



HAL
open science

Perceptions of French healthcare students of vaccines and the impact of conducting an intervention in health promotion

Quentin Lepiller, Kévin Bouiller, Céline Slekovec, Dominique Millot, Nathalie Mazué, Virginie Pourchet, Rachel Balice, Fabienne Garrien-Maire, Edith Simon, Valérie Wintenberger, et al.

► To cite this version:

Quentin Lepiller, Kévin Bouiller, Céline Slekovec, Dominique Millot, Nathalie Mazué, et al.. Perceptions of French healthcare students of vaccines and the impact of conducting an intervention in health promotion. *Vaccine*, 2020, 38 (43), pp.6794-6799. 10.1016/j.vaccine.2020.08.036 . hal-03045632

HAL Id: hal-03045632

<https://hal.science/hal-03045632>

Submitted on 21 Sep 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial 4.0 International License

1 **TITLE: Perceptions of French healthcare students of vaccines and the impact of conducting**
2 **an intervention in health promotion**

3

4 **Quentin Lepiller^{a,b,c}, Kévin Bouiller^{b,d}, Céline Slekovec^{b,e}, Dominique Millot^f, Nathalie**
5 **Mazué^f, Virginie Pourchet^g, Rachel Balice^h, Fabienne Garrien-Maireⁱ, Edith Simon^f, Valérie**
6 **Wintenberger^j, Agnès Guillaume^k, Marie-Françoise Monaton^j, Béatrice Van Eis^l, Xavier**
7 **Bertrand^{b,m}, Djamila Bennabi^{b,n}, Thierry Moulin^{b,o}, Raphaël Anxionnat^{b,p}, and Virginie**
8 **Nerich^{b,q,r}**

9 ^aLaboratoire de Virologie, CHU Besançon, France; ^bUFR Santé, Université Bourgogne France-
10 Comté, France ; ^cEA3181, Université Bourgogne France-Comté, France; ^dService de Maladies
11 Infectieuses, CHU Besançon, France; ^eCPIAS, CHU Besançon, France; ^fInstitut Régional de
12 Formation Sanitaire et Sociale Bourgogne Franche-Comté, France; ^gInstitut de Formation en
13 Soins Infirmiers, Besançon, France; ^hInstitut de Formation en Soins Infirmiers, Pontarlier,
14 France; ⁱInstitut de Formation en Soins Infirmiers, Dole, France; ^jInstitut de Formation aux
15 Métiers de la Santé, Hôpital Nord Franche-Comté, Montbéliard, France; ^kUnité de formation
16 en Masso-kinésithérapie, CHU Besançon, France; ^lEcole de Sage-femmes, CHU Besançon,
17 France; ^mService d'hygiène hospitalière, CHU Besançon, France; ⁿService de Psychiatrie de
18 l'adulte, CHU Besançon, France; ^oService de Neurologie, CHU Besançon, France; ^pService de
19 Pédiatrie, CHU Besançon, France; ^qDepartment of Pharmacy, CHU Besançon,
20 France; ^rINSERM, EFS BFC, UMR1098, University of Bourgogne Franche-Comté, Besançon,
21 France

22

23 **Collaborators « SSES BFC Study Group »:**

24 Nicolas Barbat, Marie-Annick Basset, Anne-Pauline Bellanger, Christiane Bideau, Marie-
25 Noelle Braichotte, Catherine Chirouze, Julie Correia, Christophe Dinet, Benoit Faverge, Claire
26 Fay, Noor Hafsi, Didier Hocquet, Laurence Gandon, Camille Gonin, Christophe Jauffrey, Katy
27 Jeannot, Marie Jounin, Elise Labeuche, Pascal Leroux, Marion Martinod, Christine Meyer,
28 Héloïse Nicolas, Stéphanie Paris, Estelle Poulnot, Jean-Luc Prétet, Line Puget, Pascale Rey,
29 Juliette Receveur, and Candice Serette.

30

31 **Running title:** Perceptions of French healthcare students of vaccines

32

33 **#Correspondence:** Dr. Quentin Lepiller, Laboratoire de Virologie, CHU Besançon, 3,
34 Boulevard Fleming, 25 030, Besançon France, E-Mail: q1lepiller@chu-besancon.fr

35 Phone number: +33(0)370632513

36

37 **Word count:** abstract = 292; text = 3232

38

39 **KEYWORDS:** health promotion; health students; perception; vaccine hesitancy

40

41

42

43

44 **ABSTRACT**

45 **BACKGROUND:** The perceptions of healthcare students of vaccines have been poorly
46 explored and appropriate training strategies to address possible confidence gaps concerning
47 vaccination for these future professionals is still a subject of debate.

48 **METHODS:** A questionnaire to assess the perceptions of vaccination and the feeling of
49 preparedness to address patient concerns was submitted to 874 multidisciplinary healthcare
50 students enrolled in the French program “Service Sanitaire des Etudiants en Santé” (SSES).
51 The evolution of their perceptions during the year and the impact of having performed a
52 primary prevention intervention in the context of the SSES program were assessed.

