unvaccinated and
539 unfavorable participants (see **Table 5**, and supplementary **Table C9**), suggesting that the
540 inclusion of a more representative HCW sample with lower vaccine coverage and less favorable
541 opinion would have led to higher coefficients (in absolute terms) in combined estimates for the
542 attributes “EPI”, “SAFETY”, “INCENTIVE”, and lower coefficients for the attributes
543 “EFFECTIVENESS” and “INDIRECT PROTECTION”. To attenuate the limitation by non-
544 representative sampling, we show in this manuscript the stratified analyses that yielded the most
545 important variation in preferences.

546 Caution is needed in interpreting our results because of the hypothetical nature of the
547 choices. Hypothetical bias is a concern in stated preference surveys when respondents tend either
548 to overestimate the uptake of hypothetical programs and/or the willingness to pay, because they

549 do not face the opportunity costs directly (Loomis, 2011). We tried to reduce the prevalence of
550 hypothetical bias *ex ante* by asking respondents to make choices as honestly as possible, as in a
551 real-life situation. Finally, our empirical models did not account for decision heuristics such as
552 attribute non-attendance, where some respondents base their decision considering only a subset
553 of attributes.

554

555 Our experimental design has some limitations. First, we used a main-effects D-efficient
556 design, which is not optimal for estimating non-linear models with random intercept. We have
557 analyzed the properties of our design a posteriori and found that our design was 81% D-efficient
558 compared to the best possible design for a random intercept logit model using our estimated
559 model' parameters as priors. Thus, the loss in statistical efficiency is reasonable. Second, our
560 experiment was not designed to test interactions effects between attributes. However, we had not
561 a priori assumptions regarding how specific attributes would interact with each other. Estimation
562 of non-linear in attributes utility functions in the context of vaccines should be included in
563 further research. We believe that qualitative work may help defining such interactions a priori.
564 Finally, the number of choices sets presented to each respondent (i.e. 16) was quite high, which
565 could have resulted in respondents' fatigue. We investigated this effect using heteroskedastic
566 probit models by including the position of the choice task (i.e., early phase: task 1 to 6, middle
567 phase: task 7 to 12, and late phase: task 13 to 16) as determinant of the variance of the error term
568 (Campbell et al., 2015). We did not find any significant impact of the position of the choice task
569 on the scale of utility (results are available upon request), thus rejecting the assumption of
570 fatigue or decrease in survey engagement. This finding is consistent with previous research
571 conducted in various fields of non-market valuation such as transportation / marketing (Hess et
572 al., 2012) and health (Bech et al., 2011), which did not find decreasing trend in response
573 consistency (scale) across choice tasks. Finally, we cannot exclude that a qualitative study prior
574 to tool development would have revealed barriers and levers that drive vaccine decisions

575 specifically among French HCWs and which have not yet been described in the published
576 literature.

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581 **4.3. Practical Implications**

582 Our results have some implications for vaccine communication towards HCWs. How
583 well they can be generalized from France to other countries requires further investigation. A
584 clear recommendation would carry on clear and factual statements about vaccine safety profiles.
585 Explaining drugs safety appears crucial, particularly how international efforts allow quickly
586 knowing the safety profile of a new vaccine. The communication on scientific uncertainty is
587 difficult, but controversy is clearly worse (Betsch et al., 2013; Seanehia et al., 2017).

588 Another recommendation would carry on avoiding the notion of “insufficient coverage”
589 and rather using positive approaches such as storytelling about vaccinated colleagues and
590 providing factual information about low but continuously increasing coverage. Our results
591 suggest that explaining indirect protection and social benefits may in part counterbalance low
592 disease risk perception, while emphasizing participation in disease control may be more effective
593 than requesting altruism.

594 Using incentives such as badges should be avoided in vaccination promotion to HCWs,
595 as it may even have negative impact, in particular among those who usually get vaccinated. By
596 contrast, a clear argumentation and communication on the relatively high impact that can be
597 expected from high coverage given indirect protection - even with vaccines of limited direct
598 effectiveness - may increase motivation for vaccination, in particular among HCWs who are
599 unvaccinated but favorable to vaccination in general.

600 Finally, in order to improve vaccination among HCWs who are unfavorable towards
601 vaccination, our study suggests that beliefs about the meaning of uncertainty and controversy
602 need to be addressed in priority and further research is required in order to develop appropriate
603 (targeted) communication contents.

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606

607 **4.4. Conclusion**

608 Using a DCE among French hospital HCWs, we evaluated the relative importance of
609 individual and inter-individual level characteristics of vaccination scenarios against frequent,
610 usually mild disease that can be severe among vulnerable groups, such as influenza and
611 pertussis. We identified the dominant negative impact of controversies and the notion of “recent
612 vaccines”; distinct preferences among HCWs who recently have refused influenza vaccination
613 and according to their general attitude towards vaccination; and a pronounced negative impact
614 from proposing incentives such as wearing badges “*I’m vaccinated*”. We suggest optimizing the
615 communication on indirect protection by emphasizing disease control rather than altruism and
616 stimulating positive social conformism. These results illustrate that DCE studies for specific
617 vaccine programs and target groups help understanding vaccination decisions in a refined way,
618 particularly by exploring preferences among specific subgroups and by pretesting interventions.

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Tables

Table 1. Attributes and levels in the discrete choice experiment

Attributes	Levels	Assumptions to be tested
Epidemic situation (EPI)	The epidemic situation is normal with no worrying number of cases (normal)	<i>Reference</i>
	Many of your colleagues have already been sick this year. (cases colleagues)	H ₁ : OR>1
	Many of your patients have already been sick this year. (cases patients)	H ₂ : OR>1
	Health authorities think there is a very high risk of infection during the coming season. (authorities, high risk)	H ₃ : OR>1 if high risk perception and trust towards authorities
Vaccine safety (SAFETY)	This vaccine is well known without a severe side effect. (known, no adverse effect)	<i>Reference</i>
	The media speak of a controversy about vaccine safety involving a few medical professionals, while health authorities question the suspicion. (controversy)	H ₄ : OR<1
	This vaccine is well known and has a low marginal risk of developing a neurological disorder. (known, neuro effect)	H ₅ : OR<1
	This vaccine is recent but no severe side effect is known. (recent, no adverse effect)	H ₆ : OR<1
Vaccine effectiveness (EFFECTIVENESS)	The vaccine allows avoiding 30% of cases over a 1-year period. (30%1y)	<i>Reference</i>
	The vaccine allows avoiding 30% of cases over a 3-5 years period. (30%3-5y)	H ₇ : OR>1
	The vaccine allows avoiding 90% of cases over a 1-year period (90%1y)	H ₈ : OR>1
	The vaccine allows avoiding 90% of cases over a 3-5 years period. (90%3-5y)	H ₉ : OR>1
Vaccine coverage (COVERAGE)	Vaccine coverage among French HCWs is insufficient (insufficient)	<i>Reference</i>
	80% of French HCWs are vaccinated (VC 80%)	H ₁₀ : OR>1 if social conformism H ₁₁ : OR<1 if free-riding
	30% of French HCWs are vaccinated (VC 30%)	H ₁₂ : OR<>1 : depends on the perception of “insufficient coverage”
	Few of your coworkers are vaccinated (few colleagues)	H ₁₃ : OR<1 if social conformism

