Understanding the factors influencing COVID-19 vaccine intention among French healthcare workers using the 7C psychological antecedents

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List of Abbreviations

HCW = healthcare worker(s)

COVID-19 = corona virus disease 2019

VH = vaccine hesitancy

HV = l'hesitation vaccinale

KA = knowledge & attitudes

K = knowledge

A = attitude

3C = Confidence, Complacency, Convenience

5C = Confidence, Complacency, Convenience, Calculation, Collective Responsibility

7C = Confidence in Vaccine, Confidence in System, Complacency, Convenience, Calculation, Collective Responsibility, Social Conformism

SPF = Santé Publique France (French Public Health)

USA = United States of America

DAG = directed acyclic graphs

OR = odds ratio

R2 = pseudo R squared

GERES = Research Group for the Prevention of Occupational Infections in Healthcare Workers

CHU = Centre Hospitalier Universitaire

GDPR = General Data Protection Regulation

HPV = Human Papilloma Virus

SM = Supplementary Material

Abstract

Background

Healthcare workers (HCW) are a priority group to vaccinate against COVID-19 to prevent disease-related absenteeism and nosocomial infection. The start of the COVID-19 vaccination campaign among HCW in France offered an opportunity to explore the antecedents of vaccine hesitancy (VH), in particular their extension from the 5C model (complacency, confidence, convenience, calculation, collective responsibility) to a 7C model, including social conformism and confidence in the system and the how much individual items explain VH within socio-professional demographic determinants. Furthermore, understanding the role of knowledge in vaccine intention.

Methods

We developed a knowledge and attitude (KA) questionnaire with 30 items relating to the 7 components of psychological antecedents. The questionnaire was administered online among a snowballing sample of French healthcare workers, recruited in December 2020-January 2021 through professional organizations. We used multivariate logistic regression to explore the association of 7C components and individual KA items with COVID-19 vaccine intention. For alternative analyses, knowledge items were grouped into a separate knowledge score to see the effects of knowledge separate from the attitude items. A mediation analysis was conducted to evaluate which KA-7C items can explain socio- professional demographic determinants of COVID-19 vaccine intention.

Results

Among the 5234 participants, the vaccine intention model fits (pseudo R-squared values) ranged from $R2=0.48$ for Calculation to $R2=0.07$ for Convenience, with $R2=0.29$ for Confidence in System and $R2=0.26$ for Social Conformism. In nested models including the initial 5C components, adding Confidence in System increased the model fit significantly from $R2=0.60$ to 0.61 ($p<0.001$), and Social Conformism from $R2=0.60$ to 0.62 ($p<0.001$). In multivariate models including a shortlist of 15 items, the strongest association with vaccine intention was observed for a positive attitude on the vaccine's benefit-risk balance (strongly agree vs. strongly disagree: odds ratio 16.81, 95%-confidence interval 9.66-29.25). In a 7C model without the knowledge items, adding a knowledge score did not increase the model fit substantially (both $R2=0.64$). In mediation analyses keeping the basic model of socio- professional determinants, 98.2% COVID-19 vaccine intention in nursing assistants compared to nurses could be explained by including collective action to stop the epidemic and the professional environment opinion. Meanwhile, 95.6% of vaccine intention in medical professionals were explained by 10 items.

Discussion

The results suggest that social conformism and confidence in the system are essential independent antecedents of VH, knowledge does not have as strong of an influence, and which items in the KA-7C antecedents explain COVID-19 vaccine intention. These results can aid in better understanding the psychological antecedents that influence VH against COVID-19 vaccination among HCW.

Key Words: COVID-19 vaccine, vaccine hesitancy, healthcare workers

Résumé en français :

Contexte

Les soignants (HCW) sont un groupe prioritaire à vacciner contre la COVID-19 pour éviter l'absentéisme dû à la maladie et les infections nosocomiales. Le début de la campagne vaccinale contre la COVID-19 parmi les soignants en France, représente une opportunité pour explorer les antécédents de l'hésitation vaccinale (HV), spécifiquement par l'extension du modèle 5C (complaisance, confiance, commodité, calcul, et responsabilité collective) à un modèle 7C, comprenant conformisme social et confiance dans le système et combien chaque éléments expliquent HV dans les catégories socio- professionnel. En outre, comprendre le rôle des connaissances dans l'intention vaccinale.

Méthodes

Nous avons développé un questionnaire de connaissances et d'attitudes (KA) avec 30 objets relatifs aux sept composantes des antécédents psychologiques de l'hésitation vaccinale. Le questionnaire a été administré en ligne par "*effet boule de neige*" à des soignants français, recrutés entre 18 décembre 2020 – 1 février 2021 par des organisations professionnelles. Nous avons utilisé des régressions logistiques multivariées pour explorer l'association des composantes 7C et d'items KA individuels avec l'intention vaccinale contre la COVID-19. Les éléments de connaissance ont été regroupés dans un score a part, afin d'observer les effets de connaissance séparés des éléments d'attitude. Une analyse de médiation a été réalisée pour évaluer quels items KA-7C expliquaient les déterminants socio- professionnels démographiques de l'intention vaccinale de COVID-19.

Résultats

Parmi les 5234 participants, le pourcentage de variance d'intention de COVID-19 expliquée par des composantes (fit, valeurs pseudo R carré) allait de $R^2=0.48$ pour calcul à $R^2=0.07$ pour la complaisance, avec $R^2=0.29$ pour la confiance dans le système et $R^2=0.26$ pour le conformisme social. Dans les modèles imbriqués comprenant les premières composantes 5C, ajouter confiance dans le système a augmenté le fit de manière significative de $R^2=0.60$ à $R^2=0.61$ ($p<0.001$), et conformisme social de $R^2=0.60$ à $R^2=0.62$ $p<0.001$). Dans des modèles multivariés comprenant une sélection de 15 items, les associations les plus fortes avec l'intention vaccinale ont eu une influence positive sur la balance risque-bénéfice du vaccin (tout à fait d'accord vs pas du tout d'accord : OR 16.81, 95%-CI 9.66-29.25). Dans un modèle 7C sans les items de connaissance, ajouter le score de connaissances n'a augmenté le fit du modèle (les deux $R^2=0.64$). Les analyses de médiation gardent le modèle basique des déterminants socio-professionnels, 98.2% l'intention vaccinale de COVID-19 était expliquée par

l'action collective à arrêter l'épidémie et l'opinion de l'environnement professionnel. Entre-temps, 95.6% d'intention vaccinale était expliquée par 10 objets.

