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1 **Vaccine hesitancy and self-vaccination behaviors among nurses in southeastern France**

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14

15 **Abstract N=298 (limit: 300)**

16 Background: Health care worker vaccine uptake rates are below official targets, and studies
17 demonstrate some are vaccine hesitant. We assessed self-vaccination behavior, vaccine
18 hesitancy (VH), and associated factors in a representative sample of nurses.

19 Methods: Cross-sectional questionnaire survey in 2017-18 in southeastern France (5 million
20 inhabitants): community nurses were randomly selected from a list provided by the Inter-
21 Regional Nurses' Council (stratified by gender and district of practice) and interviewed by
22 telephone. Because no such list exists for hospital nurses (74% of all nurses in southeastern
23 France), we randomly selected hospitals, taking their size into account and stratifying by
24 district. Hospital nurses practicing in medicine, surgery, obstetrics, and gynecology
25 departments and present at the time of the survey were included and interviewed face-to face.
26 We measured VH according to the WHO definition (refusal, delay, or acceptance with doubts
27 about at least one vaccine). Interviewers administered the questionnaires. We used
28 multivariable logistic regression to analyze potential associations between VH, vaccine risk
29 perceptions and trust in health authorities.

30 Results: Interviews were completed with 1539 nurses (response rate: 85%). Self-reported
31 vaccine coverage ranged from 27% (seasonal influenza vaccine, recommended, 2016/17
32 season) to 96% (Bacillus Calmette–Guérin vaccine, mandatory). The VH prevalence rate was
33 44% (95% confidence interval: 38.7–48.4) and most often concerned seasonal influenza or
34 A(H1N1) vaccines (54%) and the hepatitis B vaccine (18%). VH was significantly more
35 frequent among nurses with low trust in health authorities or high vaccine risk perceptions.

36 Conclusion: Nurses in southeastern France have low levels of self-vaccination acceptance for
37 most recommended vaccines. In addition, they have a high VH prevalence focused on the
38 same vaccines as among the general population. These are important findings given that

39 nurses are in regular contact with patients vulnerable to vaccine-preventable diseases and their
40 VH could negatively influence patients' vaccination acceptance.

41 **Keywords:** Health care workers; Vaccination perceived risks; Trust; Self-Vaccination
42 behavior; Vaccine hesitancy

43 **Introduction**

44 Like many other countries in the world, France faces a crisis of confidence in vaccination and
45 vaccines. The debate in France dates back to the 1990s when a controversy about an alleged
46 link between hepatitis B vaccination and multiple sclerosis led the Ministry of Health (MoH)
47 to stop a mass vaccination campaign in schools in 1998. Vaccine coverage against hepatitis B
48 in infants only attained the levels achieved in other European countries years later [1]. Since
49 then, several other vaccine controversies have spread into French media (print, broadcast, and
50 social), some initiated by physicians (e.g., concerning the human papilloma virus [HPV]
51 vaccine [2]). In 2016, almost 50% of parents of children were vaccine hesitant (VH) [3],
52 according to the WHO definition (delay in acceptance or refusal of at least one vaccine
53 despite availability of vaccine services) [4], one of the highest rates of VH documented in a
54 Western country [5]. One of its most prominent determinants appears to be the public
55 perception that the risks of vaccines exceed their perceived benefits [3,5].

56 Health care professionals (pediatricians, general practitioners [GPs], nurses, and pharmacists,
57 depending on the type of vaccination service and the country) play a pivotal role in explaining
58 vaccine benefits and risks, recommending vaccines, and vaccinating the population. They are
59 the cornerstone of maintaining vaccine acceptance. In France, most vaccines are prescribed by
60 GPs and then delivered by community pharmacies to patients, who take them to their GP or
61 nurse for administration. Nurses are not currently allowed to prescribe vaccines (except for
62 seasonal influenza vaccine in target groups), but they may discuss vaccination with patients.
63 Studies in various countries have shown that health care workers (HCWs) may, like the
64 general population, be vaccine hesitant [6–10]. This can affect their vaccine recommendation
65 behaviors toward patients and their ability to convince hesitant individuals.