	Most of your coworkers are vaccinated (Most colleagues)	H ₁₄ : OR>1 if social conformism H ₁₅ : OR<1 if free-riding
Potential for indirect protection (INDIRECT PROTECTION)	The vaccine provides only individual protection (individual only) Vaccinating yourself allows participation in disease control. (disease control) Vaccinating yourself will indirectly protect vulnerable people in your family. (family) Vaccinating yourself will indirectly protect your patients. (patients)	Reference H ₁₆ : OR>1: If altruistic attitude H ₁₇ : OR>1: If altruistic attitude H ₁₈ : OR>1: If altruistic attitude
Incentive (INCENTIVE)	There is no specific action proposed. (no action) If vaccinated, you can wear a badge “I’m vaccinated”. (badge) If your department achieved vaccine coverage above 60%, you will receive a certificate for communication. (certificate) If the service vaccine coverage is low, hygiene rules will be reinforced. (hygiene)	<i>Reference</i> H ₁₉ : OR>1 if sensitivity to a reward or to an exterior brand of vaccination H ₂₀ : OR<1 if negative relationship between intrinsic motivation and external incentive H ₂₁ : OR>1 if sensitivity to the reputation of the service H ₂₂ : OR<1 if negative relationship between intrinsic motivation and external incentive H ₂₃ : OR>1 if sensitivity to external pressure and constraints H ₂₄ : OR<1 if ‘protest’ against increased constraints and control
Attitude of the management (MANAGEMENT)	The management does not give any message regarding this vaccination (no message) The management asks the HCW to get vaccinated to protect patients and avoid absenteeism (message)	<i>Reference</i> H ₂₅ : OR>1 if sensitivity to external injunction H ₂₆ : OR<1 if disutility from hierarchical pressure or injunction

HCW: health care worker
OR: odds ratio

Table 2. Participant characteristics. Survey among 1214 hospital health care workers in France, June-September 2018.

	n	%
Gender:		
Women	993	81.8
Men	221	18.2
Age groups (years):		
18-29	188	15.48
30-49	603	49.67
50-65+	423	34.84
Profession:		
Nurse	880	72.49
Doctor	128	10.54
Nursing health manager	110	9.06
Other health care profession	96	7.41
Vaccine hesitancy:		
No hesitancy	535	45.8
Low hesitancy	292	25.00
Medium hesitancy	71	6.08
Strong hesitancy	270	23.12
Influenza vaccination during 2017-18 season:		
Do not know	8	0.66
No	578	47.61
Yes	628	51.73
Trust in health authorities *:		
Yes	1014	83.52
Trust in vaccine information from media *:		
Yes	206	17.0
Trust in vaccine information from pharmaceutical industrial *:		
Yes	254	20.9
Favorable to vaccination in general *:		
Yes	1132	93.25
Unfavorable to influenza vaccination in particular **::		
Yes	200	16.48
Smokes daily:		
Yes	196	16.14
Uses alternative medicine:		
Yes	573	47.20
Uses homeopathic protection against flu:		
Yes	194	15.98

* Replies were given on a Likert-scale with the modalities “strongly agree/somewhat agree/ somewhat disagree/ strongly disagree”. ‘Strongly agree and ‘somewhat agree’ were collapsed into one category ‘yes’ for analysis, vs. ‘no’ (‘somewhat disagree/ strongly disagree’).

** Coded ‘yes’ if participants mentioned “influenza vaccine” when asked: “Are you unfavorable to a vaccination in particular?” / “If yes, which?”

Table 3. Vaccination acceptance statistics in the discrete choice experiment. Survey among 1214 hospital health care workers in France, June-September 2018.

Total number of responses	N=19,424	
Between variability in acceptance (SD)		0.333
Within variability in acceptance (SD)		0.365
Straight-liners ^a (n, %)	355	29.24
- Always accepting the hypothetical vaccines (n, %)	235	19.36
- Always refusing the hypothetical vaccines (n, %)	120	9.88
Overall vaccination acceptance (n, %)	11,270	58.0
- The most accepted scenario (n, %)	578	83.7
- The least accepted scenario (n, %)	133	25.4
- Realistic influenza scenario (n, %)	513	74.2
- Realistic pertussis scenario (n, %)	426	81.5
Willingness to accept incremental pain among accepted scenarios	N=11,270	
- Redness / swelling at the injection site (n, %)	5,182	46.0
- Minor pain during the injection (n, %)	112	9.9
- Minor arm pain while three days (n, %)	2,182	19.4
- One day in bed with fever (n, %)	2786	24.7

SD: standard deviation

^aStraight-liners are defined as those always refusing or accepting the hypothetical vaccines.

Table 4. Preference weights for attributes of hypothetical vaccination acceptance (binary outcome) and willingness to accept increase in level of minor side effect (ordinal outcome) among 1214 hospital health care workers. France, June-September 2018.

Attributes	Levels	Accept vaccination		WTA increase in level of minor side effect	
		OR	(95%-CI)	OR	(95%-CI)
EPI	normal	1		1	
	cases colleagues	1.23	(1.06-1.42)	1.15	(0.95-1.38)
	cases patients	1.33	(1.16-1.54)	1.13	(0.96-1.34)
	authorities, high risk	1.76	(1.49-2.07)	1.49	(1.22-1.80)
SAFETY	known, no side effect	1		1	
	controversy	0.04	(0.04-0.05)	0.76	(0.64-0.90)
	known, neuro effect	0.05	(0.05-0.06)	0.96	(0.82-1.12)
	recent, no side effect	0.30	(0.26-0.34)	0.93	(0.81-1.07)
EFFECTIVENESS	30% 1y	1		1	
	30% 3-5y	1.39	(1.20-1.60)	1.00	(0.83-1.20)
	90% 1y	1.73	(1.49-1.99)	1.06	(0.90-1.26)
	90% 3-5y	2.22	(1.94-2.55)	1.24	(1.05-1.47)
COVERAGE	insufficient	1		1	
	VC 30%	1.19	(1.03-1.37)	0.82	(0.70-0.98)
	VC 80%	1.45	(1.26-1.67)	0.93	(0.78-1.11)
	Few colleagues	1.04	(0.90-1.20)	0.95	(0.80-1.13)
	Most colleagues	1.89	(1.63-2.19)	1.00	(0.83-1.19)
INDIRECT PROTECTION	individual only	1		1	
	disease control	2.34	(1.98-2.77)	1.20	(0.97-1.49)
	family	2.41	(2.04-2.84)	1.43	(1.15-1.78)
	patients	2.08	(1.77-2.46)	1.19	(0.96-1.46)
INCENTIVE	no action	1		1	
	badge	0.47	(0.41-0.54)	0.88	(0.75-1.04)
	certificate	0.57	(0.50-0.65)	0.97	(0.83-1.14)
	hygiene	0.79	(0.69-0.90)	0.98	(0.83-1.15)
MANAGEMENT	no message	1		1	
	message	1.02	(0.91-1.14)	0.94	(0.82-1.08)

OR: odds ratio. Results in bold are significant at the 5% level

95%-CI: 95% confidence interval

WTA: willingness-to-accept

Table 5. Results of random intercept logit models of vaccination acceptance including interactions between attributes and individual characteristics. France, June-September 2018.