Discussion

Les résultats suggèrent que le conformisme social et la confiance dans le système sont des antécédents essentiels et indépendant de la HV contre la vaccination du vaccin COVID-19, que les connaissances n'ont pas une influence essentielle, et que les antécédents de KA-7C expliquent l'intention vaccinale de COVID-19. Ces résultats peuvent contribuer à une meilleure compréhension des facteurs et antécédents psychologiques de l'HV VH et appuyer la promotion vaccinale.

Les mots clé : COVID-19 vaccin, hésitation vaccinale, soignants

INTRODUCTION

Vaccination is a main tool to respond to the current pandemic of COVID-19 affecting the world in various areas. Healthcare workers (HCW) are among the priority groups in most countries, to provide them protection given their continuous exposure, protect the health care system from absenteeism and prevent nosocomial transmission of Sars-Cov-2 [1]. In France, COVID-19 vaccination has been proposed to HCW starting from January 2021, initially based on age and risk factors, then to the end of spring without any conditions. At the end of May 2021, the COVID-19 vaccine coverage for at least one dose among HCW in France was estimated at 95.2% [2], but this figure is likely an overestimate due to imputation of retired HCW and non-HCW and may in fact be below 70%. Because there may be differences in uptake between professional categories [3], it will be important to understand and follow-up vaccine hesitancy (VH) against COVID-19 vaccination.

The term VH was coined to describe the sentiment of delay in acceptance or refusal towards vaccination despite availability [4]. France has had a history with VH and some of it is connected to the distrust of the systems involved in vaccination [5]. Even among healthcare workers, general practitioners are seen as reliable sources but not necessarily vaccine experts; thereby, having their own reasons to be skeptical of vaccines [6]. In a study done in the general population in the USA, a majority of people were likely to get a vaccine when recommended by their healthcare provider [7]. The role of a HCW in the vaccination process is influential, and there are varying degrees of hesitancy among the healthcare professions [3]. For example, nurses are more likely to be hesitant about vaccines than medical doctors [8].

In order to better understand the source of VH, it is important to consider the psychological aspects of human behavior and choice. Thus, the 3C psychological antecedents [4] were developed as a tool to describe sources of VH and to evaluate interventions to mitigate it. The original three components were *confidence* (the system that delivers them, including the reliability and competence of the health services and health professionals), *complacency* (need of the vaccine given its effectiveness and severity of the disease), and *convenience* (accessibility to the vaccine) [4]. Betsch et al proposed an expanded 5C model including two additional C antecedents: *calculation* (risks and benefits for taking the vaccine), and *collective responsibility* (sense of altruism towards vaccinating) [9].

Based on recent observations around vaccine decisions, we propose to add *social conformism* as a sixth C antecedent. Taking decisions by imitating peers is known as an important heuristic that helps reduce mental load in daily life [10]. For example, in religious environments, concerns towards vaccine safety or theological based objections were pertinent

within a community of those with VH [9]. Several discrete choice experiments described higher theoretical acceptance in scenarios presenting higher coverage in the community [11,12,13].

Our second variable is about epidemic management, we examine whether the confidence component should be split into creating a seventh C antecedent – specifically during the current epidemic vaccine response situation – into confidence in the vaccine itself and confidence in the overall public or governmental system [14]. In previous cases, governments can mandate vaccines within the population as seen in school admissions. The United States of America allows each state to declare their own rules on immunization, and in California a signed consent from parents declaring religious beliefs as the reason is sufficient without further questioning to opt out of required vaccination [15]. This implies that people can claim to have religious beliefs as the main reason even though it could hide other factors such as governmental mistrust or lack of confidence in the vaccines. In France, the COVID-19 vaccine is not mandatory, but understanding what motivates people to opt in or opt out in taking the vaccine may be connected to governmental distrust. Among French healthcare workers, the distrust could be connected to the lack of funding from the government in hospitals and mishandling of previous scandals from governmental agencies [16].

The third objective is to determine which of the items within the C antecedents and to what extent those items explain COVID-19 vaccine intention. This can expose the possible mediator relationship with socio- professional determinants on vaccine intention. Since there are differences in vaccine intention by professional categories [3], by testing for mediation, we could achieve better precision in understanding what C antecedent items explains vaccine intention among professionals. This could in fact aid in health promotion from a public health standpoint. As HCWs maintain a vital role in administering vaccines as well as treating patients, exposing the items that best explain the intention on COVID-19 vaccination could be used to better cater and improve the information socio- professional demographic groups are receiving on vaccines.

A fourth objective was to evaluate the role of knowledge. Knowledge is a key aspect targeted by most vaccine promotion interventions. However, its influence on vaccination may be less important than attitudes and opinions, as emphasized by health promotion concepts such as the health belief theory [17] and COM-B [18]. In the COM-B model, vaccination can be applied as the behavior with a split between individual and contextual influences [18]. Knowledge would be considered as part of the known capabilities to execute behavior while attitudes would play a role in the actual motivation. Though this study focuses on intention rather than uptake, intention could lead to a behavioral action towards vaccination. By grouping the 7C items into knowledge and attitude (KA) attributes in the questionnaire, we can measure the items that influence COVID-19 vaccine intention.

The roll-out of COVID-19 vaccination among HCW in France provided an opportunity to study how the additional psychological antecedents influence vaccine intention, the extent to which the C antecedent items explain vaccine intention, and to discriminate the role of knowledge and attitudes. Likewise, the mediation analysis will help specify what aspects within the KA-7C antecedents best influence COVID-19 vaccine intention among socio- professional demographic groups and could also be replicated to help with vaccine promotion within specific populations among HCW. These results could aid in targeting HCW in COVID-19 vaccine promotion and possibly be utilised in applying the concepts of the KA-7C antecedents on other demographics such as the general population or even other countries.