53 **RESULTS:** In total, 530 students of nursing (42.5%), medicine (31.5%), physiotherapy (11.3%),
54 pharmacy (10.9%), and midwifery (3.8%) completed the questionnaires. Among them, 7.0%
55 carried out an intervention within the topic “vaccination and hygiene” and 93.0% within
56 another topic (“nutrition and physical activity” or “addiction”). A portion of the students
57 showed traits of vaccine hesitancy, including specific concerns about side effects (61.5%) or
58 the number of vaccines in the vaccination schedule (30.0%). They felt ill prepared to address
59 vaccine-hesitant patients, with poor confidence of their knowledge about vaccines (52.5%),
60 their ability to inform patients about the side effects (42.5%), the benefit/risk of adjuvants
61 (51.7%), and the rules for introducing a new vaccine (51.9%). They showed significant
62 differences in perception depending on their curriculum. Misconceptions and hesitancy
63 concerning vaccines were significantly improved after the students had performed the
64 primary prevention intervention, regardless of the topic.

65 **CONCLUSIONS:** A portion of French healthcare students show traits of vaccine hesitancy,
66 with significant differences depending on the courses attended. Programs of health
67 promotion, such as the French SSES program, which includes a primary prevention
68 intervention conducted by multidisciplinary groups of students, may improve the global
69 confidence of healthcare students concerning vaccination.

70 **INTRODUCTION**

71 Vaccination is one of the cornerstones of public health, but confidence in vaccination is
72 becoming increasingly fragile. Such growing skepticism, also known as "vaccine hesitancy", is
73 a fertile ground for the emergence of under-vaccinated groups and outbreaks of vaccine-
74 preventable diseases [1]. Vaccine hesitancy refers to a "delay in acceptance or refusal of
75 vaccines despite the availability of vaccination services" [2]. The WHO Strategic Advisory
76 Group of Experts (SAGE) Working Group has proposed a matrix of determinants to describe
77 vaccine hesitancy, distributed within contextual influences (religious beliefs, influential
78 leaders, and anti/pro-vaccination lobbies, communication and media environment),
79 individual and group influences (perception of benefit/risk, knowledge, level of trust in the
80 healthcare system), and vaccine- or vaccination-specific issues (scientific evidence of
81 benefit/risk, vaccination schedules, mode of administration) [3].

82 Healthcare workers (HCWs) have a key role in addressing vaccine hesitancy. Their own
83 knowledge, attitudes, and beliefs concerning vaccination are major drivers of vaccine
84 acceptance among vaccine-hesitant patients [4]. Previous studies have highlighted a
85 disparity among the recommendations and practices of HCWs concerning vaccines [5–7],
86 doubts expressed by a portion of HCWs about the utility and benefit-risk balance of certain
87 vaccines [6,8], and a feeling of being inadequately prepared to address vaccination concerns

88 with patients [9]. In contrast to practicing HCWs, very few studies have been conducted to
89 assess the perceptions of healthcare students concerning vaccines and vaccination [10].

90 We sought to characterize the perceptions concerning vaccination among healthcare
91 students enrolled in a new French program of primary prevention interventions, called
92 “Service Sanitaire des Etudiants en Santé” (SSES). We particularly explored their feeling of
93 preparedness to address patient concerns about vaccines and the evolution of their
94 perceptions before and after having performed the primary prevention project, regardless of
95 the topic.

96 **MATERIALS AND METHODS**

97 **SSES program**

98 SSES is a French national program of health promotion established in September 2018
99 [11,12]. It is mandatory for all healthcare students from medicine, pharmacy, midwifery,
100 physiotherapy, and nursing curricula in each French Region. Thus, in the Franche-Comté
101 region (1.2 million inhabitants), all healthcare students from medicine (3rd year), pharmacy
102 (5th year), midwifery (4th year), physiotherapy (4th year), and nursing (2nd year) participate in
103 shared training by e-learning on major issues in “primary prevention/health
104 promotion/intervention” and public health, such as “nutrition and physical activity”,
105 “vaccination and hygiene”, and “addiction”. Vaccination training is based exclusively on
106 videos explaining the history of vaccination (10 slides), its principles and mechanisms of
107 action (12 slides), the various types of vaccines (15 slides), and the main controversies
108 surrounding vaccination in the general population (20 slides). Organized into
109 interdisciplinary groups of four to five individuals and supervised by two tutors (HCWs),
110 healthcare students prepare and manage a primary prevention intervention for various

111 target audiences around one topic between "nutrition and physical activity", "vaccination
112 and hygiene", and "addiction" (e.g. alerting primary school children to the danger of
113 microbes through games or alerting university students to the risk of addiction, the benefits
114 of fruits and vegetables, or the consequences of vaccine-preventable diseases). The
115 preparation of such interventions is organized during four sessions with tutors (with
116 standardized activities, regardless of the topic of the students' intervention) and work
117 between the sessions. The SSES program was conducted from September 2018 to April 2019,
118 with the students' interventions taking place during one week in March 2019.

119 **Exploration of the students' perceptions**

120 A Likert scale questionnaire to assess the determinants of vaccine hesitancy was submitted
121 to the SSES students (irrespective of the theme of their intervention) through the
122 CleanWeb® platform (Telemedicine Technologies, Boulogne-Billancourt, France) at the
123 beginning of the academic year in September 2018 and again in May 2019, after completion
124 of the student interventions in health promotion. Students were highly encouraged to
125 complete the surveys, without any incentive or penalty whether they accepted to participate
126 or not. Questionnaires were completed anonymously but students had to indicate their age,
127 sex, attended course, and the topic of their intervention during the SSES.