Variables	Estimates (log OR)	95% CI
Individual characteristics		
Age (<i>ref = 18-29</i>)	<i>ref</i>	
30-49	-0.19	[-0.77,0.39]
50-65+	0.24	[-0.39,0.87]
Profession (<i>ref = Nurse</i>)		
Doctor	0.63**	[0.08,1.17]
Nursing health manager	0.04	[-0.52,0.60]
Other	-0.06	[-0.68,0.56]
Attitudes towards vaccination (<i>ref = Vaccinated</i>)		
Not vaccinated & unfavorable	-5.19***	[-7.15,-3.22]
Not vaccinated but favorable	-2.83***	[-3.46,-2.20]
Attitudes towards influenza vaccination (<i>ref = Favorable</i>)		
Unfavorable	-1.98***	[-2.55,-1.42]
Vaccine hesitancy (<i>ref = No hesitancy</i>)		
Low hesitancy	-0.02	[-0.52,0.48]
Medium hesitancy	-1.27***	[-2.11,-0.42]
High hesitancy	-1.18***	[-1.71,-0.65]
Trust in media (<i>ref = No</i>)		
Yes	0.67***	[0.17,1.17]
Use of alternative medicine (<i>ref = Do not use nor advise nor consult</i>)		
Uses, advises AND consults	-0.04	[-0.68,0.60]
Uses, advises OR consults	0.16	[-0.30,0.62]
Attributes * Individual characteristics		
EPI		
Normal		<i>ref</i>
Cases colleagues ^a	-0.08	[-0.32,0.15]
Cases patients ^a	0.12	[-0.12,0.36]
Authorities, high risk ^a	0.19	[-0.09,0.48]
Epi * Attitudes towards vaccination (<i>ref = Vaccinated</i>)		
Cases colleagues * Not vaccinated but favorable	0.41**	[0.09,0.74]
Authorities, high risk * Not vaccinated but favorable	0.49**	[0.11,0.87]
SAFETY		
Known, no side effects		<i>ref</i>
Controversy ^a	-2.70***	[-3.21,-2.19]
Known, neuro effect ^a	-2.96***	[-3.43,-2.48]
Recent, no side effect ^a	-1.58***	[-2.08,-1.09]
Safety * Age (<i>ref = 18-29 y</i>)		
Controversy * 30-49 y	-0.45**	[-0.89,-0.01]
Recent, no side effect * 50-65+ y	0.66***	[0.21,1.11]
Safety * Attitudes towards vaccination (<i>ref = Vaccinated</i>)		
Known, neuro effect * Not vaccinated & unfavorable	-1.48**	[-2.95,-0.00]
Known, neuro effect * Not vaccinated but favorable	0.42**	[0.09,0.75]
Recent, no side effect * Not vaccinated & unfavorable	-0.98**	[-1.87,-0.09]
Safety * Trust in media (<i>ref = Do not trust</i>)		
Controversy * Trust	-0.82***	[-1.25,-0.39]

Safety * Use of alternative medicine (<i>ref = Do not use nor advise nor consult</i>)		
Controversy * Use, advise AND consult	-0.61**	[-1.09,-0.13]
Known, neuro effect * Use, advise AND consult	-0.48**	[-0.93,-0.03]
Known, neuro effect * Use, advise OR consult	-0.40**	[-0.72,-0.09]
EFFECTIVENESS		
30% 1y		<i>ref</i>
30% 3-5y ^a	0.23	[-0.20,0.66]
90% 1y ^a	0.37*	[-0.06,0.80]
90% 3-5y ^a	0.65***	[0.24,1.05]
Effectiveness * Age (<i>ref = 18-29 y</i>)		
90% 3-5y * 50-65+ y	-0.50**	[-0.91,-0.08]
Effectiveness * Attitudes towards vaccination (<i>ref = Vaccinated</i>)		
90% 3-5y * Not vaccinated but favorable	0.36**	[0.05,0.68]
COVERAGE		
Insufficient		<i>ref</i>
VC 30% ^a	0.47***	[0.19,0.76]
VC 80% ^a	0.31**	[0.04,0.58]
Few colleagues ^a	0.16	[-0.12,0.45]
Most colleagues ^a	0.65***	[0.36,0.94]
Coverage * Attitudes towards vaccination (<i>ref = Vaccinated</i>)		
VC 30% * Not vaccinated but favorable	-0.60***	[-0.93,-0.28]
INDIRECT PROTECTION		
Individual only		<i>ref</i>
Disease control ^a	0.96***	[0.64,1.29]
Family ^a	1.26***	[0.94,1.58]
Patients ^a	1.01***	[0.69,1.33]
Indirect protection * Attitudes towards vaccination (<i>ref = Vaccinated</i>)		
Patients * Not vaccinated but favorable	-0.41**	[-0.77,-0.04]
Indirect protection * Use of alternative medicine (<i>ref = Do not use nor advise nor consult</i>)		
Family * Use, advise OR consult	-0.40**	[-0.73,-0.07]
INCENTIVES		
No action		<i>ref</i>
Badge ^a	-1.09***	[-1.36,-0.82]
Certificate ^a	-0.71***	[-0.99,-0.44]
Hygiene ^a	-0.22	[-0.49,0.05]
Incentives * Vaccine hesitancy (<i>ref = No hesitancy</i>)		
Badge * Medium hesitancy	0.62**	[0.03,1.21]
Incentives * Attitudes towards vaccination (<i>ref = Vaccinated</i>)		
Badge * Not vaccinated but favorable	0.36**	[0.05,0.68]
Certificate * Not vaccinated but favorable	0.26*	[-0.04,0.57]
MANAGEMENT		
No message		<i>ref</i>
Message ^a	0.13	[-0.10,0.36]
Management * Profession (<i>ref = Nurse</i>)		
Message * Nursing health manager	0.41**	[0.07,0.74]
Management * Vaccine Hesitancy (<i>ref = No hesitancy</i>)		
Message * High hesitancy	-0.35***	[-0.61,-0.09]

Note: only interaction effects (attributes*HCWs individual characteristics) significant at the 5% level are displayed.

^a Represents the impact of the attribute's level for the reference category / categories of the individual characteristics (e.g., age, gender, vaccination attitudes) used in the interaction model. Should not be interpreted as main effects.

Statistical significance: ***< 1%, **< 5%, *<10%

Figures

Figure 1. Example choice task

Example scenario Q999

Reminder: You participate in an information meeting that aims at promoting vaccination for health care professionals. The disease against which the vaccine protects is frequent, with low case fatality if no risk factor exists, but which may immobilize you during one week. It is easily transmitted through contact and aerosols. Vaccination is not mandatory but recommended by the Ministry of Health to your professional group. You can get vaccinated immediately and for free after this meeting.

- **Few of your colleagues** are vaccinated.
- The **management asks** the staff to get vaccinated, to protect patients and reduce days of work lost.
- **Several of your patients** have already been ill with this disease this month.
- The vaccine allows **avoiding 30% of cases for a duration of 1 year**.
- After vaccination, you can wear a **badge "I am vaccinated"**.
- By getting vaccinated, you also **protect your patients**.
- The vaccine's safety profile is well known, it **marginally increases the risk of developing a neurological disease**.

Question:

Do you accept to get vaccinated now?