METHODS

Participant inclusion

Between December 18, 2020 through February 1, 2021, the Research Group for the Prevention of Occupational Infections in Healthcare Workers (GERES) published an online questionnaire through the Sphinx online survey platform, which was disseminated throughout France by different healthcare networks. All French regions were considered, including the overseas departments, albeit the latter contributed to a small representation. Through the "snowball sampling" effect, the questionnaire reached a total of 9580 participants of diverse health-related careers and sectors. Since participants forwarded the questionnaire across their own networks, response rate could not be estimated.

Data Collection

Participants varied in representing all regions within France including the overseas territories from ages 18 and older. The study period was divided into three phases: Period 1 (18 December, 2020 - 4 January, 2021), Period 2 (5 January, 2021 - 14 January, 2021), and Period 3 (15 January, 2021 - 1 February, 2021).

The questionnaire itself consisted of three parts where the first and third parts of the survey collected socio- professional demographic and health-related characteristics of the participants and intention to accept and recommend the COVID-19 vaccination. Following the general characteristic questions, the second part of the survey directed participants between a discrete choice experiment, or the present KA-7C questionnaire by choosing a shape (square or triangle). The KA-7C questionnaire received 5234 participants in response. Anticipated and effective survey completion time was approximately 8 minutes.

Item Development & Questionnaire:

The knowledge and attitude (KA) questionnaire was based on the 3C and 5C Psychological Antecedents presented by (MacDonald et al., 2015) and (Betsch et al., 2018) respectively. Based on recent evidence, two additional dimensions of antecedents were added: Social Conformism [11,12,13] and Confidence in Systems as a dimension separate from Confidence in Vaccines [8].

Each antecedent consisted of at least one attitude and knowledge question. In total, the KA-7C questionnaire had 30 questions; 9 questions were associated with the attitude towards the vaccine and the delivering systems, 19 were associated with the knowledge about the vaccines, their development and COVID-19, while the final 2 were general attitude questions.

Attitude items were evaluated using 5-point Likert-scales. Where needed, attitude items were reduced to a 3-point scale (do not agree / do not know / agree) for simplicity of presentation. However, regression models included the 5-point Likert scale for precision. Knowledge items were evaluated using either a statement with "right/ do not know / wrong" appreciation or a single choice from several options with "do not know". For analysis, knowledge variables were coded as an incorrect answer, a does not know response, and a correct answer. Two general attitude questions were included to assess the confidence in epidemic management and worry about the COVID-19 epidemic, evaluated on an 11-point scale and transformed for analysis in three categories (low 0-3, medium 4-6, high 7-10).

Data Analysis:

We used bivariate logistic regression models to explore the association of participant characteristics and individual KA items with vaccine intention. We explored vaccine intention both through the original three-level variable (yes / do not know / no) and a two-level variable (yes / no or do not know).

To identify socio- professional and health-related determinants of vaccine intention, we included variables with P-value <0.20 in bivariate regression into a multivariate logistic regression model using a stepwise forward procedure (basic model). We evaluated collinearity between the KA-7C items using the *collin* command in STATA. For variables with variance inflation factor (VIF) >2, we conducted pairwise Spearman correlation testing and considered any correlation with rho <0.70 as not critical.

In addition, logistic regression models including different combinations of KA items according to their grouping in 7C dimensions were constructed. We first defined the fit of each 7C component item group individually. Then included 7C components stepwise into a full model, in descending order according to their individual pseudo R-squared values. Significant contribution of each component was assessed based on the nested log likelihood ratio test. We

examined the contribution of each 7C dimension to vaccine intention (fit) based on pseudo R-squared values.

To construct the mediation analysis, the association between the socio- professional-demographic determinants and COVID-19 vaccination was neutralised by KA-7C individual items in stepwise models and visually drawn using directed acyclic graphs (DAGs) (**Figure 1**). The determinants were assumed as confounders to account for possible recruitment effects which could have influenced exposure. Once we had identified the items that best neutralised the association per determinant, mediation was evaluated using the *ldecomp* command which we chose due to its ability to evaluate multiple mediators in logistic models. The outcome of COVID-19 vaccine intention was limited to a binary output (yes vs do not know/no).

Figure 1: KA-7C items in a mediation model diagram adjusted for socio- professional demographic confounders. The odds ratio represents the association between the determinants (exposure) on COVID-19 vaccine intention (outcome).
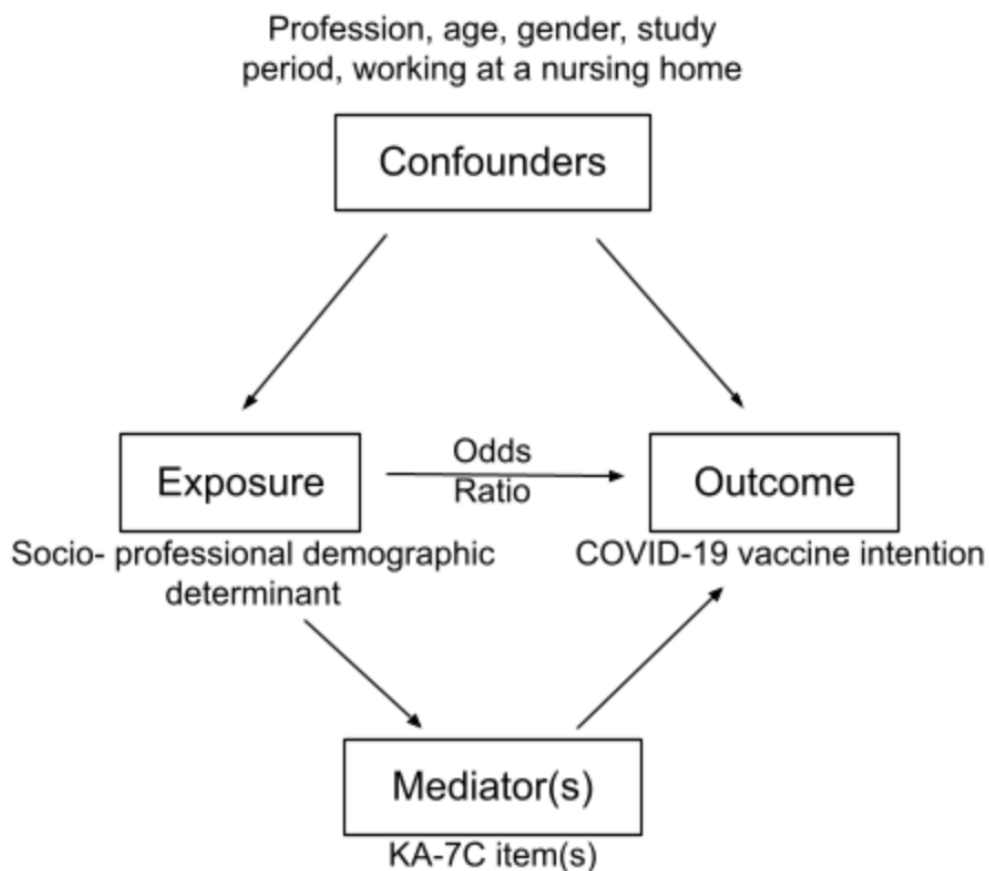
We constructed a knowledge score based on all 19 knowledge items. Knowledge variables were summed up (correct = 2 points, do not know = 1 point, incorrect = 0 points) to