66 Changes in the demography of HCWs are expected to modify their role in vaccination. The
67 French MoH has already decided to authorize community pharmacists to vaccinate at-risk

68 patients against seasonal influenza at their pharmacy, starting in autumn 2019, and is
69 considering allowing nurses to prescribe childhood vaccines as well as seasonal influenza
70 vaccine among adults. However, little is known about nurses' attitudes regarding vaccines in
71 France, and studies elsewhere, as in Quebec, show they may feel uncertain about their risks
72 [11–13]. At the same time, nurses' self-vaccination behavior regarding vaccines that are
73 recommended to HCWs, notably but not only that against seasonal influenza, has been shown
74 to be less than optimal in many countries [14–16]. As nurses already play an important role in
75 promoting vaccination and influencing patients' vaccination decisions in some countries and
76 may soon do so in others [17], it is important to understand their concerns about vaccination
77 for both patients and themselves.

78 We conducted a cross-sectional to study the behavior and attitudes towards vaccination and
79 vaccines among hospital nurses and community nurses [18]. It sought to describe and
80 quantify: 1) nurses' self-reported vaccination behaviors regarding mandatory and
81 recommended vaccination for themselves; 2) the prevalence of VH among them, according to
82 the WHO definition, and its associated factors, especially risk perceptions of vaccines and
83 trust of the MoH.

84 **Methods**

85 We conducted the survey from October 2017 to March 2018 in southeastern France (5 million
86 inhabitants). Its methods have been published elsewhere [19]. In brief, the study population
87 included community and hospital nurses who had been working in southeastern France for at
88 least three months before the survey started. Community nurses account for 26% of all nurses
89 practicing in this region and hospital nurses, 74%. We randomly selected community nurses
90 from the virtually exhaustive list for southeastern France provided by the Inter-Regional

91 Nurses' Council (CIROI), stratifying by gender and administrative *département* (district) of
92 practice.

93 Hospital nurses practicing in departments of medicine, surgery, obstetrics, or gynecology
94 were included. We excluded those working in emergency departments and intensive care
95 units because the feasibility of recruiting participants from these units is poor. We also
96 excluded temporarily employed nurses, students, and those on long-term sick leave. As no
97 reliable sampling database exists for hospital nurses, they were directly recruited onsite by
98 student nurses from eight partner Nursing Training Institutes (NTIs), to ensure geographical
99 representativeness. To identify the hospitals to be included, we randomly selected those in the
100 districts where these NTIs were located, taking into account the numbers of practicing nurses
101 in each hospital and stratifying by district. We included 17 hospitals of 160 eligible in
102 southeastern France [20]. In each hospital, all of the nurses at work during the study period
103 were invited to participate in the study.

104 We developed a standardized questionnaire based on a literature review and discussion with
105 nurses, experts in epidemiology, vaccination, and social sciences. We pilot-tested the
106 questionnaire for clarity, length, and face validity with 20 nurses and made only minor
107 changes afterwards. The questionnaire addressed: 1) nurses' professional characteristics; 2)
108 their self-reported behavior regarding vaccination for themselves: like all HCWs in France,
109 nurses are required to receive the Bacillus Calmette–Guérin (BCG), diphtheria-tetanus-
110 poliomyelitis (dTPolio) and hepatitis B vaccines [21]. Other vaccines are recommended for
111 them, specifically, those against seasonal influenza, pertussis, varicella, and measles, mumps
112 and rubella (MMR) [21]; 3) nurses' self-reported VH according to the WHO definition
113 (declining a vaccine considered dangerous or unnecessary; delaying a vaccine because of
114 doubts about it, accepting a vaccine despite doubts about its efficacy or safety [4]) and the
115 vaccines associated with it. The questionnaire also included the following items to be

116 answered on a 5-level Likert scale including a “don’t know” option: perceived risks of various
117 vaccines (perceived likelihood of causal links between severe adverse effects and certain
118 vaccines or vaccine components, 5 items, Table 4); trust in the MoH as a reliable source of
119 information on vaccination (1 item); and discussing risks and benefits of vaccines with their
120 patients as a proxy for interactions with patients about vaccination.

121 Data collection differed for community and hospital nurses. For the former, professional
122 interviewers conducted telephone interviews using computer-assisted telephone interview
123 software. For the latter, trained nursing students from the partner NTIs conducted face-to face
124 interviews, using the same questionnaire as that for community nurses.