128 The survey questions were closely inspired by those reported by the WHO SAGE Working
129 Group to assess the determinants of vaccine hesitancy, with the main drivers of hesitancy
130 organized into three domains: "contextual influences", "individual and group influences",
131 and "vaccine- or vaccination-specific issues" [3]. The first part of the questionnaire (10 items)
132 was designed to explore the perceptions of students concerning vaccination, whereas the
133 second part (10 items) explored their perceived preparedness to address vaccination

134 concerns with patients (Table 1). The three domains of determinants identified by the WHO
135 SAGE Group were explored in each part. The questionnaire was first tested by 12 healthcare
136 workers to ensure the understandability of the questions, without additional quantitative
137 analysis of its consistency.

138 **Statistical analysis**

139 The questionnaires were based on a four-point Likert scale ("strongly agree", "agree",
140 "disagree", "strongly disagree"). Responses were split into two levels depending on the
141 results: "agree" (grouping "strongly agree" and "agree") and "disagree" (grouping "disagree"
142 and "strongly disagree"). Categorical variables are described by the number and percentage
143 of cases. Differences in qualitative parameters for independent samples were analyzed using
144 the Chi-squared test. Qualitative parameters for dependent samples, such as agreement
145 before and after intervention, were compared using the Z-test. All tests were two-tailed and
146 considered significant at an alpha threshold of 5%. Statistical analysis was performed using
147 SAS software, version 9.4 (SAS Institute Inc., Cary, NC, USA).

148 **RESULTS**

149 **Study population**

150 During the 2018-2019 academic year, the French SSES program enrolled 874 students from
151 nursing (55.5%), medicine (24.4%), physiotherapy (9.3%), pharmacy (8.0%), and midwifery
152 (2.9%) curricula in the Franche-Comté region. The students were distributed into 213
153 multidisciplinary teams of four to five individuals and each team chose and carried out a
154 project of primary prevention in "vaccination and hygiene", "nutrition and physical activity",
155 or "addiction". Among them, 530 (60.6%) fully completed the questionnaires at the
156 beginning and end of the program: 225 (42.5%) in nursing, 167 (31.5%) in medicine, 60

157 (11.3%) in physiotherapy, 58 (10.9%) in pharmacy, and 20 (3.8%) in midwifery. More than
158 three-quarters were women (n = 403). Thirty-seven (7.0%) carried out a project on the topic
159 “vaccination and hygiene” (including 18 students in nursing, 12 in medicine, 4 in pharmacy,
160 and 3 in midwifery), whereas the other 493 students (93.0%) performed a project in another
161 topic.

162 **Contextual influences and vaccine perception**

163 ***Perceptions before the intervention***

164 Information from the media and social media concerning vaccines was considered to be
165 relevant by 37.2% of the students (Q1) (Table 1). Students who planned to carry out an
166 intervention on vaccination tended to be more critical of media information than the other
167 groups (16.2% vs 38.7%, $p = 0.007$) (Table 2). Among the students, 16.8% generally agreed
168 with the arguments claimed by vaccination opponents (Q2), this proportion reaching 29.8%
169 among the nursing students (Table 1). The students showed differences in opinion
170 depending on the curricula, with the highest level of trust in the media (Q1, $p < 0.0001$) and
171 the lowest level of trust in the pharmaceutical industry (Q4, $p = 0.003$) among students from
172 physiotherapy and nursing. Freedom to be vaccinated or refuse (Q3) was supported by
173 55.7% of the respondents, reaching 73.3% when restricting the analysis to the nursing
174 students. Importantly, 86.0% of students felt capable of justifying the obligation of certain
175 vaccines to patients (Q13) (Table 1), suggesting a contrast between the general perception
176 of freedom to vaccinate and the ability to justify and apply a healthcare policy that includes
177 mandatory vaccination. The perception of preparedness to help patients sort through media
178 information (Q11) and the arguments of vaccination opponents (Q12) was only 58.1%

179 (59.9% for medical students) and 67.0%, respectively. Perceptions related to these
180 contextual influences did not significantly vary with sex.

181 ***Perceptions after the intervention***

182 The responses to the second questionnaire after the intervention showed a significant
183 decrease in the students' confidence in the media concerning information about vaccines
184 (Q1, $p < 0.001$) and the arguments of vaccination opponents (Q2, $p = 0.03$) and a slight
185 increase in trust in the pharmaceutical industry for the distribution of safe and effective
186 vaccines (Q4, $p = 0.04$) (Table 2). Similarly, respondents felt more prepared to help patients
187 sort through media information (Q11, $p < 0.001$) and the arguments of vaccination
188 opponents (Q12, $p < 0.001$). Surprisingly, this evolution in perception between the two
189 questionnaires was more pronounced among students who had not carried out their
190 primary prevention project on the topic "vaccination and hygiene" (items Q1-3 and Q11-12),
191 although all students had received the same integrated program by e-learning at the
192 beginning of the academic year.