create the variable "knowledge score" (**Figure 3**). The knowledge score variable was included in a logistic regression model as an added item to the existing attitude items. The contribution was assessed through the pseudo R-squared values comparing the 7C model with only attitude items and the 7C model with the knowledge score added at the end (**Table 2**).

We defined a shortlist of 15 KA-7C items, selecting two items per 7C component (one attitude and one knowledge item) based on R-squared values. We analyzed a final, full multivariate logistic regression model based on the shortlist items in 5-point Likert format (**Table 3**).

STATA/IC 16.1 software was used for data analysis.

Ethics

The study protocol was approved by the Institutional Review Board "Terre d'Ethique" of CHU St Etienne (N° IRBN1092021/CHUSTE) and the database was registered by EHESP French School of Public Health according to the General Data Protection Regulation (GDPR) regulation. Because the data collection was observational, collected no sensitive and only self-declared biomedical information, no informed consent nor ethical review was required according to French law (loi Jardé). Participants visiting the study website saw the complete study information and had to agree to study participation before starting the questionnaire. Study participation was anonymous without any risk of indirect identification.

RESULTS

Participants

Among the 5234 participants assigned to the KA-7C questionnaire (54.6%), all completed the questionnaire with similar distribution across the periods defined by roll-out of the vaccination campaign: 38.7%, 30.9% and 30.4% (**Table 1**). Women represented 78.4% of participants and 23.2%, 40.0% and 36.8%, respectively, were aged 18-34 years, 35-49 years and ≥50 years. Nurses represented 22.9%, nurse assistants 9.4%, biomedical professionals (including midwives, pharmacists and biologists) 27.7%, paramedical 15.7%, and administration 24.4% **(Table 1)**. Working at least part-time in a nursing home was reported by 24.7%. Among participants, 53.1% reported vaccination against flu during the 2019-20 winter season and 58.1% indicated intending to get vaccinated against COVID-19, while 19.8% did not know yet (**Table 1)**. The variable on receiving the previous flu vaccine in 2019 – 2020 was not included in the basic model to avoid overfitting.

All regions were significant in the bivariate analysis except for Guadeloupe, Martinique, La Reunion, Occitanie, and Pays de la Loire (**Table 1**). It is also noted that of the 3 participants

from Corse, all participants have the intention of getting the COVID-19 vaccine. Among the study periods, it is evident in the results that the intent to take the COVID-19 vaccine increased in HCW (**Table 1**).

Table 1: Socio- professional demographic determinants among 5234 French Healthcare Workers.

Socio- professional demographic determinants			Intention COVID-19		Bivariate
			No/DNK	Yes	Yes vs DNK/No
		N(%)	N(%)	N(%)	OR (95% CI)
	18 - 34	1215 (23.2)	681 (56.1)	534 (44.0)	ref
	35 - 49	2091 (40.0)	932 (44.6)	1160 (55.5)	1.59 (1.38 - 1.83)**
Age (years)	50+	1927 (36.9)	578 (30.0)	1349 (70.0)	2.98 (2.56 - 3.46)**
	Female	4103 (78.4)	1889 (46.0)	2214 (54.0)	ref
Gender	Male	1131 (21.6)	302 (26.7)	829 (73.3)	2.34 (2.03 - 2.71)**
	Nurses	1197 (22.9)	603 (50.4)	594 (49.6)	ref
	Nurse Assistants	491 (9.4)	341 (69.5)	150 (30.6)	0.45 (0.36 - 0.56)**
	Other Paramedicals	819 (15.7)	407 (49.7)	412 (50.3)	1.03 (0.86 - 1.23)
	Bio-Medical Professionals	1449 (27.7)	287 (19.8)	1162 (80.2)	4.11 (3.46 - 4.88)**
Profession	Admin/technical	1278 (24.4)	553 (43.3)	725 (56.7)	1.33 (1.14 - 1.56)**
	No	4429 (84.6)	1766 (39.9)	2663 (60.1)	ref
Nursing Home	Yes	805 (15.4)	425 (52.8)	380 (47.2)	0.59 (0.51 - 0.69)**
	1	2026 (38.7)	1113 (54.9)	913 (45.1)	ref
Period	2	1618 (30.9)	574 (35.5)	1044 (64.5)	2.22 (1.94 - 2.54)**