125 The study complied with the data privacy laws of the National Commission for Informatics
126 and Civil Liberties and was approved by the Aix-Marseille University Ethics Committee.

127 Statistical analysis

128 We weighted data for age, gender, place of nurses’ practice (community or hospital) and its
129 geographical location (district) to match the nursing population in southeastern France.

130 Nurses were considered vaccine-hesitant if they answered “yes” to one at least of the three
131 items operationalizing the WHO definition of VH (see above); we used this definition to
132 construct a binary VH variable (Yes/No) [3]. We calculated a perceived vaccine risk score
133 (range (5;20); Cronbach’s alpha=0.72) by adding up nurses’ responses on the Likert scale to
134 the five questions about the perceived risks of various vaccines (Table 4).

135 Finally, we tested a logistic regression model adjusted for age, gender, and area of practice,
136 using binary VH status as a dependent variable to analyze its association with place of
137 practice (community versus hospital), the perceived vaccine risk score, and trust in the MoH.

138 All analyses were based on two-sided *P*-values, with statistical significance defined by $P \leq$
139 0.05, and conducted with SAS 9.4 statistical software (SAS Institute, Cary, North Carolina,
140 US).

141 **Results**

142 Four hundred community (response rate: 79%) and 1139 hospital nurses (87%) completed the
143 questionnaire (overall response rate: 85%); 84% were women. The mean age was 43, with
144 community nurses generally older and more frequently male than the hospital nurses (Table
145 1). Only 9% had attended a training session on vaccination in the past three years (hospital
146 nurses: 12%; community nurses: 2%) (Table 1).

147 Self-reported vaccination behavior

148 Among the mandatory vaccines, 96% of nurses reported having received the BCG vaccine,
149 73% the dTPolio booster vaccine in the past 10 years (it is recommended at 25, 45 and 65
150 years), and 61% three or more doses of the hepatitis B vaccine (at least one dose: 90.4%,
151 Table 2). Among the recommended vaccines, self-reported uptakes were: 58% for pertussis,
152 64% for measles, 39% for varicella, and 27% for seasonal influenza during the last season
153 (2016-17). Community nurses reported lower vaccination uptake than hospital nurses for all
154 vaccines except for varicella and seasonal influenza. Occupational physicians performed the
155 vaccinations for 55% of hospital nurses (versus 44% of community nurses).

156 Prevalence of VH and vaccines of concern

157 The VH prevalence rate among nurses was 44% (95% confidence interval [CI]: 38.7–48.4),
158 with more VH among hospital than community nurses (Table 3). Prevalence rates for those
159 who accepted vaccines while doubtful and those who declined vaccination were respectively
160 24% and 23%. The vaccines most frequently the object of VH were those against seasonal

161 influenza and the A(H1N1) pandemic (54% of nurses with VH), hepatitis B (18%), and HPV
162 (10%). VH extended to all vaccines for 2%.

163 Risk perception about various vaccines

164 A causal link between the hepatitis B vaccine and multiple sclerosis was considered likely or
165 very likely by 57% of the nurses (Table 4); the corresponding percentages were 34% for a
166 link between aluminum adjuvants and Alzheimer's disease, and 14% for a link between the
167 measles vaccine and autism. "Don't know" answers were frequent; 41% so responded about
168 the alleged link between measles vaccine and autism. The distribution of answers about links
169 between the hepatitis B vaccine and multiple sclerosis and between aluminum adjuvants and
170 Alzheimer's disease did not differ between hospital and community nurses. For the other
171 items (Table 4), "not at all" or "not very likely" answers were significantly more frequent
172 among community nurses than among hospital nurses while "don't know" answers were more
173 frequent among the latter. After adjustment for gender and place of practice, we found a
174 significant association between age and risk perceptions (i.e., considering that a link between
175 vaccination and severe adverse effects for hepatitis B and seasonal influenza vaccines is
176 likely). Compared with older nurses, the youngest nurses more frequently answered "I don't
177 know" for these two vaccines. For the seasonal influenza vaccine, the younger nurses also
178 believed that this link is likely more frequently than older nurses (Table S1).

179 Apart from risk perceptions, trust in the MoH as a reliable source of information about
180 vaccination benefits and risks was significantly higher among community than hospital nurses
181 ($P < 0.001$, Table 1).