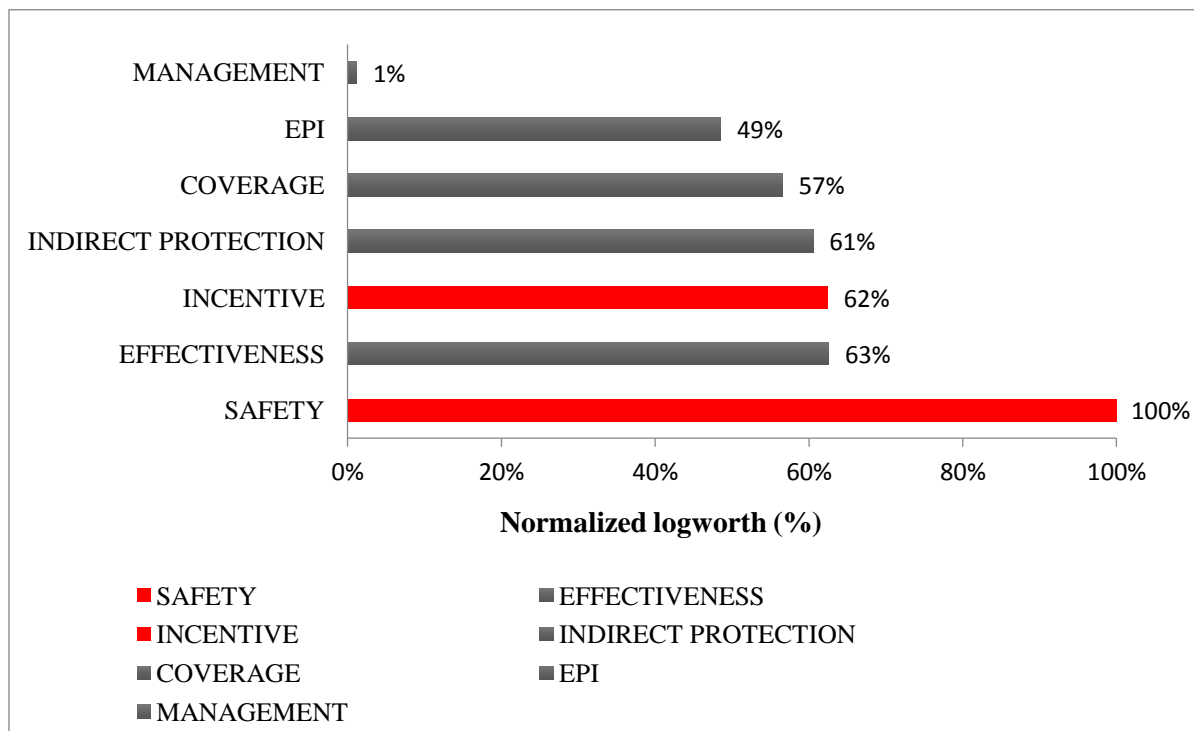
- Yes
- No

If yes, up to which minor side effect would you accept getting vaccinated?

- Pain during injection
- Pain in the arm during three days
- Redness and swelling at the injection site during one day.
- One day of fever during which you need to stay in bed.

Note: Authors' translation from French into English.

Figure 2. Importance of the seven attributes in the random effects logit model among 1214 hospital health care workers. France, June-September 2018



Note: The bar charts express the logworth statistic of each DCE attribute relatively to the logworth of the most important attribute: 'SAFETY' (normalized to 100%).

Legend: Attributes highlighted in red color have a negative impact on stated vaccination acceptance.

Supplementary materials (A, B, C) for the article “Quantifying preferences around vaccination against frequent, mild disease with risk for vulnerable persons: A discrete choice experiment among French hospital health care workers”

Supplementary material A. Additional information on the experimental design

Several constraints were added to the fractional design to avoid implausible combinations of attributes. In total, 6 constraints were imposed: the following combinations of attributes could not be selected in the final design (see the table A.1).

Table A1. Description of constraints added to the fractional design

Constraint number	Implausible attributes' levels combinations
1	The vaccine provides only individual protection. (individual only)
	The management asks the HCW to get vaccinated to protect patients and avoid absenteeism. (message)
2	The vaccine provides only individual protection. (individual only)
	Many of your patients have already been sick this year. (cases patients)
3	The vaccine allows avoiding 30% of cases over a 1-year period. (30%1y)
	Vaccinating yourself allows participation in disease control. (disease control)
4	Health authorities think there is a very high risk of infection during the coming season. (authorities, high risk)
	The management does not give any message regarding this vaccination. (no message)
5	The epidemic situation is normal with no worrying number of cases. (normal)
	If the service vaccine coverage is low, hygiene rules will be reinforced. (hygiene)
6	Most of your coworkers are vaccinated. (most colleagues)
	Many of your colleagues have already been sick this year. (cases colleagues)

These constraints automatically generated some correlations between attributes, but these correlations were low as the final design was 90.5% D-efficient compared to the best possible orthogonal design.

Figure A1. Most realistic scenario for influenza vaccination

Reference scenario Influenza

Reminder: You participate in an information meeting that aims at promoting vaccination for health care professionals. The disease against which the vaccine protects is frequent, with low case fatality if no risk factor exists, but which may immobilize you during one week. It is easily transmitted through contact and aerosols. Vaccination is not mandatory but recommended by the Ministry of Health to your professional group. You can get vaccinated immediately and for free after this meeting.

- The vaccination **coverage is insufficient among French HCWs**
- The direction **didn't send any specific message** about this vaccination
- **Several of your patients** have already been ill with this disease this month
- The vaccine allows **avoiding 30% of cases for the duration of 1 year**
- There is **no rewards nor restrictive measures** announced
- By getting vaccinated, you **participate to the control of the disease**
- The vaccine's safety profile is well known, it **marginally increases the risk of developing a neurological disease**

Question:

- Do you accept to get vaccinated now?

- Yes
 No

If yes, up to which minor side effect would you accept getting vaccinated?



- Pain during injection
- Pain in the arm during three days.
- Redness and swelling at the injection site during one day
- One day of fever during which you need to stay in bed.

Figure A2. Most realistic scenario for pertussis vaccination.

Reference scenario Pertussis

Reminder: You participate in an information meeting that aims at promoting vaccination for health care professionals. The disease against which the vaccine protects is frequent, with low case fatality if no risk factor exists, but which may immobilize you during one week. It is easily transmitted through contact and aerosols. Vaccination is not mandatory but recommended by the Ministry of Health to your professional group. You can get vaccinated immediately and for free after this meeting.

- **80% of French health care workers** are vaccinated
- The direction **didn't send any specific message** about this vaccination
- **Usual** epidemiological situation
- The vaccine allows **avoiding 30% of cases for the duration of 3 to 5 years**
- Display of a **certificate** if the **vaccination coverage of your service exceeds 60%**
- By getting vaccinated, you also **protect the vulnerable people in your family**
- The vaccine is **recent** but **no serious adverse effect is known**

Question:

- Do you accept to get vaccinated now?

- Yes
 No

If yes, up to which minor side effect would you accept getting vaccinated?



- Pain during injection
- Pain in the arm during three days.
- Redness and swelling at the injection site during one day
- One day of fever during which you need to stay in bed.

Supplementary material B. Introduction to the choice tasks. Author's translations from French into English.

Introduction

- We will introduce you to 16 fictive vaccination scenarios. For each of them, we will ask you whether or not you would accept to be vaccinated in these conditions.
- Please try, as much as possible, to make your decision independently of yours answers to the others scenarios.

Context

You are attending an information meeting organized by the hygiene department - or the working health service of your hospital facility - in order to promote the interest of vaccination as a health car worker. Vaccination is not mandatory but recommended by the Ministry of Health to your professional group.

You can get vaccinated immediately and for free after this meeting.

The disease targeted by vaccination is described as:

- Frequent
- Rapidly evolving in few days
- Can be disabling the time of a week
- Can be easily transmitted through contact and aerosols even if there is no symptoms
- There is a low risk of fatality if there is no supplementary risk factor (e.g., being an infant, elderly or adult with chronic disease)

Your decision for each scenario

- Your first decision will be:
 - 'Accept' or
 - 'Don't accept' vaccination in these condition
- If you accept the vaccination, you must indicate for which maximum minor side effect
- Some minor side effects may occur (listed in order of increasing severity):



- Pain during injection
- Pain in the arm during three days
- Redness and swelling at the injection site during one day
- One day of fever during which you need to stay in bed

These scenarios will vary according to various attributes:

- The **epidemic situation** of the disease targeted by the vaccine. For instance, if some of your colleagues or patient have become ill or if the epidemic risk is estimated high by the public health authority.
- The **vaccine safety**:
 - The vaccine can be recent or well known
 - The vaccine may or may not have known serious side effect listed

- In some scenarios, the vaccination can be associated with **a marginal increase in developing a disabling neurological disorder for life** (usually affecting **35 out of every 100 000 unvaccinated people**, increasing to **39 out of every 100 000 people vaccinated**).
- In some other scenarios, the **media** speak about a **controversy about the vaccine safety**. A small group of health care workers (including doctors) have alerted the public about the possibility of a serious side effect associated with this vaccine. However, the French health authority questions the relationship between these rare symptoms observed in some individuals and the vaccine.
- The **vaccine effectiveness** (i.e., percentage of cases avoided by the vaccine for an adult in good health) and **the duration of protection** (e.g., 1 year, 3 to 5 years).
- The **vaccine coverage**, determined by the prevalence of French coworkers being vaccinated, thus information on **how the vaccine is accepted by your profession**.
- The possible **indirect protection** if you accept to be vaccinated: by getting vaccinated **you can protect other people like your family or your patients**.
- The **incentive to be vaccinated** (e.g., badges or the hygiene rules will be reinforced).
- The **attitude of the management** about this vaccination. For instance, the management can ask the HCW to get vaccinated to protect patients and avoid absenteeism.