	3	1590 (30.4)	504 (31.7)	1086 (68.3)	2.63 (2.29 - 3.01)**
Flu Vaccine in 2019 - 2020	No	2457 (46.9)	1460 (59.4)	731 (26.3)	ref
	Yes	2777 (53.1)	998 (40.6)	2046 (73.7)	4.10 (3.65 - 4.61)
	Auvergne Rhone-Alps	1,017 (19.43)	470 (46.2)	547 (53.8)	5.24 (1.13 - 24.5)*
	Burgogne-Franche-Comté	197 (3.76)	60 (30.5)	137 (69.5)	10.27 (2.15 - 48.99)**
	Bretagne	434 (8.29)	170 (39.2)	264 (60.8)	6.99 (1.49 - 32.73)*
	Centre-Val de Loire	79 (1.51)	21 (26.6)	58 (73.4)	12.43 (2.48 - 62.26)**
	Corse	3 (0.06)	0 (0.0)	3 (100.0)	1.00
	Grand Est	324 (6.19)	100 (30.9)	224 (69.1)	10.08 (2.14 - 47.50)**
	Guadeloupe	3 (0.06)	1 (33.3)	2 (66.7)	9.00 (0.52 - 155.24)
	Guyane	11 (0.21)	9 (81.8)	2 (18.2)	ref
	Hauts-de-France	662 (12.6)	298 (45.0)	364 (55.0)	5.50 (1.18 - 25.63)*
	Île-de-France	598 (11.43)	242 (40.5)	356 (59.5)	6.62 (1.42 - 30.90)*
	La Réunion	2 (0.04)	1 (50.0)	1 (50.0)	4.50 (0.19 - 106.82)
	Martinique	4 (0.08)	1 (25.0)	3 (75.0)	13.50 (0.88 - 207.61)
	Normandie	256 (4.89)	78 (30.5)	178 (69.5)	10.27 (2.17 - 48.63)**
	Nouvelle-Aquitaine	446 (8.52)	137 (30.7)	309 (69.3)	10.15 (2.17 - 48.63)**
	Occitanie	314 (6.00)	168 (53.5)	146 (46.5)	3.91 (0.83 - 18.39)
Region	Pays de la Loire	532 (10.16)	295 (55.5)	237 (44.6)	3.62 (0.77 - 16.89)

Provence-Alps-Côte d'Azur	352 (6.73)	140 (39.8)	212 (60.2)	6.81 (1.45 - 32.01)*

*p-value <0.05 ** p-value < 0.01   ***p-value < 0.001

OR: odds ratio; DNK: Does not know

Contribution of 7C components to model fit

In individual models, all 7C components contributed significantly (log likelihood tests all P<0.05) but at various levels to the explanation of COVID-19 vaccine intention. Model fits (pseudo R-squared values) ranged from R2=0.48 for Calculation to R2=0.07 for Convenience (**Figure 2**). The additionally proposed components contributed significantly with a fit of R2=0.29 for Confidence in System and R2=0.26 for Social Conformism (**Figure 2**). In nested models including the initial 5C components, adding Confidence in System increased the model fit significantly from R2 0.60 to 0.61 (p < 0.001), and Social Conformism from R2 0.60 to 0.62 (p < 0.001) (**Table 2**).

Figure 2: Fit of regression models explaining vaccine intention: Individual contribution from 7C components. Pseudo R-squared values obtained from multivariate regression models including vaccine intention and items from a given C component (including knowledge items).
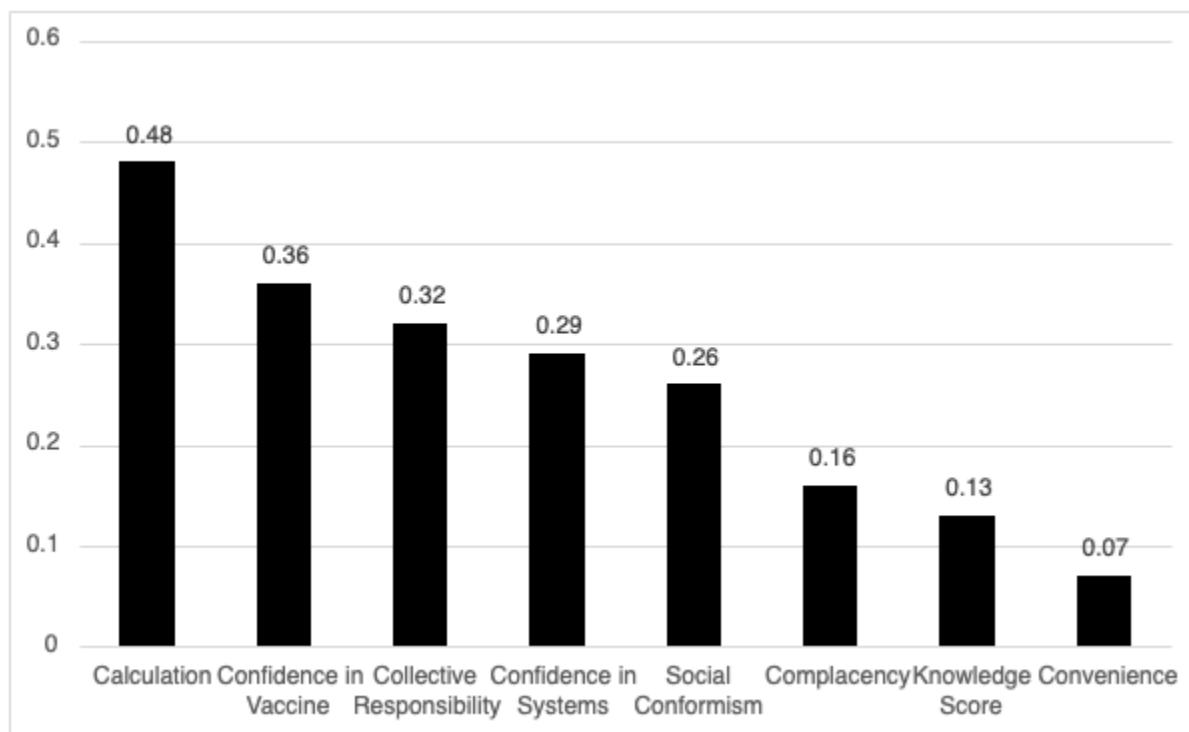
Table 2:

Model	R2
7C Long version 5P with knowledge items separated into a knowledge score	0.64
7C Shortlist version with 5-Point Likert Scale *	0.64
5C Shortlist version 5P without Social Conformism and Confidence in System	0.60
5C Shortlist version 5-Point Likert Scale with Social Conformism	0.62
5C Shortlist version 5-Point Likert Scale with Confidence in System	0.61

*questionnaire retained for further analysis

The knowledge scores ranged from 0 to 36 with a median of 28 and slight skew to the right (**Figure 3**). Compared to a 15 item 7C model with 5-point Likert scale, adding the knowledge score did not increase the model fit substantially (both R2=0.64) (**Table 2**).