182 In all, 26% of nurses stated that they often/always discussed risks and benefits of vaccines
183 with their patients. This percentage was significantly higher among community than hospital
184 nurses ($P < 0.001$, Table 1).

185 Factors associated with VH

186 VH prevalence was significantly higher in hospital than community nurses (public hospitals:
187 adjusted odds ratio, 95% confidence interval (aOR 1.39, 95%CI 1.07; 1.81, Table 5)); it
188 increased with the vaccine risk perception score (aOR 1.12; 95% CI 1.07; 1.17) and was
189 lower among nurses trusting the MoH (aOR 0.67; 95% CI 0.53; 0.86). VH prevalence also
190 decreased significantly as age increased but did not differ significantly according to gender.

191 **Discussion**

192 We found that nurses reported low uptake rates for themselves of vaccines recommended for
193 HCWs. Furthermore, our study, which is the first to address VH among French nurses,
194 showed a high prevalence of VH (44%), with hesitancy focused mainly on the vaccines
195 against seasonal influenza, hepatitis B, and HPV; VH was significantly and independently
196 more prevalent among hospital compared with community nurses and among those with high
197 vaccine risk perception or low trust in the MoH.

198 Our results are in line with those of previous articles about nurses' vaccine behaviors in
199 various countries, which have shown that uptake rates among nurses are most often below
200 health authorities' targets and lower than among physicians [14,22–25] (targets in France:
201 75% for seasonal influenza vaccine and 95% for the others [26,27]). Self-reported vaccine
202 uptake rates were especially low in our study for vaccines against seasonal influenza and
203 varicella. Moreover, our results for these vaccines are of the same order of magnitude as those
204 reported a decade ago [16], despite numerous information campaigns about influenza
205 vaccination aimed at hospital HCWs [28]. By contrast, we found an important increase in
206 vaccine uptake against measles and pertussis (Table 2) that suggests, at least for some
207 vaccines, that nurses' vaccine behaviors may be amenable to change.

208 The paradox of higher self-reported uptake rates for recommended vaccines among hospital
209 nurses than community nurses (except for the influenza vaccine) despite higher VH
210 prevalence among the former, as discussed below, may be explained by the easier access of
211 hospital nurses to occupational health services in their workplace. Access issues must also be
212 addressed when trying to reach vaccine coverage targets for HCWs [29]. On the other hand,
213 community nurses (who are self-employed) may choose to vaccinate themselves more
214 frequently against influenza than hospital nurses (who are salaried) to protect themselves from
215 falling ill and having to take time off work; unlike salaried workers, they do not receive sick
216 pay [19]. We have found similar results for private GPs compared to hospital physicians [30].

217 The hepatitis B vaccine has been mandatory for HCWs in France since 1991. The self-
218 reported uptake rate for a complete course of hepatitis B vaccination (65.8% for 3 doses or
219 more) in our study was very close to the self-reported rate observed 10 years earlier in another
220 study (65.7%, Table 2) [16]. Its authors demonstrated that this rate reflected a memory bias
221 regarding the number of injections received; they compared self-reported data to the number
222 of injections recorded in hospital occupational health files and found the latter approach
223 produced a 91% rate. The difference between the self-reported uptake rate for the boosters
224 against diphtheria-tetanus-poliomyelitis and the corresponding rate a decade earlier (Table 2)
225 may reflect, in part, the recommendation change in 2013 for adults [31]: since then, booster
226 injections are to be performed at fixed ages (25, 45, and 65 years) compared to the previous
227 recommendation of every 10 years.

228 The high VH prevalence among nurses in this study (44%) is close to the prevalence of VH
229 among parents of children found in 2016 in a nationwide study in France (42%) [3]. Both
230 groups' VH focused on the same three vaccines (against seasonal influenza, hepatitis B, and
231 human papilloma virus), in the same order of importance [32]. The high risk perception for