Supplementary material C. Additional results: sensitivity analyses and results of stratified models by HCW's individual characteristics.**Table C1.** Sensitivity analysis: comparison of random intercept logit models of vaccination acceptance including / excluding straight-liners. France, June-September 2018

Attributes	Levels	All respondents (N=1214)		Excluding straight-liners (N= 859)	
		OR	(95%-CI)	OR	(95%-CI)
EPI	normal	1		1	
	cases colleagues	1.23	(1.06-1.42)	1.24	(1.07-1.43)
	cases patients	1.33	(1.16-1.54)	1.32	(1.14-1.53)
	authorities: high risk	1.76	(1.49-2.07)	1.78	(1.51-2.10)
SAFETY	known: no side effect	1		1	
	controversy	0.04	(0.04-0.05)	0.05	(0.04-0.05)
	known: neuro effect	0.05	(0.05-0.06)	0.06	(0.05-0.07)
	recent: no side effect	0.30	(0.26-0.34)	0.30	(0.26-0.35)
EFFECTIVENESS	30% 1y	1		1	
	30% 3-5y	1.39	(1.20-1.60)	1.38	(1.19-1.60)
	90% 1y	1.73	(1.49-1.99)	1.70	(1.47-1.96)
	90% 3-5y	2.22	(1.94-2.55)	2.25	(1.95-2.58)
COVERAGE	insufficient	1		1	
	VC 30%	1.19	(1.03-1.37)	1.18	(1.02-1.35)
	VC 80%	1.45	(1.26-1.67)	1.47	(1.27-1.69)
	few colleagues	1.04	(0.90-1.20)	1.01	(0.87-1.17)
	most colleagues	1.89	(1.63-2.19)	1.87	(1.61-2.17)
INDIRECT PROTECTION	individual only	1		1	
	disease control	2.34	(1.98-2.77)	2.40	(2.02-2.84)
	family	2.41	(2.04-2.84)	2.40	(2.04-2.84)
	patients	2.08	(1.77-2.46)	2.11	(1.79-2.50)
INCENTIVE	no action	1		1	
	badge	0.47	(0.41-0.54)	0.47	(0.41-0.54)
	certificate	0.57	(0.50-0.65)	0.57	(0.50-0.65)
	hygiene	0.79	(0.69-0.90)	0.78	(0.68-0.89)
MANAGEMENT	no message	1		1	
	message	1.02	(0.91-1.14)	1.00	(0.89-1.13)

Straight-liners: respondents always refusing or accepting the hypothetical vaccines

Table C2. Results of random intercept logit models of vaccination acceptance, stratified by professional groups. France, June-September 2018

Attributes:	Levels:	Nurse (n=880)		Doctor (n=128)		Nursing health manager (n=110)	
		OR	(95%-CI)	OR	(95%-CI)	OR	(95%-CI)
EPI	normal	1		1		1	
	cases colleagues	1.30	(1.10-1.54)	0.76	(0.46-1.27)	1.21	(0.75-1.97)
	cases patients	1.32	(1.12-1.55)	1.28	(0.76-2.16)	1.74	(1.09-2.77)
	authorities: high risk	1.74	(1.44-2.10)	1.56	(0.84-2.91)	2.26	(1.32-3.87)
SAFETY	known: no side effect	1		1		1	
	controversy	0.04	(0.04-0.05)	0.04	(0.02-0.08)	0.05	(0.03-0.08)
	known: neuro effect	0.05	(0.04-0.06)	0.05	(0.03-0.09)	0.08	(0.05-0.13)
	recent: no side effect	0.26	(0.22-0.31)	0.32	(0.18-0.56)	0.58	(0.37-0.93)
EFFECTIVENESS	30% 1y	1		1		1	
	30% 3-5y	1.36	(1.15-1.61)	1.45	(0.87-2.43)	2.07	(1.27-3.36)
	90% 1y	1.83	(1.55-2.17)	1.79	(1.06-3.04)	1.68	(1.05-2.70)
	90% 3-5y	2.22	(1.89-2.60)	2.53	(1.53-4.20)	2.60	(1.64-4.12)
COVERAGE	insufficient	1		1		1	
	VC 30%	1.21	(1.03-1.43)	1.28	(0.78-2.11)	1.03	(0.65-1.64)
	VC 80%	1.36	(1.15-1.59)	2.12	(1.25-3.60)	1.56	(0.97-2.50)
	few colleagues	1.00	(0.85-1.18)	1.27	(0.74-2.16)	0.98	(0.61-1.58)
	most colleagues	1.85	(1.56-2.19)	2.04	(1.18-3.53)	1.90	(1.15-3.14)
INDIRECT PROTECTION	individual only	1		1		1	
	disease control	2.41	(1.98-2.93)	2.08	(1.14-3.78)	2.38	(1.36-4.17)
	family	2.53	(2.09-3.07)	2.07	(1.18-3.62)	2.44	(1.41-4.20)
	patients	2.17	(1.79-2.63)	1.58	(0.88-2.81)	1.94	(1.11-3.38)
INCENTIVE	no action	1		1		1	
	badge	0.47	(0.40-0.55)	0.37	(0.23-0.61)	0.58	(0.37-0.91)
	certificate	0.57	(0.49-0.66)	0.57	(0.34-0.95)	0.55	(0.35-0.86)
	hygiene	0.79	(0.68-0.92)	0.83	(0.50-1.36)	0.82	(0.52-1.28)
MANAGEMENT	no message	1		1		1	
	message	0.96	(0.84-1.09)	1.52	(1.00-2.32)	1.34	(0.91-1.96)

OR: odds ratio. Results in bold are significant at the 5% level

95%-CI: 95% confidence interval

Table C3. Results of random intercept logit models of vaccination acceptance, stratified by level of vaccine hesitancy. France, June-September 2018.