193 **Individual and group influences and perceptions of vaccines**

194 ***Perceptions at baseline***

195 Individual and group influences refer to influences that arise from personal understanding of
196 vaccination and social norms, including the perceived benefit/risk and the level of
197 knowledge about vaccines [3]. The usefulness of vaccines, even in the context of rare
198 diseases, was reported by 90.0% of students (Q7), and more than 80% felt capable of
199 explaining the principles of immunization and its individual and collective benefits to
200 patients (Q14-15, Q18) (Table 1). In contrast to this general positive opinion concerning the
201 benefits of vaccines, concerns about vaccine-related side effects were widespread among

202 students. Indeed, 61.5% perceived a lack of transparency concerning vaccine-related side
203 effects (Q5), the proportion reaching 75.6% among nursing students. Similarly, only 42.5% of
204 respondents (Q16) felt able to inform patients about the actual risk of side effects for two
205 stated vaccines, those against hepatitis B virus (HBV) and human papillomavirus (HPV), both
206 often the subject of controversy in France [13]. These concerns about vaccine-related side
207 effects may be related to insufficient academic training in vaccination. In support of this
208 hypothesis, only 52.5% of students considered their knowledge to be sufficient (Q6), with
209 significant differences depending on their curriculum ($p = 0.003$).

210 ***Evolution of perceptions during the year***

211 Concerns about a lack of transparency on vaccine-related side effects (Q5) decreased
212 significantly by the end of the SSES program ($p < 0.001$) (Table 2), both for students who had
213 performed an intervention on the topic “vaccination and hygiene” ($p = 0.03$) and the others
214 ($p < 0.001$). Similarly, all respondents felt more comfortable about addressing the actual risk
215 of side effects of hepatitis B and HPV vaccines with their future patients (Q16, $p < 0.001$).
216 Perceptions of individual knowledge about vaccines (Q6) also improved ($p < 0.001$), even for
217 students who did not perform an SSES intervention on vaccines.

218 **Specific issues related to vaccines or vaccination**

219 ***Perceptions at baseline***

220 Aside from contextual, individual, and group influences, vaccine hesitancy may be linked to
221 various specific issues related to vaccines, such as the vaccination schedule adopted by each
222 country, the rules of introduction of a new vaccine, or scientific evidence of the benefit/risk
223 [3]. Concerning the French vaccination schedule (Q8), which includes 11 mandatory vaccines
224 [14], 30.0% of respondents agreed with the statement that it results in “too many vaccines

225 for children who are too young” (Table 1), varying significantly from 5.0% among midwifery
226 students to 45.3% among nursing students ($p < 0.0001$). Only 31.9% of students thought that
227 scientific data regarding the benefit/risk of vaccines are easily available (Q9). Moreover, only
228 51.7% of respondents felt capable of explaining the benefit/risk of adjuvants to a patient
229 (Q19) and 51.9% the rules for introducing a new vaccine (Q20), which differed significantly
230 depending on the curriculum ($p < 0.0001$ for Q19, and $p = 0.01$ for Q20). Concern about the
231 rigor of vaccine trials was expressed by 22.5% of students (Q10) and varied depending on the
232 curriculum ($p = 0.0003$).

233 ***Evolution of perceptions during the year***

234 The responses to the second questionnaire showed slight but significant changes in the
235 students’ perceptions of the availability of scientific data (Q9, $p = 0.02$), the rigor of vaccine
236 trials (Q10, $p = 0.02$), and their preparedness to explain the benefit/risk of adjuvants to
237 patients (Q19, $p < 0.001$) or the rules for the introduction of a new vaccine (Q20, $p = 0.01$)
238 (Table 2). Among students who had performed their SSES intervention on “vaccination and
239 hygiene”, only 5.4% reported concerns about mandatory vaccines in France (Q8, vs 24.0% for
240 all students) and 86.5% felt comfortable about explaining the benefit/risk of adjuvants
241 (Q19).

242 **DISCUSSION**

243 Healthcare workers have a leading role to play in addressing the emergence of vaccine
244 hesitancy among patients and fostering vaccine acceptance [8,13]. However, some HCWs are
245 themselves insufficiently confident about the safety, effectiveness, and importance of
246 vaccination, or may feel unprepared to address patient concerns about these topics [5–7].
247 This may be perpetuated by a lack of adequate training during the education of the HCWs.

248 Exploring the perceptions of healthcare students about vaccines will help to define
249 appropriate training strategies and interventions to address confidence gaps for these future
250 professionals. Here, we submitted a survey to healthcare students of our region, enrolled in
251 a national program of primary prevention interventions (the SSES program), to determine
252 their perceptions about vaccination and explore their feeling of preparedness to address
253 patient concerns.

254 We observed widespread concerns about vaccine-related side effects and a lack of
255 transparency about vaccines (Q5, 61.5% of students), accompanied, for a portion of the
256 students, by mistrust of the pharmaceutical industry and health authorities concerning the
257 introduction and monitoring of new vaccines. In particular, 30.0% of students (45.3% when
258 restricting the analysis to nursing students) considered the 11 French mandatory vaccines to
259 result in "too many vaccines for children who are too young" (Q8). This negative vaccine-
260 safety sentiment expressed by a portion of the respondents is in stark contrast with general
261 agreement on the usefulness of vaccines and confidence in their individual and collective
262 benefits (Q7, Q14-15).

263 Our study was performed among multidisciplinary healthcare students. Thus, a very relevant
264 element of our results was the difference in perceptions depending on the students'
265 curriculum. Such differences were especially evident for items related to vaccine safety and
266 benefit/risk (Q4, Q5, Q10, Q19), media information (Q1), and freedom to vaccinate (Q3),
267 which globally showed greater vaccine hesitancy among nursing and sometimes
268 physiotherapy students than among medicine, pharmacy, and midwifery students. By
269 contrast, we observed a widespread feeling of insufficient knowledge, regardless of the

270 students' curriculum, with difficulties in obtaining scientific data and explaining the principle
271 of adjuvants to patients (Q6, Q9, Q19).