232 specific vaccines, strongly associated with nurses' VH (Table 5), echoes the numerous vaccine
233 controversies in France — most of which focused on these three vaccines and their safety —
234 and elsewhere (Wakefield controversy on measles vaccination in England) over the past two
235 decades. It is noteworthy that the impact of the hepatitis B vaccine controversy in the 1990s
236 [9] was still perceptible among more than half the nurses two decades later, as among the
237 French general population in 2016 [32] (Table 4). Neither the mandatory status of the
238 hepatitis B vaccine for HCWs — since 1991 — nor the large body of epidemiological
239 evidence against the claimed link between this vaccine and multiple sclerosis has allayed
240 persistent fears about its safety (Table 4). These results underscore the potential limitations of
241 vaccine mandates in view of the need to restore trust in some vaccines [33]. They also call
242 into question the adequacy of nurses' initial training and continuous education in the field of
243 vaccination and whether these provide them with the knowledge and skills necessary for their
244 practice. Our result that uncertainties and/or doubts about the safety of hepatitis B and
245 seasonal influenza vaccines were more frequent in young nurses than in older ones provides
246 some evidence that nurses' initial training in the field of vaccination is inadequate. Currently
247 in France, vaccination training for student nurses covers techniques of vaccine administration,
248 immunology, and the health benefits of vaccination. Once qualified, some may be offered an
249 online video (optional), funded by a pharmaceutical company, that addresses various myths
250 surrounding vaccination [34]. Our findings showed that only a small minority of nurses had
251 had continuing medical education in vaccines and vaccination in the three years before their
252 participation in our study.

253

254 Several hypotheses may explain the higher prevalence of VH among hospital than community
255 nurses. First, community nurses are more frequently involved in prevention and vaccination
256 tasks, as indirectly shown by their higher level of interactions with patients about vaccination.

257 Second, hospital nurses had a significantly lower level of trust in the MoH than did
258 community nurses. This might reflect their perceptions of the policy changes enacted by
259 successive governments to control hospital health expenses and their consequences on
260 hospital working organization and conditions [35]). Third, barriers to hospital nurses'
261 vaccination acceptance should be analyzed more holistically, that is, considering as well other
262 hospital HCWs' vaccination beliefs and behaviors, relationships between nurses and the other
263 HCWs, and the role of hospital administrators and patient behavior [36].

264 Strengths and Limitations

265 Our study has several strengths. First, it addresses the attitudes and behaviors of both
266 community and hospital nurses regarding vaccination, showing that they differ substantially.
267 Second, it enabled us to quantify VH prevalence among a large, representative sample of
268 nurses by methods allowing the comparison of VH levels between nurses and other
269 population groups [3]. Moreover, the questionnaire allowed nurses to specify their hesitancy
270 for individual vaccines.

271 This study has several limitations, however. It took place in southeastern France, which
272 accounted for only 7.5% of the national French population in 2018: caution is thus required
273 regarding the generalization of its results to France as a whole and to other countries.

274 Hospital nurses, because they were interviewed face-to-face by other (albeit, student) nurses,
275 may have been more guarded in their responses than community nurses, who were questioned
276 by professional interviewers on the telephone. A social desirability bias may thus be more
277 marked in the hospital compared with among community nurses; this might have induced
278 some underestimation of risk perceptions and VH among hospital nurses and reduced the
279 differences between them and community nurses. Such differences were nonetheless clear and
280 the main conclusions of our study are thus unlikely to be affected. Additionally, self-reported

281 behavior might overestimate vaccine uptake rates, although other studies have shown that the
282 size of this bias is limited for seasonal flu vaccination [37,38]. Inversely, however, a memory
283 bias is also possible, especially when people are asked about the number of injections they
284 have previously had of the same vaccine [16]. Finally, as we used a cross-sectional design, no
285 causal conclusion can be drawn from the associations found in the regression model in our
286 study.

287 **Conclusion**

288 Nurses in southeastern France had low levels of uptake for recommended vaccines and high
289 levels of VH; their risk perceptions and trust in the MoH differed systematically between
290 hospital and community nurses. These are important findings in view of the current
291 discussions at the French MoH to give nurses more responsibility for vaccination, as the
292 physician per population ratio declines [39] and in view of the major role nurses play in
293 vaccinating the population in other countries (including Canada, Australia, the USA, and the
294 UK) [17]. Measuring and understanding the determinants of VH among health care
295 professionals is a research priority in view of the need to address doubts and concerns among
296 health care providers themselves, for they play a crucial role in promoting vaccine acceptance
297 among patients [8,42].