Attributes	Levels :	No hesitancy (n=535)		Low hesitancy (n=292)		Medium hesitancy (n=71)		Strong hesitancy (n=270)	
		OR	(95%-CI)	OR	(95%-CI)	OR	(95%-CI)	OR	(95%-CI)
EPI	normal	1		1		1		1	
	cases colleagues	1.20	(0.96-1.49)	1.05	(0.77-1.42)	1.04	(0.59-1.83)	1.40	(1.02-1.92)
	cases patients	1.37	(1.10-1.71)	1.29	(0.95-1.74)	1.40	(0.80-2.44)	1.25	(0.93-1.68)
	authorities: high risk	1.82	(1.40-2.35)	1.59	(1.11-2.29)	1.56	(0.84-2.91)	1.68	(1.20-2.34)
SAFETY	known: no side effect	1		1		1		1	
	controversy	0.04	(0.03-0.06)	0.04	(0.03-0.05)	0.03	(0.02-0.06)	0.05	(0.04-0.07)
	known: neuro effect	0.06	(0.05-0.07)	0.04	(0.03-0.06)	0.03	(0.02-0.06)	0.07	(0.05-0.09)
	recent: no side effect	0.36	(0.29-0.44)	0.27	(0.19-0.37)	0.23	(0.13-0.39)	0.27	(0.21-0.35)
EFFECTIVENESS	30% 1y	1		1		1		1	
	30% 3-5y	1.39	(1.11-1.74)	1.41	(1.03-1.93)	1.38	(0.78-2.43)	1.47	(1.08-2.01)
	90% 1y	1.68	(1.35-2.10)	1.70	(1.24-2.33)	1.27	(0.72-2.22)	2.04	(1.51-2.74)
	90% 3-5y	2.17	(1.75-2.68)	2.19	(1.63-2.95)	1.59	(0.94-2.67)	2.56	(1.92-3.41)
COVERAGE	insufficient	1		1		1		1	
	VC 30%	1.19	(0.96-1.49)	1.76	(1.29-2.39)	1.00	(0.58-1.72)	0.90	(0.67-1.20)
	VC 80%	1.57	(1.26-1.95)	1.39	(1.03-1.88)	1.15	(0.68-1.97)	1.47	(1.10-1.97)
	few colleagues	1.07	(0.86-1.34)	1.09	(0.80-1.48)	0.76	(0.43-1.34)	1.03	(0.76-1.39)
	most colleagues	1.92	(1.52-2.41)	2.10	(1.53-2.90)	1.61	(0.91-2.85)	1.71	(1.26-2.32)
INDIRECT PROTECTION	individual only	1		1		1		1	
	disease control	2.41	(1.86-3.12)	2.31	(1.63-3.30)	1.92	(0.99-3.71)	1.99	(1.39-2.85)
	family	2.53	(1.97-3.25)	2.68	(1.90-3.78)	1.73	(0.91-3.31)	2.10	(1.47-3.00)
	patients	2.19	(1.70-2.82)	2.32	(1.64-3.30)	1.34	(0.71-2.55)	1.79	(1.26-2.54)
INCENTIVES	no action	1		1		1		1	
	badge	0.44	(0.36-0.54)	0.38	(0.28-0.51)	0.80	(0.47-1.34)	0.55	(0.41-0.73)
	certificate	0.56	(0.45-0.69)	0.53	(0.39-0.71)	0.88	(0.53-1.46)	0.53	(0.41-0.70)
	hygiene	0.77	(0.62-0.94)	0.70	(0.53-0.94)	1.17	(0.70-1.95)	0.92	(0.70-1.21)
MANAGEMENT	no message	1		1		1		1	
	message	1.11	(0.92-1.32)	1.13	(0.88-1.44)	1.41	(0.89-2.22)	0.76	(0.59-0.96)

Results in bold are significant at the 5% level

Table C4. Results of random intercept logit models of vaccination acceptance, stratified by influenza vaccination status during the 2017-18 season. France, June-September 2018.

Attributes	Levels :	Vaccinated (N=628)		Not vaccinated (N=578)	
		OR	(95%-CI)	OR	(95%-CI)
EPI	normal	1		1	
	cases colleagues	0.94	(0.74-1.17)	1.40	(1.13-1.72)
	cases patients	1.12	(0.89-1.41)	1.41	(1.16-1.72)
	authorities: high risk	1.25	(0.95-1.65)	2.05	(1.64-2.56)
SAFETY	known: no side effect	1		1	
	controversy	0.03	(0.03-0.04)	0.05	(0.04-0.06)
	known: neuro effect	0.04	(0.03-0.05)	0.06	(0.05-0.08)
	recent: no side effect	0.27	(0.21-0.34)	0.29	(0.25-0.35)
EFFECTIVENESS	30% 1y	1		1	
	30% 3-5y	1.19	(0.95-1.48)	1.46	(1.19-1.80)
	90% 1y	1.54	(1.23-1.95)	1.93	(1.58-2.35)
	90% 3-5y	1.59	(1.29-1.96)	2.73	(2.25-3.32)
COVERAGE	insufficient	1		1	
	VC 30%	1.71	(1.37-2.15)	0.90	(0.74-1.09)
	VC 80%	1.19	(0.97-1.47)	1.62	(1.33-1.97)
	Few colleagues	1.15	(0.92-1.43)	0.99	(0.81-1.21)
	Most colleagues	1.92	(1.52-2.42)	1.84	(1.50-2.26)
INDIRECT PROTECTION	individual only	1		1	
	disease control	2.55	(1.99-3.27)	2.16	(1.70-2.75)
	family	2.97	(2.34-3.79)	2.08	(1.64-2.64)
	patients	2.81	(2.18-3.61)	1.74	(1.38-2.20)
INCENTIVES	no action	1		1	
	badge	0.35	(0.28-0.43)	0.54	(0.45-0.66)
	certificate	0.50	(0.40-0.62)	0.63	(0.52-0.75)
	hygiene	0.81	(0.66-1.00)	0.84	(0.70-1.01)
MANAGEMENT	no message	1		1	
	message	1.17	(0.98-1.40)	0.88	(0.75-1.03)

Results in bold are significant at the 5% level

Table C5. Results of random intercept logit models of vaccination acceptance, stratified by attitude towards vaccination in general. France, June-September 2018.

Attributes	Levels :	Favorable (n=1013)		Unfavorable (n=201)	
		OR	(95%-CI)	OR	(95%-CI)
EPI	normal	1		1	
	cases colleagues	1.23	(1.05-1.43)	1.32	(0.85-2.03)
	cases patients	1.39	(1.19-1.62)	1.06	(0.71-1.58)
	authorities: high risk	1.73	(1.45-2.07)	1.87	(1.21-2.91)
SAFETY	known: no side effect	1		1	
	controversy	0.04	(0.04-0.05)	0.04	(0.03-0.06)
	known: neuro effect	0.06	(0.05-0.07)	0.04	(0.03-0.06)
	recent: no side effect	0.32	(0.27-0.37)	0.23	(0.17-0.32)
EFFECTIVENESS	30% 1y	1		1	
	30% 3-5y	1.39	(1.19-1.62)	1.46	(0.97-2.20)
	90% 1y	1.86	(1.58-2.17)	1.23	(0.83-1.81)
	90% 3-5y	2.25	(1.94-2.62)	1.94	(1.32-2.84)
COVERAGE	insufficient	1		1	
	VC 30%	1.26	(1.08-1.48)	0.86	(0.58-1.27)
	VC 80%	1.45	(1.24-1.69)	1.56	(1.05-2.30)
	few colleagues	1.11	(0.95-1.29)	0.84	(0.56-1.26)
	most colleagues	1.96	(1.67-2.31)	1.63	(1.09-2.45)
INDIRECT PROTECTION	individual only	1		1	
	disease control	2.34	(1.95-2.81)	2.37	(1.44-3.90)
	family	2.53	(2.12-3.01)	2.09	(1.27-3.43)
	patients	2.11	(1.76-2.52)	1.96	(1.20-3.18)
INCENTIVE	no action	1		1	
	badge	0.47	(0.41-0.55)	0.42	(0.28-0.62)
	certificate	0.58	(0.50-0.67)	0.52	(0.36-0.74)
	hygiene	0.82	(0.71-0.95)	0.71	(0.49-1.02)
MANAGEMENT	no message	1		1	
	message	1.05	(0.93-1.19)	0.85	(0.61-1.17)

Results in bold are significant at the 5% level

Table C6. Results of random intercept logit models of vaccination acceptance, stratified by trust in vaccine information from media. France, June-September 2018