272 Safety has been reported to be the primary area of concern about vaccines in European
273 populations, with a belief that the risks of vaccination outweigh the benefits [15]. In a recent
274 study conducted in 67 countries, France had the highest level of distrust of vaccine safety,
275 expressed by 41% of respondents (compared to a global average of 13%) [16]. In particular,
276 misconceptions about HPV and HBV vaccines are particularly pronounced in France and in
277 Europe, with doubts about their risk-benefit balance, speculation about long-term adverse
278 reactions, and accusations about promoting severe diseases, such as multiple sclerosis, or
279 even sterilization for the HPV vaccine, even though there are no scientific data to support
280 these theories [8,15]. Controversy surrounding the number of injections for children and the
281 presence of mandatory vaccines in vaccination schedules have also been reported in France
282 and Europe. In a recent survey conducted in the French general population, 33.8% of
283 respondents considered the French vaccination policy, with 11 mandatory vaccines, to
284 present a risk to children [13], a well-described fear of an "immunogenical overload"
285 reported in many studies worldwide [4,17,18], without any scientific support [19]. Among
286 HCWs, 12.1% of Italian pediatricians at least partially agree with the statement that children
287 receive too many vaccines [20]. As observed in our study, these perceptions may vary
288 depending on the type of HCW. Indeed, practicing pediatric nurses were significantly more
289 vaccine-hesitant than pediatricians in a recent Spanish survey [4].

290 Positions reported by the various media about vaccines and the visibility of anti/pro-
291 vaccination lobbies may greatly influence vaccine hesitancy. In France, conspiracy theories
292 and misinformation about vaccines are particularly well developed and easily accessible on

293 the internet. When questioned about information delivered by the media and social media,
294 37.2% of our students considered this information to be relevant (Q1). Indeed, information
295 delivered on vaccines may vary greatly depending on the type of media, leading to
296 difficulties for students to sort through this information by themselves, as well as patients
297 (as expressed by 58.1% of students in Q11). In a recent French study that explored the
298 population perception of the mandatory childhood vaccination program, the news media
299 was reported as a major source of information for 49.2% of respondents, whereas only 7.7%
300 of respondents trusted information found on social media networks [13]. Further studies are
301 needed to better understand the impact of various types of media on HCWs and healthcare
302 students.

303 A lack of specific training and knowledge may lead to misconceptions about vaccines
304 (effectiveness, safety, side effects) and vaccine-preventable diseases (perception of the risk,
305 severity, and prevalence) among HCWs [5]. Suboptimal education of healthcare students
306 about vaccines has already been observed in France. In a large survey of 2,118 students in
307 their last year of medical studies, 66% felt inadequately prepared to address concerns about
308 the side effects of vaccines and 90% the side effects of adjuvants [10]. Several solutions have
309 been proposed to improve vaccine training, including the implementation of practical
310 training during healthcare studies [10], an extra-curricular multidisciplinary seminar [21], or
311 specific education on the most common controversies and how to communicate with
312 patients about them [22]. Here, we suggest that a standardized program of health
313 promotion, such as the SSES program, which includes multidisciplinary training by e-learning
314 and a specific primary prevention intervention in the field, may reduce misconceptions and
315 doubts about vaccination among healthcare students. Indeed, the evolution of perceptions

316 significantly changed during the year, with a global reduction in vaccine hesitancy after
317 having performed the primary prevention project. Through the preparation of this project,
318 students are made aware of various concepts of health and primary prevention. They are
319 then exposed to a target audience to carry out an intervention that promotes a specific
320 aspect of health. Interestingly, the decrease in vaccine hesitancy between the two
321 questionnaires was observed for each domain of determinants, regardless of the theme of
322 the primary prevention intervention, suggesting a global impact of the SSES program on
323 students' perceptions about vaccines. Apart from the SSES program, we cannot exclude the
324 possibility that the observed modifications in the students' perceptions during the study
325 period were influenced by other elements, such as additional curricular and extracurricular
326 learning or personal experiences concerning vaccination and vaccine-preventable diseases,
327 although we suggest that the SSES program had an independent impact on the students'
328 perceptions. A social desirability bias, for at least a part of the students (e.g. minimizing their
329 true misconceptions and hesitancy about vaccines or responding in a manner perceived to
330 be appropriate for a healthcare student), is also possible, although the use of an anonymous
331 and online questionnaire likely limited its impact.

332 In conclusion, our study findings show several traits of vaccine hesitancy among a portion of
333 French healthcare students, with specific concerns about vaccine safety and side effects, as
334 observed in the general population. In addition, the students felt inadequately prepared to
335 address the concerns of vaccine-hesitant patients. We observed significant differences in
336 perceptions depending on the students' curriculum, which should help to adapt the primary
337 program to reduce misconceptions about vaccines for each subgroup of students. Programs
338 of health promotion, such as the French SSES program, which include a primary prevention

339 intervention conducted by multidisciplinary groups of healthcare students, may help to
340 improve global confidence in vaccination for these future healthcare providers.