298 Efforts should be devoted to reinforcing the study of vaccination in the curriculum of student
299 nurses. The results of our study may help in designing training tailored to nurses' perceptions
300 of vaccines and vaccination. Nonetheless, educational interventions on their own might not
301 improve vaccine uptake rates and vaccine acceptance among nurses [40]. This, and the fact
302 that pressure from above can lead to further rejection of vaccines, means that educational
303 initiatives should be coupled with empowering nurses through promoting decision-making
304 skills (integrated through training curricula, their work place, and further education) [41].

305 Finally, further research — especially qualitative — is needed to better understand nurses’
306 vaccination perceptions and to identify their specific vaccination concerns. This research is
307 necessary to design effective interventions specifically directed at nurses.

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321 **Conflicts of interest**

322 None to declare.

323 **Contributors' statements**

324 RW participated in results interpretation and drafted the manuscript; AZ, AN and LS
325 performed the statistical analysis and drafted the methods and results sections; AB, PC, CC,
326 SB and ED, participated in the design of the study and revised the manuscript; PV designed

327 the study and its questionnaire, coordinated the study and its analysis, and revised the
328 manuscript.

329

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1 **Tables**

2 Table 1. Demographic and professional characteristics, and exposure to vaccine-preventable
 3 diseases among nurses in southeastern France, n=1539.

	Community (n=400)		Hospital (n=1139)		All (n=1539)		P- value†
	N	w%	N	w%	N	w%	
Gender ^a							0.04
Male	71	19.4	116	14.9	187	16.1	
Female	329	80.7	1018	85.1	1347	83.9	
Age [22; 69 years] - mean (SD) ^b	395	45.6 (10.3)	1137	41.5 (12.2)	1532	42.5 (11.9)	<.0001
Experience [0; 48 years] - mean (SD) ^c	399	18.4 (11.3)	1136	15.1 (12.1)	1535	16.0 (12.0)	<.0001
Secondary/complementary activity in retirement home, nursing home, health facility	20	4.7	69	6.0	89	5.7	0.33
Specialty ^d	55	13.3	171	17.2	226	16.2	0.07
Professional training on infectious diseases and vaccination in the past 3 years ^e	7	1.8	151	12.1	158	9.4	<.0001
Discuss risks and benefits of vaccines with patients ^c							<.0001
Never	28	6.7	420	37.5	448	29.4	
Sometimes	134	33.8	529	47.2	663	43.7	
Often	141	36.3	130	10.5	271	17.2	
Always	97	23.3	45	4.0	142	9.0	
Don't know	0	0.0	9	0.8	9	0.6	
Trust the reliability of information provided by the Ministry of Health about vaccination ^f							<.0001
Distrust	21	5.8	135	13.3	156	11.3	
Distrust somewhat	65	15.4	203	16.9	268	16.5	
Trust somewhat	222	56.1	576	50.2	798	51.7	
Strongly trust	89	22.4	198	17.7	287	19.0	
Don't know	1	0.3	19	1.9	20	1.5	

4 Abbreviations. w% = weighted percentages. Boldface indicates percentages significantly higher than average

5 † Chi² tests.

6 ^a 5 missing values

7 ^b 7 missing values

8 ^c 4 missing values

9 ^d 1 missing value; specialty in anesthesia, operating room, health executive, else