Figure 3: Knowledge Score Distribution
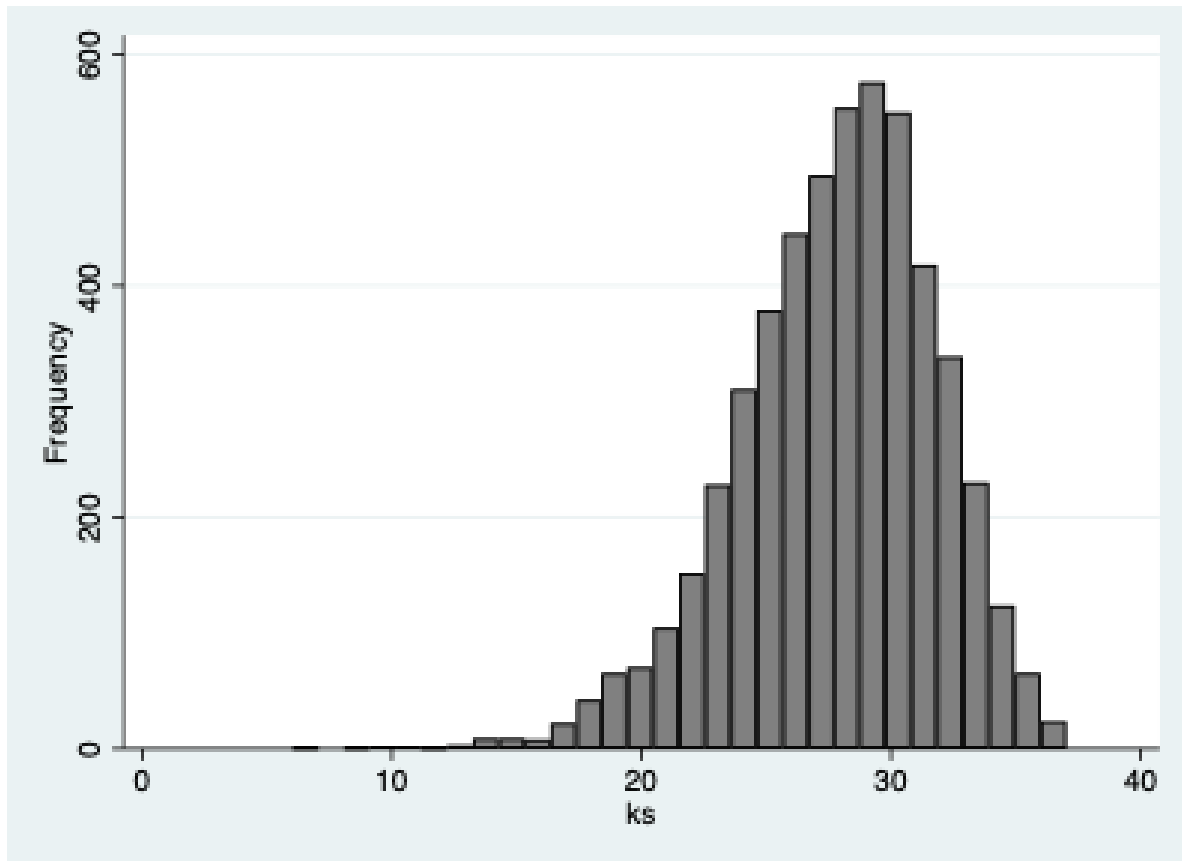
*ks = knowledge score

Items' association with vaccine intention

In individual analyses adjusting for socio- professional demographic characteristics, all KA items were significantly associated with COVID-19 vaccine intention, except for knowledge items, severe side effects beyond 6 months, Report side effects, Obesity risk, and worry about the epidemic (**Table 3**). No critical collinearity between KA-7C variables was identified. The maximum VIF observed was 2.42 for the attitude towards the benefit risk ratio in getting the COVID-19 vaccine and 2.24 for vaccination as a collective action to stop the epidemic, with a correlation of rho=0.67.

In a full model including the shortlist KA-7C items and adjusting for socio- professional demographic characteristics, the strongest associations were observed for a positive attitude on the vaccine's benefit-risk balance (strongly agree vs. strongly disagree, OR 16.81, 95%-CI 9.66-29.25), fear of a severe side effect (strongly agree vs. strongly disagree, OR 12.47 (7.80-19.92) and a very favorable majority opinion among family and friends (vs. very skeptical, OR 11.02 (4.19-29.01) (**Table 3**).

Table 3: Shortlist of 15 KA-7C items on a 5-point Likert scale by intention to get vaccinated (yes vs. no do not know) at the start of the COVID-19 vaccination campaign among 5324 healthcare workers in France. Full multivariate model adjusting for socio- professional demographic determinants.

KA-7C item			Intention COVID-19		Full multivariate model (Yes vs DNK/No)
			No/DNK	Yes	
		N (%)	N (%)	N (%)	OR (95% CI)
Confidence in Vaccine					
I am afraid of having a severe side effect of vaccination.	Strongly disagree	1203 (23.0)	127 (10.6)	1076 (89.4)	12.36 (7.76 - 19.70)***
	Disagree	1341 (25.6)	245 (18.3)	1096 (81.7)	10.52 (7.02 - 15.79)***
	Undecided	959 (18.3)	418 (43.6)	541 (56.4)	4.87 (3.30 6 7.17)***
	Agree	891 (17.0)	652 (73.2)	239 (26.8)	2.19 (1.48 - 3.24)***
	Strongly agree	840 (16.1)	749 (89.2)	91 (10.8)	ref
	False (i)	92 (1.76)	79 (85.9)	13 (14.1)	ref

The security of vaccines is monitored not only at the national level, but also in collaboration between other European countries.	DNK	855 (16.3)	596 (69.7)	259 (30.3)	1.43 (0.42 - 4.84)
	True (c)	4287 (81.9)	1516 (35.4)	2771 (64.6)	2.20 (0.66 - 7.29)

Confidence in Systems

If my employer incites me to get vaccinated, this …	Dissuades me	274 (5.2)	247 (90.2)	27 (9.9)	ref
	Has no effect	3409 (65.1)	1695 (49.7)	1714 (50.3)	2.71 (1.45 – 5.06)
	Motivates me	1551 (29.6)	249 (16.1)	1302 (84.0)	6.41 (3.36 – 12.22)
Some stages of vaccine development (control) have been skipped due to the epidemic emergency.	False (c)	2252 (43.0)	399 (17.7)	1853 (82.3)	2.36 (1.73 - 3.22)**
	DNK	2023 (38.7)	1071 (52.9)	952 (47.1)	2.02 (1.50 - 2.71)**
	True (i)	959 (18.3)	721 (75.2)	238 (24.8)	ref