341

342 **FUNDING:** None

343 **COMPETING INTERESTS:** None declared

344

345 REFERENCES

- 346 [1] Phadke VK, Bednarczyk RA, Salmon DA, Omer SB. Association Between Vaccine Refusal and
347 Vaccine-Preventable Diseases in the United States: A Review of Measles and Pertussis. *JAMA*
348 2016;315:1149–58. <https://doi.org/10.1001/jama.2016.1353>.
- 349 [2] MacDonald NE, SAGE Working Group on Vaccine Hesitancy. Vaccine hesitancy: Definition,
350 scope and determinants. *Vaccine* 2015;33:4161–4.
351 <https://doi.org/10.1016/j.vaccine.2015.04.036>.
- 352 [3] Larson HJ, Jarrett C, Eckersberger E, Smith DMD, Paterson P. Understanding vaccine hesitancy
353 around vaccines and vaccination from a global perspective: a systematic review of published
354 literature, 2007–2012. *Vaccine* 2014;32:2150–9. <https://doi.org/10.1016/j.vaccine.2014.01.081>.
- 355 [4] Picchio CA, Carrasco MG, Sagué-Vilavella M, Rius C. Knowledge, attitudes and beliefs about
356 vaccination in primary healthcare workers involved in the administration of systematic
357 childhood vaccines, Barcelona, 2016/17. *Euro Surveill* 2019;24. <https://doi.org/10.2807/1560-7917.ES.2019.24.6.1800117>.
- 359 [5] Hollmeyer HG, Hayden F, Poland G, Buchholz U. Influenza vaccination of health care workers in
360 hospitals--a review of studies on attitudes and predictors. *Vaccine* 2009;27:3935–44.
361 <https://doi.org/10.1016/j.vaccine.2009.03.056>.
- 362 [6] Verger P, Fressard L, Collange F, Gautier A, Jestin C, Launay O, et al. Vaccine Hesitancy Among
363 General Practitioners and Its Determinants During Controversies: A National Cross-sectional
364 Survey in France. *EBioMedicine* 2015;2:891–7. <https://doi.org/10.1016/j.ebiom.2015.06.018>.
- 365 [7] Agrinier N, Le Maréchal M, Fressard L, Verger P, Pulcini C. Discrepancies between general
366 practitioners' vaccination recommendations for their patients and practices for their children.
367 *Clin Microbiol Infect* 2017;23:311–7. <https://doi.org/10.1016/j.cmi.2016.08.019>.
- 368 [8] Collange F, Fressard L, Pulcini C, Sebbah R, Peretti-Watel P, Verger P. General practitioners'
369 attitudes and behaviors toward HPV vaccination: A French national survey. *Vaccine*
370 2016;34:762–8. <https://doi.org/10.1016/j.vaccine.2015.12.054>.
- 371 [9] Paterson P, Meurice F, Stanberry LR, Glismann S, Rosenthal SL, Larson HJ. Vaccine hesitancy and
372 healthcare providers. *Vaccine* 2016;34:6700–6. <https://doi.org/10.1016/j.vaccine.2016.10.042>.
- 373 [10] Kernéis S, Jacquet C, Bannay A, May T, Launay O, Verger P, et al. Vaccine Education of Medical
374 Students: A Nationwide Cross-sectional Survey. *Am J Prev Med* 2017;53:e97–104.
375 <https://doi.org/10.1016/j.amepre.2017.01.014>.
- 376 [11] Décret n° 2018-472 du 12 juin 2018 relatif au service sanitaire des étudiants en santé. 2018.
- 377 [12] Arrêté du 12 juin 2018 relatif au service sanitaire pour les étudiants en santé. n.d.

- 378 [13] Mathieu P, Gautier A, Raude J, Goronflot T, Launay T, Debin M, et al. Population perception of
379 mandatory childhood vaccination programme before its implementation, France, 2017. *Euro*
380 *Surveill* 2019;24. <https://doi.org/10.2807/1560-7917.ES.2019.24.25.1900053>.
- 381 [14] Lévy-Bruhl D, Desenclos J-C, Quelet S, Bourdillon F. Extension of French vaccination mandates:
382 from the recommendation of the Steering Committee of the Citizen Consultation on
383 Vaccination to the law. *Euro Surveill* 2018;23. [https://doi.org/10.2807/1560-](https://doi.org/10.2807/1560-7917.ES.2018.23.17.18-00048)
384 [7917.ES.2018.23.17.18-00048](https://doi.org/10.2807/1560-7917.ES.2018.23.17.18-00048).
- 385 [15] Karafillakis E, Larson HJ, ADVANCE consortium. The benefit of the doubt or doubts over
386 benefits? A systematic literature review of perceived risks of vaccines in European populations.
387 *Vaccine* 2017;35:4840–50. <https://doi.org/10.1016/j.vaccine.2017.07.061>.
- 388 [16] Larson HJ, de Figueiredo A, Xiahong Z, Schulz WS, Verger P, Johnston IG, et al. The State of
389 Vaccine Confidence 2016: Global Insights Through a 67-Country Survey. *EBioMedicine*
390 2016;12:295–301. <https://doi.org/10.1016/j.ebiom.2016.08.042>.
- 391 [17] Gellin BG, Maibach EW, Marcuse EK. Do parents understand immunizations? A national
392 telephone survey. *Pediatrics* 2000;106:1097–102. <https://doi.org/10.1542/peds.106.5.1097>.
- 393 [18] Hulseley E, Bland T. Immune overload: Parental attitudes toward combination and single antigen
394 vaccines. *Vaccine* 2015;33:2546–50. <https://doi.org/10.1016/j.vaccine.2015.04.020>.
- 395 [19] Nicoli F, Appay V. Immunological considerations regarding parental concerns on pediatric
396 immunizations. *Vaccine* 2017;35:3012–9. <https://doi.org/10.1016/j.vaccine.2017.04.030>.
- 397 [20] Filia A, Bella A, D’Ancona F, Fabiani M, Giambi C, Rizzo C, et al. Childhood vaccinations:
398 knowledge, attitudes and practices of paediatricians and factors associated with their
399 confidence in addressing parental concerns, Italy, 2016. *Euro Surveill* 2019;24.
400 <https://doi.org/10.2807/1560-7917.ES.2019.24.6.1800275>.
- 401 [21] Marotta C, Raia DD, Ventura G, Casuccio N, Dieli F, D’Angelo C, et al. Improvement in
402 vaccination knowledge among health students following an integrated extra curricular
403 intervention, an explorative study in the University of Palermo. *J Prev Med Hyg* 2017;58:E93–8.
- 404 [22] Le Marechal M, Fressard L, Agrinier N, Verger P, Pulcini C. General practitioners’ perceptions of
405 vaccination controversies: a French nationwide cross-sectional study. *Clin Microbiol Infect*
406 2018;24:858–64. <https://doi.org/10.1016/j.cmi.2017.10.021>.
- 407