10 ^e 9 missing values

11 ^f 10 missing values

12

13 Table 2. Self-reported vaccination coverage rates (nurses in southeastern France, n=1539)

	Community (n=400)		Hospital (n=1139)		All (n=1539)		2009 national data‡
	N	w%	N	w%	N	w%†	
BCG ^a						<i>P</i> =0.05	<i>P</i> =0.52
Yes	385	96.0	1087	96.3	1472	96.3	94.8
No	11	2.8	13	1.3	24	1.7	4.7
Cannot remember	4	1.2	28	2.4	32	2.1	0.5
Last diphtheria-tetanus-polio (dTPolio) booster ^b						<i>P</i> <.0001	<i>P</i> =0.012
<10 years	275	70.3	836	74.1	1111	73.1	85.4
10-20 years	67	16.9	148	12.5	215	13.6	
>20 years	19	3.5	19	1.6	38	2.1	4.2
No	6	1.7	0	0.0	6	0.5	
Cannot remember	33	7.6	127	11.9	160	10.8	10.4
Hepatitis B ^c						<i>P</i> <.0001	<i>P</i> =1.00
Yes, 3 or more doses	199	49.1	736	65.8	935	61.4	65.7
Yes, fewer than 3 doses	154	41.3	296	25.8	450	29.8	28.8
Not vaccinated	18	3.6	18	1.4	36	2.0	0.7
Cannot remember	25	6.0	73	7.1	98	6.8	4.8
Contraindication	4		8		12		-
Pertussis ^d						<i>P</i> <.0001	<i>P</i> <.0001
Yes, up to date	198	52.5	720	59.3	918	57.5	11.6
No	119	27.5	151	16.3	270	19.2	33.3
Cannot remember	83	20.1	256	24.5	339	23.3	55.1
Measles ^e						<i>P</i> <.0001	<i>P</i> =0.002
Yes	228	60.5	795	64.6	1023	63.5	42.0
No	148	34.5	214	24.1	362	26.9	12.3
Cannot remember	24	5.1	115	11.3	139	9.6	45.7
Varicella ^f						<i>P</i> =0.0002	<i>P</i> =1.00
Yes	49	50.8	232	36.5	281	38.5	36.7
No	30	30.7	308	52.8	338	49.7	3.7
Cannot remember	20	18.5	72	10.8	92	11.9	59.6
Not concerned (childhood experience of varicella)	301		513		814		-
Seasonal influenza during last season ^g						<i>P</i> <.0001	<i>P</i> =0.73
Yes	158	37.9	221	22.6	379	26.6	24.4
No	241	61.9	897	76.7	1138	72.8	75.6
Cannot remember	1	0.2	5	0.7	6	0.6	0.0

14 Abbreviations. w% = weighted percentages. BCG = Bacillus Calmette–Guérin. Boldface indicates percentages significantly
 15 higher than average

16 † Chi² tests were performed to compare community and hospital nurses self-reported vaccination coverage rates.

17 ‡ Source: Guthmann, 2011 (n=110, France, self-reported vaccination coverage rates among hospital nurses only). Chi² tests
18 were performed between hospital nurses from our study and the 2009 national data, testing each time the first modality
19 (respectively yes, <10 years, yes 3 or more doses, yes up to date, yes, yes, yes) against the other(s).
20 ^a 11 missing values in our study
21 ^b 9 missing values in our study
22 ^c 8 missing values in our study. In the 2009 national data, exclusion of nurses reporting experience of VHB infection in the
23 past; 5 missing values; when calculated from occupational health vaccination files, 90.9 % of nurses had received 3 or more
24 doses.
25 ^d 12 missing values in our study
26 ^e 15 missing values in our study. In the 2009 national data (at least one dose), exclusion of nurses reporting experience of
27 measles; N=48
28 ^f 14 missing values in our study. In the 2009 national data (at least one dose), exclusion of nurses reporting experience of
29 varicella; N=19
30 ^g 16 missing values in our study. Season 2016-2017 in our study, 2008-2009 in the 2009 national data.
31

32 Table 3. Prevalence and subjects of vaccine hesitancy according to the WHO SAGE
 33 definition (nurses in southeastern France, n=1539).

	Community (n=400)	Hospital (n=1139)	All (n=1539)	P-value†
	w % [95% CI]	w % [95% CI]	w % [95% CI]	
Declined a vaccine they considered dangerous or useless ^a	14.6 [11.1;18.1]	25.3 [21.1;29.6]	22.5 [18.4;26.6]	<.0001
Delayed a vaccine because of doubts about it ^b	8.4 [5.7;11.1]	8.6 [5.8;11.3]	8.5 [5.8;11.3]	0.91
Vaccinated despite doubts about its efficacy or safety ^c	20.6 [16.6;24.6]	25.4 [21.1;29.6]	24.1 [19.9;28.3]	0.06
Vaccine hesitancy (VH, defined as a 'yes' response to at least one of these three questions) ^d	34.8 [30.1;39.4]	46.7 [41.8;51.5]	43.6 [38.7;48.4]	<.0001
Main vaccines subject to VH ^e	w % (n=139)	w % (n=531)	w % (n=670)	
Seasonal influenza/A(H1N1)	47.5	55.8	54.1	0.08
Hepatitis B	27.2	15.8	18.1	0.002
Human papilloma vaccine	4.6	11.9	10.4	0.012
BCG	2.2	2.8	2.7	0.69
Meningitis	3.3	1.3	1.7	0.12
MMR	1.1	1.7	1.6	0.59
All vaccines	1.7	1.5	1.6	0.91
Pertussis	1.1	1.5	1.4	0.75