Attributes	Levels :	No trust (n=1008)		Trust (n=206)	
		OR	(95%-CI)	OR	(95%-CI)
EPI	normal	1		1	
	cases colleagues	1.29	(1.10-1.52)	0.98	(0.69-1.40)
	cases patients	1.37	(1.17-1.60)	1.19	(0.84-1.69)
	authorities: high risk	1.71	(1.43-2.04)	2.05	(1.37-3.06)
SAFETY	known: no side effect	1		1	
	controversy	0.05	(0.04-0.06)	0.02	(0.01-0.03)
	known: neuro effect	0.06	(0.05-0.07)	0.04	(0.03-0.06)
	recent: no side effect	0.31	(0.26-0.36)	0.25	(0.18-0.36)
EFFECTIVENESS	30% 1y	1		1	
	30% 3-5y	1.41	(1.20-1.66)	1.29	(0.90-1.84)
	90% 1y	1.78	(1.52-2.09)	1.51	(1.06-2.17)
	90% 3-5y	2.21	(1.90-2.57)	2.34	(1.66-3.28)
COVERAGE	insufficient	1		1	
	VC 30%	1.14	(0.98-1.34)	1.38	(0.98-1.95)
	VC 80%	1.39	(1.20-1.63)	1.78	(1.26-2.52)
	few colleagues	1.01	(0.86-1.18)	1.18	(0.83-1.70)
	most colleagues	1.81	(1.53-2.13)	2.40	(1.67-3.47)
INDIRECT PROTECTION	individual only	1		1	
	disease control	2.35	(1.95-2.83)	2.35	(1.55-3.55)
	family	2.42	(2.02-2.90)	2.43	(1.61-3.66)
	patients	2.09	(1.74-2.51)	2.11	(1.40-3.18)
INCENTIVE	no action	1		1	
	badge	0.45	(0.39-0.52)	0.57	(0.41-0.80)
	certificate	0.55	(0.48-0.64)	0.65	(0.47-0.89)
	hygiene	0.79	(0.68-0.91)	0.80	(0.58-1.11)
MANAGEMENT	no message	1		1	
	message	1.03	(0.90-1.17)	0.98	(0.73-1.31)

Results in bold are significant at the 5% level

Table C7. Results of random intercept logit models of vaccination acceptance, stratified by use of alternative medicine. France, June-September 2018.

Attributes	Levels :	Uses*, advises** and consults§ (n=178)		Uses, advises or consults (n=559)		Does not use, nor advise nor consult (n=421)	
		OR	(95%-CI)	OR	(95%-CI)	OR	(95%-CI)
EPI	normal	1		1		1	
	cases colleagues	1.34	(0.89-1.99)	1.23	(1.00-1.52)	1.19	(0.92-1.54)
	cases patients	1.27	(0.86-1.87)	1.37	(1.12-1.68)	1.33	(1.04-1.71)
	authorities: high risk	1.33	(0.86-2.06)	2.08	(1.64-2.64)	1.50	(1.13-2.00)
SAFETY	known: no side effect	1		1		1	
	controversy	0.03	(0.02-0.04)	0.04	(0.03-0.05)	0.05	(0.04-0.07)
	known: neuro effect	0.04	(0.03-0.06)	0.05	(0.04-0.06)	0.07	(0.06-0.09)
	recent: no side effect	0.26	(0.18-0.37)	0.27	(0.22-0.33)	0.37	(0.29-0.48)
EFFECTIVENESS	30% 1y	1		1		1	
	30% 3-5y	1.43	(0.96-2.13)	1.33	(1.08-1.64)	1.36	(1.05-1.76)
	90% 1y	1.67	(1.12-2.50)	1.66	(1.35-2.03)	1.57	(1.22-2.03)
	90% 3-5y	2.10	(1.45-3.04)	2.20	(1.81-2.68)	2.09	(1.64-2.67)
COVERAGE	insufficient	1		1		1	
	VC 30%	0.86	(0.59-1.27)	1.24	(1.01-1.51)	1.29	(1.00-1.65)
	VC 80%	1.25	(0.86-1.81)	1.55	(1.26-1.89)	1.43	(1.12-1.83)
	few colleagues	0.89	(0.60-1.33)	1.06	(0.86-1.31)	0.97	(0.76-1.25)
	most colleagues	1.49	(1.00-2.24)	1.87	(1.52-2.32)	1.90	(1.46-2.47)
INDIRECT PROTECTION	Individual only	1		1		1	
	disease control	3.33	(2.09-5.32)	1.97	(1.55-2.51)	2.65	(1.97-3.56)
	family	3.09	(1.95-4.90)	1.88	(1.48-2.38)	3.07	(2.30-4.10)
	patients	2.80	(1.77-4.43)	1.80	(1.42-2.28)	2.24	(1.68-3.00)
INCENTIVE	no action	1		1		1	
	badge	0.55	(0.38-0.80)	0.50	(0.41-0.61)	0.38	(0.30-0.48)
	certificate	0.70	(0.49-0.99)	0.60	(0.50-0.73)	0.47	(0.37-0.59)
	hygiene	0.90	(0.63-1.29)	0.80	(0.66-0.97)	0.71	(0.56-0.90)
MANAGEMENT	no message	1		1		1	
	message	1.11	(0.81-1.52)	1.03	(0.88-1.22)	1.01	(0.82-1.24)

* If answered 'yes' to the question: "Do you use homeopathic products as an alternative to influenza vaccine"?

** If answered 'yes' to the question: "Do you recommend one or more of these alternative medicines to the patients with whom you are in contact?"

§ If answered 'yes' to the question: "Do you consult specialists of alternative medicine (e.g., acupuncturist, homeopath, relaxation therapist, etc.)?"

Results in bold are significant at the 5% level.

Table C8. Results of random intercept logit models of vaccination acceptance, stratified by attitude towards influenza vaccination. France, June-September 2018.

Attributes	Levels	Unfavorable to influenza vaccination (N=200)		Favorable to influenza vaccination (N=1014)	
		OR	(95%-CI)	OR	(95%-CI)
EPI	normal	1		1	
	cases colleagues	1.39	(0.95-2.03)	1.18	(1.00-1.38)
	cases patients	1.46	(1.02-2.09)	1.32	(1.12-1.54)
	authorities: high risk	2.23	(1.49-3.33)	1.66	(1.38-1.99)
SAFETY	known: no side effect	1		1	
	controversy	0.06	(0.04-0.08)	0.04	(0.03-0.05)
	known: neuro effect	0.09	(0.06-0.13)	0.05	(0.04-0.06)
	recent: no side effect	0.35	(0.26-0.48)	0.28	(0.24-0.33)
EFFECTIVENESS	30% 1y	1		1	
	30% 3-5y	1.44	(0.99-2.12)	1.36	(1.16-1.60)
	90% 1y	2.78	(1.95-3.97)	1.13	(1.34-1.85)
	90% 3-5y	3.93	(2.77-5.60)	1.15	(1.71-2.31)
COVERAGE	insufficient	1		1	
	VC 30%	0.90	(0.63-1.29)	1.25	(1.07-1.46)
	VC 80%	1.48	(1.04-2.11)	1.42	(1.22-1.66)
	few colleagues	1.15	(0.80-1.65)	1.02	(0.87-1.19)
	most colleagues	1.70	(1.18-2.44)	1.94	(1.64-2.28)
INDIRECT PROTECTION	themselves only	1		1	
	disease control	1.74	(1.13-2.70)	2.43	(2.01-2.92)
	family	2.04	(1.33-3.14)	2.50	(2.09-2.99)
	patients	1.87	(1.3-2.83)	2.13	(1.77-2.55)
INCENTIVES	no action	1		1	
	badge	0.59	(0.41-0.84)	0.45	(0.39-0.52)
	certificate	0.68	(0.49-0.93)	0.56	(0.48-0.65)
	hygiene	0.91	(0.65-1.27)	0.79	(0.68-0.91)
MANAGEMENT	no message	1		1	
	message	0.79	(0.59-1.06)	1.18	(1.00-1.38)