408

409

410 TABLES AND FIGURES

411

412 **Table 1. Perceptions of students at baseline. Items were designed to explore the**
413 **perception of students about vaccination (Q1-Q10) and their perceived preparedness to**
414 **address vaccination concerns with patients (Q11-Q20), in accordance with the**
415 **determinants of vaccine hesitancy identified by the WHO SAGE group [3]. The percentage**
416 **of agreement for each category of students for each item is specified and any statistical**

417 differences between the proportion of agreement shown as *P* values. (NURS: nursing;
418 PHAR: pharmacy; MED: Medicine; MIDW: midwifery; PHYS: physiotherapy)

419

420 **Table 2. Evolution of the students' perceptions during the year. The proportion of**
421 **agreement obtained before and after the primary prevention intervention is indicated for**
422 **each item of the questionnaire (Q1 to Q20), both for students who performed their**
423 **intervention on the topic "Vaccination and Hygiene" and those who performed an**
424 **intervention on another topic.**

Table 1

Items	Percentage of agreement (%)						P value	
	Global (n=530)	NURS (n=225)	PHAR (n=58)	MED (n=167)	MIDW (n=20)	PHYS (n=60)		
<i>Perception of students concerning vaccination</i>								
Q1	I believe that information reported by the media and social media about vaccination is relevant <i>(Contextual influences - Communication and media environment)</i>	37.2	40.8	20.7	32.3	5.0	45.0	< 0,0001
Q2	I generally agree with the arguments claimed by vaccination opponents <i>(Contextual influences - Influential leaders, anti- or pro-vaccination lobbies)</i>	16.8	29.8	5.2	6.6	10.0	10.0	< 0,0001
Q3	I believe that everyone is free to be vaccinated or refuse vaccination <i>(Contextual influences - Health policies)</i>	55.7	73.3	29.3	41.3	40.0	60.0	< 0,0001
Q4	I trust pharmaceutical companies to provide safe and effective vaccines <i>(Contextual influences - Pharmaceutical industry: trust, safety, effectiveness)</i>	71.1	63.6	86.2	76.7	75.0	68.3	0.003
Q5	I believe that there is a lack of transparency about vaccine-related side effects <i>(Individual and group influences – perceived risk/benefit)</i>	61.5	75.6	43.1	47.3	30.0	76.7	< 0,0001
Q6	I believe that I have sufficient knowledge about vaccines and how they work <i>(Individual and group influences - knowledge/awareness)</i>	52.5	55.1	72.4	47.3	40.0	41.7	0.003
Q7	I believe that vaccination against certain rare diseases is no longer useful <i>(Individual and group influences - social norm and usefulness of immunization)</i>	10.0	15.5	3.4	5.4	0.0	11.7	0.002
Q8	I believe the 11 mandatory vaccines in the (French) vaccination schedule results in too many vaccines for children who are too young <i>(Specific issues of vaccination - Vaccination schedule)</i>	30.0	45.3	17.2	18.0	5.0	26.7	< 0,0001
Q9	I believe that scientific data (clinical trials, guidelines) on the benefit / risk of vaccines are easily available <i>(Specific issues of vaccination - Scientific evidence of risk/benefit)</i>	31.9	34.7	29.3	31.7	30.0	25.0	0.68
Q10	I believe that new vaccines are tested using the same rigorous standards as any other medicine <i>(Specific issues of vaccination - Introduction of a new vaccine)</i>	77.5	68.9	91.4	83.1	90.0	76.7	0.0003