Complacency

I am afraid of getting a severe form of COVID-19.	Strongly disagree	1109 (21.2)	528 (47.6)	581 (52.4)	ref
	Disagree	1524 (29.1)	673 (44.2)	851 (55.8)	1.28 (0.94 - 1.73)
	Undecided	1222 (23.4)	488 (39.9)	734 (60.1)	1.38 (0.96 - 1.93)
	Agree	796 (15.2)	284 (35.7)	512 (64.3)	1.88 (1.30 - 2.71)**
	Strongly agree	583 (11.1)	218 (37.4)	365 (62.6)	2.76 (1.76 - 4.33)**
The gravity of the epidemic requires making vaccines quickly available.	False (i)	411 (7.9)	331 (80.5)	80 (19.5)	ref
	DNK	513 (9.8)	387 (75.4)	126 (24.6)	1.73 (0.97 - 3.12)
	True (c)	4310 (82.4)	1473 (34.2)	2837 (65.8)	1.72 (1.05 - 2.82)*

Convenience

	Strongly disagree	2429 (46.4)	772 (31.8)	1657 (68.2)	ref

In practice, it will be difficult for me to get vaccinated.	Disagree	1386 (26.5)	610 (44.0)	776 (56.0)	0.93 (0.72 - 1.20)
	Undecided	765 (14.6)	436 (57.0)	329 (43.0)	0.60 (0.44 - 0.81)**
	Agree	361 (6.9)	182 (50.4)	179 (49.6)	1.08 (0.71 - 1.65)
	Strongly agree	293 (5.6)	191 (65.2)	102 (34.8)	0.71 (0.41 - 1.22)
It is necessary to have 2 injections to be immunized. *	False (i)	159 (3.0)	98 (61.6)	61 (38.4)	ref
	DNK	524 (10.0)	372 (71.0)	152 (29.0)	0.76 (0.38 - 1.51)
	True (c)	4551 (87.0)	1721 (37.8)	2830 (62.2)	1.14 (0.62 - 2.09)

Calculation

I think that vaccination against COVID-19 will have more benefits than risks for me.	Strongly disagree	496 (9.5)	437 (88.1)	59 (11.9)	ref
	Disagree	670 (12.8)	603 (90.0)	67 (10.0)	0.74 (0.42 - 1.31)
	Undecided	1136 (21.7)	841 (74.0)	295 (26.0)	1.33 (0.80 - 2.20)
	Agree	1205 (23.0)	242 (20.1)	963 (79.9)	6.39 (3.82 - 10.67)**
	Strongly agree	1727 (33.0)	68 (3.9)	1659 (96.1)	16.97 (9.78 - 29.47)**
For a person with risk factors, these vaccines have more benefits than risks in the current epidemic situation. *	False (i)	148 (2.8)	124 (83.8)	24 (16.2)	ref
	DNK	875 (16.7)	700 (80.0)	175 (20.0)	0.76 (0.32 - 1.81)
	True (c)	4211 (80.5)	1367 (32.5)	2844 (67.5)	0.87 (0.37 - 2.00)

Collective Responsibility

Getting vaccinated will also be a collective action to stop the crisis due to the epidemic.	Strongly disagree	253 (4.8)	231 (91.3)	22 (8.7)	ref
	Disagree	318 (6.1)	297 (93.4)	21 (6.6)	0.70 (0.28 - 1.73)
	Undecided	686 (13.1)	620 (90.4)	66 (9.6)	0.71 (0.33 - 1.55)
	Agree	1222 (23.4)	612 (50.1)	610 (49.9)	2.35 (1.12 - 4.93)*

	Strongly agree	2755 (52.6)	431 (15.6)	2324 (84.4)	5.04 (2.44 - 10.43)**
The vaccine blocks transmission of the virus to those around you in case of infection. *	False (c)	781 (14.9)	1095 (41.7)	1531 (58.3)	0.91 (0.67 - 1.22)
	DNK	1827 (34.9)	820 (44.9)	1007 (55.1)	0.95 (0.69 - 1.30)
	True (i)	2626 (50.2)	276 (35.3)	505 (64.7)	ref
Social Conformism					
Among your family and friends, how would you describe the majority opinion towards COVID-19?	Very favorable	390 (7.5)	8 (2.1)	382 (98.0)	11.57 (4.51 - 29.67)**
	Favorable	1418 (27.1)	199 (14.0)	1219 (86.0)	4.42 (2.70 - 7.22)**
	Both skeptical and favorable	1653 (31.6)	701 (42.4)	952 (57.6)	2.28 (1.43 - 3.63)**
	Skeptical	1319 (25.2)	897 (68.0)	422 (32.0)	1.59 (0.99 - 2.56)
	Very skeptical	454 (8.7)	386 (85.0)	68 (15.0)	ref
Do you know the approximate percentage of healthcare workers who intend to get the vaccine?	30% (i)	1743 (33.3)	906 (52.0)	837 (48.0)	ref
	DNK	2064 (39.4)	937 (45.4)	1127 (54.6)	1.14 (0.89 - 1.46)
	60% & 90% (c)	1427 (27.3)	348 (24.4)	1079 (75.6)	1.41 (1.07 - 1.86)*

*p-value <0.05 ** p-value < 0.01   ***p-value < 0.001
OR: odds ratio; DNK: does not know
(i): incorrect knowledge item response
(c): correct knowledge item response
Confidence: Confidence in the authorities to managed the health and economic crisis due to COVID-19
Worry about epidemic: Worry about Covid-19 epidemic in France
* These questions were introduced as follows: "For the most advanced COVID-19 vaccines (close to licensure), the scientific data show that …"

Mediation Analysis

When adjusted for the socio- professional demographic determinants, the items of vaccination being a collective action to stop the epidemic and the professional environment opinion explained 98.2% of the lower COVID-19 vaccine intention among nursing home workers (compared to other professional settings) **(Table 4)**. Similarly, 96.2% of the lower COVID-19

vaccine intention among nurse assistants (vs. nurses) was explained by Vaccination as a collective action to stop the epidemic and fear of a side effect **(Table 4**). Ten KA items explained 95.6% of the higher COVID-19 vaccine intention among medical professionals (vs. nurses). And 98.8% of the higher COVID-19 vaccine intention among men (vs. women) was explained by perceiving more benefits than risks with the vaccine, fear of a side effect, and believing there is higher efficacy in the COVID-19 vaccine compared to the flu vaccine.