34 Abbreviations. Abbreviations. w% = weighted percentages. CI = confidence interval. BCG = Bacillus Calmette–Guérin.

35 MMR = Measles, mumps and rubella. Boldface indicates percentages significantly higher than average

36 † Chi² tests.

37 ^a 8 missing values

38 ^b 7 missing values

39 ^c 9 missing values

40 ^d 5 missing values

41 ^e Collected using an open-ended format

42 Table 4. Perceived likelihood of links between specific vaccines and potential severe adverse
 43 effects (nurses in southeastern France nurses, n=1539).

	Not at all likely	Not very likely	Somewhat likely	Very likely	Don't know	P-value†
	w%					
Hepatitis B vaccine & multiple sclerosis ^a						0.60
Community (n=400)	7.6	20.8	41.5	14.9	15.2	
Hospital (n=1139)	7.1	18.1	42.8	14.1	17.9	
All (n=1539)	7.3	18.8	42.5	14.3	17.2	
Aluminum adjuvants & Alzheimer's disease ^b						0.06
Community (n=400)	7.3	23.2	29.6	6.2	33.7	
Hospital (n=1139)	8.4	18.4	25.9	7.6	39.7	
All (n=1539)	8.1	19.7	26.9	7.2	38.1	
Human papilloma vaccine & multiple sclerosis ^c						0.03
Community (n=400)	9.6	29.2	23.3	4.2	33.7	
Hospital (n=1139)	9.3	22.5	22.4	6.1	39.8	
All (n=1539)	9.3	24.2	22.6	5.6	38.2	
Measles vaccine & autism ^d						0.001
Community (n=400)	19.1	31.6	11.1	2.3	35.8	
Hospital (n=1139)	22.4	21.1	10.6	3.5	42.4	
All (n=1539)	21.5	23.9	10.7	3.2	40.7	
Seasonal influenza vaccine & severe adverse effects ^a						<.0001
Community (n=400)	13.6	49.2	27.2	6.0	4.0	
Hospital (n=1139)	7.7	35.2	33.2	11.7	12.3	
All (n=1539)	9.2	38.8	31.6	10.2	10.1	

44 Abbreviations. w% = weighted percentages. Boldface indicates percentages significantly higher than average

45 † Chi² tests.

46 ^a 9 missing values

47 ^b 10 missing values

48 ^c 11 missing values

49 ^d 17 missing values

Table 5. Univariable and multivariable logistic regression analyses of factors associated with vaccine hesitancy (nurses in southeastern France, n=1539) †

	Vaccine hesitancy (ref. No)	
	Univariable	Multivariable
	(n=1539)	(n=1508 ^a)
	OR [95% CI]	ORa [95% CI]
Gender (ref. Female)		
Male	0.67 [0.49;520.92]	0.75 [0.53;1.04]
Age (ref. < 30 years)		
30-47 years	0.52 [0.40;0.68]	0.58 [0.44;0.76]
...> 47 years	0.44 [0.33;0.59]	0.47 [0.34;0.64]
Place of practice (ref. Community)		
Hospital	1.72 [1.36;2.18]	1.39 [1.07;1.81]
Strongly or somewhat trust the Ministry of Health as a reliable source of information about vaccination (ref. No)		
Yes	0.58 [0.46;0.72]	0.67 [0.53;0.86]
Score of perceived likelihood of links between vaccines and severe adverse effects [5;20]		
	1.15 [1.10;1.20]	1.12 [1.07;1.17]

† Unweighted data. Multivariable analyses adjusted on area of practice.

Abbreviations. OR [95% CI] = odds-ratio [95% confidence interval], aOR = adjusted odds-ratio. Boldface indicates statistical significance ($P \leq 0.05$)

^a 31 missing values.

Hosmer–Lemeshow goodness-of-fit test: $P > 0.05$. We found no issue of multicollinearity.