Table 1

Items	Percentage of agreement (%)						P value
	Global (n=530)	NURS (n=225)	PHAR (n=58)	MED (n=167)	MIDW (n=20)	PHYS (n=60)	
<i>Perceived preparedness to address vaccination concerns with patients</i>							
Q11 I feel capable of helping patients to sort through the information in the media about vaccines <i>(Contextual influences - Communication and media environment)</i>	58.1	59.1	74.1	59.9	65.0	31.7	< 0,0001
Q12 I feel capable of helping patients to adopt a critical perspective towards the arguments of vaccination opponents <i>(Contextual influences - Influential leaders, anti/pro-vaccination lobbies)</i>	67.0	64.4	74.1	71.3	75.0	55.0	0.1000
Q13 I feel able to justify the obligation of certain vaccines <i>(Contextual influences - Health policies)</i>	86.0	87.6	91.4	85.0	90.0	76.7	0.16
Q14 I feel able to explain the individual benefits of vaccination <i>(Individual and group influences - social norm and usefulness of immunization)</i>	81.1	81.3	79.3	90.4	70.0	60.0	< 0,0001
Q15 I feel able to explain the collective benefits of vaccination <i>(Individual and group influences - social norm and usefulness of immunization)</i>	89.1	88.0	93.1	92.8	95.0	76.7	0.008
Q16 I feel able to inform patients about the true risk of side effects associated with hepatitis B or HPV vaccines <i>(Individual and group influences - perceived risk/benefit)</i>	42.5	48.4	41.4	41.3	50.0	21.7	0.006
Q17 I feel able to inform patients about the risk that results from refusing a vaccine <i>(Individual and group influences – perceived risk/benefit)</i>	75.9	76.0	84.5	80.2	85.0	51.7	0.0002
Q18 I feel capable of explaining to a patient what a vaccine is and how it works <i>(Individual and group influences - knowledge/awareness)</i>	84.7	83.1	84.5	88.6	90.0	78.3	0.32
Q19 I feel able to explain the benefit/risk of adjuvants in a vaccine <i>(Specific issues of vaccination - Vaccination schedule/vaccine formulation)</i>	51.7	45.3	72.4	62.9	45.0	26.7	< 0,0001
Q20 I feel capable of explaining to a patient how a new vaccine is introduced and monitored (pharmacovigilance) <i>(Specific issues of vaccination - Introduction of a new vaccine)</i>	51.9	56.9	54.5	54.5	50.0	30.0	0.01

Table 2

	Global			Intervention on the topic Vaccination and Hygiene			Intervention on another topic		
	Agreement before intervention N (%)	Agreement after intervention N (%)	p value	Agreement before intervention N (%)	Agreement after intervention N (%)	p value	Agreement before intervention N (%)	Agreement after intervention N (%)	p value
Q1	197 (37.2)	141 (26.6)	<0.001	6 (16.2)	7 (18.9)	0.71	191 (38.7)	134 (27.2)	<0.001
Q2	89 (16.8)	68 (12.8)	0.03	2 (5.4)	4 (10.8)	0.41	87 (17.7)	64 (13.0)	0.01
Q3	295 (55.7)	199 (37.6)	<0.001	18 (48.7)	15 (40.5)	0.40	277 (56.2)	184 (37.3)	<0.001
Q4	377 (71.1)	399 (75.3)	0.04	27 (73.0)	30 (81.1)	0.26	350 (71.0)	369 (74.9)	0.06
Q5	326 (61.5)	272 (51.3)	<0.001	21 (56.8)	12 (32.4)	0.03	305 (61.9)	260 (52.7)	<0.001
Q6	278 (52.5)	365 (68.9)	<0.001	17 (46.0)	28 (75.7)	0.01	261 (52.9)	337 (68.4)	<0.001
Q7	53 (10.0)	57 (10.8)	0.64	2 (5.4)	1 (2.7)	0.56	51 (10.3)	56 (11.4)	0.55
Q8	159 (30.0)	127 (24.0)	0.01	7 (18.9)	2 (5.4)	0.06	152 (30.9)	125 (25.4)	0.01
Q9	169 (31.9)	202 (38.1)	0.02	13 (35.1)	12 (32.4)	0.76	156 (31.6)	190 (38.5)	0.01
Q10	410 (77.5)	436 (82.4)	0.02	32 (86.5)	31 (83.8)	0.65	378 (76.8)	405 (82.3)	0.02
Q11	308 (58.1)	355 (67.0)	<0.001	27 (73.0)	33 (89.2)	0.09	281 (57.0)	322 (65.3)	<0.001
Q12	355 (67.0)	398 (75.1)	<0.001	29 (78.4)	31 (83.8)	0.48	326 (66.1)	367 (74.4)	<0.001
Q13	456 (86.0)	473 (89.3)	0.08	31 (83.8)	36 (97.3)	0.06	425 (86.2)	437 (88.6)	0.19
Q14	430 (81.1)	464 (87.6)	0.01	32 (86.5)	34 (91.9)	0.42	398 (80.7)	430 (87.2)	0.01
Q15	472 (89.1)	478 (90.2)	0.50	33 (89.2)	37 (100.0)	0.05	439 (89.1)	441 (89.5)	0.82
Q16	225 (42.5)	282 (53.2)	<0.001	22 (59.5)	32 (86.5)	0.01	203 (41.2)	250 (50.7)	<0.001
Q17	402 (75.9)	438 (82.6)	<0.001	32 (86.5)	35 (94.6)	0.26	370 (75.1)	403 (81.7)	0.01
Q18	449 (84.7)	467 (88.1)	0.06	32 (86.5)	35 (94.6)	0.18	417 (84.6)	432 (87.6)	0.03
Q19	274 (51.7)	323 (60.9)	<0.001	20 (54.1)	32 (86.5)	0.01	254 (51.5)	291 (59.0)	0.01
Q20	275 (51.9)	313 (59.1)	0.01	22 (59.5)	25 (67.6)	0.44	253 (51.3)	288 (58.4)	0.01