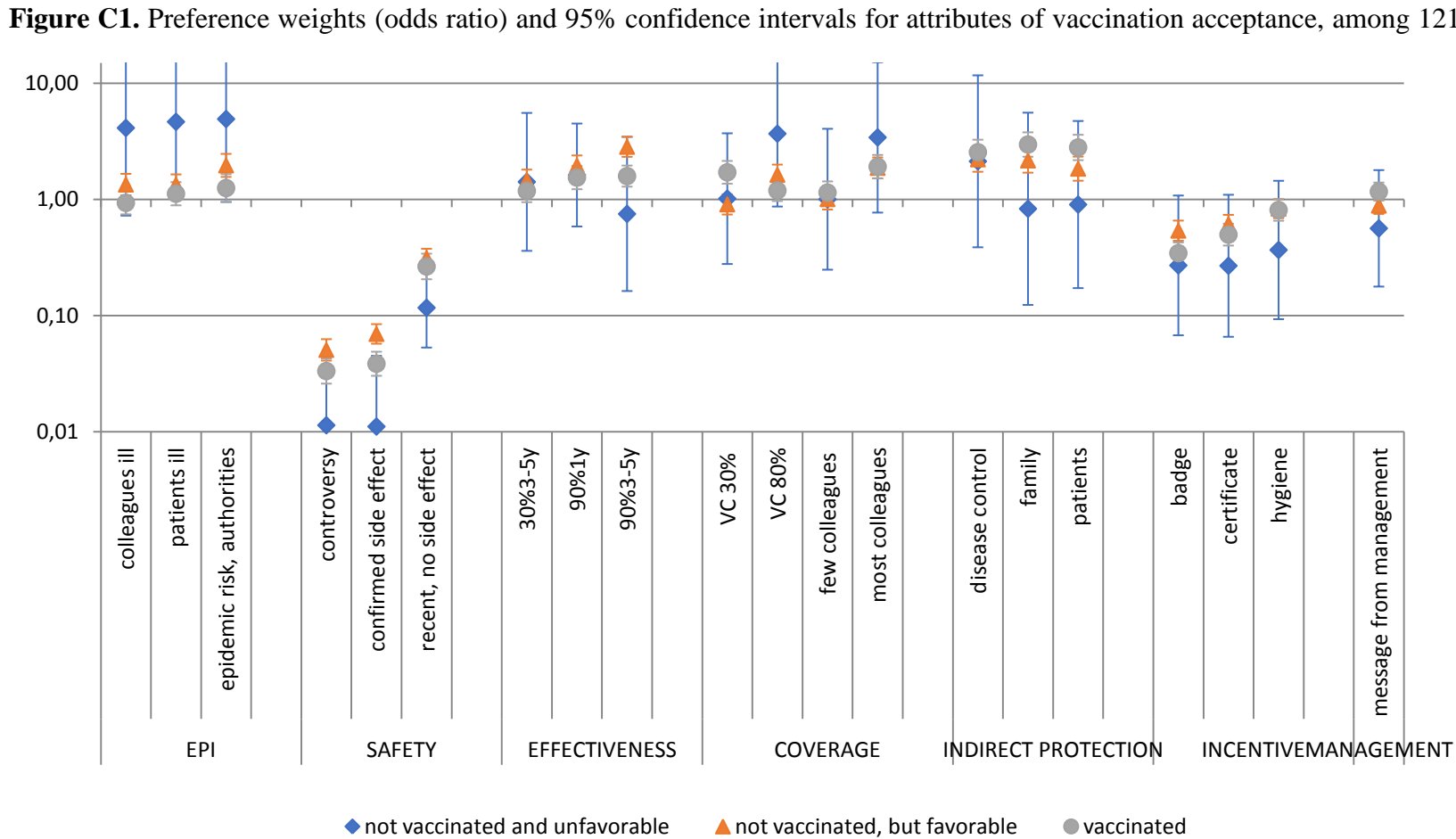
Results in bold are significant at the 5% level

Table C9. Results of random intercept logit models of vaccination acceptance, stratified by influenza vaccination 2017-18 and attitude towards vaccines in general. France, June-September 2018

	Not vaccinated and vaccine-unfavorable (n=76)		Not vaccinated <u>but</u> vaccine-favorable (n=502)		Vaccinated (n=628)	
	OR	(95%-CI)	OR	(95%-CI)	OR	(95%-CI)
EPI						
normal	1		1		1	
cases colleagues	4.13	(0.73-23.51)	1.34	(1.09-1.66)	0.94	(0.74-1.17)
cases patients	4.67	(1.04-20.99)	1.34	(1.10-1.64)	1.12	(0.89-1.41)
authorities: high risk	4.93	(0.95-25.52)	1.97	(1.56-2.47)	1.25	(0.95-1.65)
SAFETY						
known: no side effect	1		1		1	
controversy	0.01	(0.00-0.05)	0.05	(0.04-0.06)	0.03	(0.03-0.04)
known: neuro effect	0.01	(0.00-0.05)	0.07	(0.06-0.08)	0.04	(0.03-0.05)
recent: no side effect	0.12	(0.05-0.26)	0.31	(0.26-0.38)	0.27	(0.21-0.34)
EFFECTIVENESS						
30% 1y	1		1		1	
30% 3-5y	1.42	(0.36-5.57)	1.46	(1.18-1.81)	1.19	(0.95-1.48)
90% 1y	1.62	(0.59-4.51)	1.96	(1.60-2.40)	1.54	(1.23-1.95)
90% 3-5y	0.75	(0.16-3.47)	2.84	(2.33-3.47)	1.59	(1.29-1.96)
COVERAGE						
insufficient	1		1		1	
VC 30%	1.02	(0.28-3.72)	0.91	(0.74-1.11)	1.71	(1.37-2.15)
VC 80%	3.68	(0.87-15.60)	1.63	(1.34-2.00)	1.19	(0.97-1.47)
few colleagues	1.01	(0.25-4.06)	1.01	(0.82-1.24)	1.15	(0.92-1.43)
most colleagues	3.42	(0.77-15.20)	1.87	(1.52-2.30)	1.92	(1.52-2.42)
INDIRECT PROTECTION						
individual only	1		1		1	
disease control	2.13	(0.39-11.72)	2.22	(1.73-2.83)	2.55	(1.99-3.27)
family	0.83	(0.12-5.59)	2.17	(1.70-2.76)	2.97	(2.34-3.79)
patients	0.90	(0.17-4.74)	1.84	(1.45-2.34)	2.81	(2.18-3.61)
INCENTIVE						
no action	1		1		1	
badge	0.27	(0.07-1.08)	0.54	(0.44-0.66)	0.35	(0.28-0.43)
certificate	0.27	(0.07-1.10)	0.61	(0.51-0.74)	0.50	(0.40-0.62)
hygiene	0.37	(0.09-1.45)	0.83	(0.69-1.01)	0.81	(0.66-1.00)
MANAGEMENT						
no message	1		1		1	
message	0.56	(0.18-1.79)	0.89	(0.75-1.04)	1.17	(0.98-1.40)

Results in bold are significant at the 5% level

workers,
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September
2018



Lecture note: compared to the “not vaccinated but vaccine-favorable” group (in red), participants who were “not vaccinated and vaccine-unfavorable” (in blue) showed substantially greater sensitivity to vaccine safety (“confirmed side effects”: OR= 0.01 vs. OR=0.05; “recent vaccine, no side effect”: OR= 0.12 vs. OR=0.31). Exact estimates (OR) underpinning this Figure are displayed in supplementary **Table C9**.