Table 4: Mediation analysis of socio- professional demographic determinants among 5234 healthcare workers in France. Odds ratios of the basic model then in a final model with the KA items that best explain the association between the determinant and the COVID-19 vaccine intention.

Basic Model: period + profession + age categories + working at a nursing home + gender

Determinant	KA-7C item	OR (95% CI)	% Explained
Nursing Home vs others			
	Including Professional environment opinion	1.07 (0.89 - 1.28)	72.1
	Including Collective action to stop epidemic	0.99 (0.80 - 1.23)	70.0
Final Model	Including Collective action to stop epidemic + professional environment opinion	1.14 (0.92 - 1.43)	98.2
Period (2 & 3 vs 1)			
	Including family environment opinion	1.56 (1.33 - 1.81) & 2.03 (1.71 - 2.40)	56.8 & 56.1
	Including professional environment opinion	1.63 (1.40 - 1.91) & 2.15 (1.83 - 2.52)	44.6 & 44.5
	Including fear of a side effect	1.69 (1.42. - 2.00) & 2.32 (1.95 - 2.77)	55.0 & 47.7
	Including family environment opinion + professional environment opinion + fear of a side effect	1.34 (1.12 - 1.61) & 1.53 (1.26 - 1.86)	82.7 & 79.2
	Including family environment opinion + professional environment opinion + fear of a side effect + two doses + vaccine coverage among HCWs	1.23 (1.01 - 1.48) & 1.36 (1.11 - 1.65)	86.8 & 83.5

Final model	Including family environment opinion + professional environment opinion + fear of a side effect + two doses + vaccine coverage among HCWs + fear of a severe form of COVID-19 + severe side effects after 6 months	1.19 (0.98 - 1.45) & 1.34 (1.09 - 1.64)	89.6 & 86.5
Nursing Assistants vs Nurses			
	Including fear of a side effect	0.64 (0.48 - 0.85)	63.4
	Including collective action to stop epidemic	0.67 (0.49 - 0.91)	68.1
Final Model	Including Collective action to stop epidemic + fear of a side effect	0.96 (0.67 - 1.34)	96.2
Medical Professionals (vs Nurses)			
	Including fear of a side effect + collective action to stop the epidemic + confidence in authorities to manage health and economic crisis + professional environment opinion + family environment opinion	1.09 (0.84 - 1.43)	93.4
	Including fear of side effect + collective action to stop the epidemic + confidence in authorities to manage health and economic crisis + employer influence + professional environment opinion + family environment opinion + vaccine coverage among HCWs + higher efficacy than flu vaccine	1.03 (0.78 - 1.34)	95.1
Final Model	Including Fear of a side effect + collective action to stop the epidemic + confidence in authorities to manage health and economic crisis + employer influence + professional environment opinion + family environment opinion + vaccine coverage among HCWs + higher efficacy than flu vaccine + worry about epidemic + severity of epidemic	1.00 (0.76 - 1.32)	95.6
Gender (Female vs Male)			
	Including more benefits than risks with the vaccine + fear of a side effect + EU securely monitoring vaccines	1.01 (0.80 - 1.28)	95.9
	Including more benefits than risks with the vaccine + fear of a side effect + higher efficacy than flu vaccine + EU securely monitoring vaccines	0.97 (0.76 - 1.22)	98.8
Final Model	Including More benefits than risks with the vaccine + fear of a side effect + higher efficacy than flu vaccine	0.98 (0.77 - 1.23)	98.8

DISCUSSION

In this cross sectional study in a snow-ball sample of French healthcare workers exploring the antecedent of COVID-19 vaccine intention and hesitancy, we found that Social Conformity was an essential sixth component to vaccine intention, in addition to the 5-component model previously presented [9]. Additional precision in explaining vaccine intention could be gained by adding Confidence in Systems as a separate component, beyond Confidence in Vaccines. The full 7C-questionnaire with a knowledge score explained 64% of the variance in vaccine intention, while across the seven components, most explanatory power came from attitude items with limited contribution from knowledge items (**SM Table 1)**.

In Social Conformism, the description of the majority opinion on COVID-19 vaccination among colleagues or family and friends was strongly associated with vaccine intention of the individual healthcare worker. The perception of the social norm in vaccine intention among healthcare workers is influential as it affects their colleagues and the circle in which each professional treats their patients [19]. Vaccination is a socially influenced process, and through *homophily* (self-selected association to similar people) [19] those who intend to vaccinate will likely be in a social network with those who share the same sentiments and vice versa. In another perspective, choosing not to vaccinate may foster a sense of exclusion from being able to partake in certain activities [20] and could be seen in the talks for vaccine passports among the European Union and abroad. Vaccination can be seen as a social contract where vaccinating is considered morally correct [21]. This may then foster negative judgement in those who do not partake in the morally upright action, in this case vaccination. However, it could also motivate those who were hesitant to be more inclined.

Our results are in concordance with previous reports of discrete choice experiments, where the presentation of higher community level vaccine coverage was associated with more frequent theoretical acceptance among HCW (seasonal flu and pertussis) [13], parents and adolescents (Human Papilloma Virus, HPV) and university students [12]. This interaction with the social environment may be even more important among healthcare workers, as they are the bridge between public health decisions and patients, thereby influencing vaccine uptake in the population. Furthermore, in an American study, patients are more likely to take a vaccine when recommended by their healthcare provider [7]. The heuristic concept of *imitating-your-peers* [10] might be something to further explore in promoting vaccination among healthcare workers. In our results the percentage of HCWs who believed the majority of their peers would be vaccinated with the COVID-19 vaccine were more inclined to get vaccinated (OR 1.41 CI-95% 1.07 - 1.86) (**Table 3**). Likewise, within the professional groups, doctors are more likely to get the COVID-19 vaccine compared to nurses. Personality types and other factors may influence HCW when choosing their profession within the healthcare field. It would be interesting to take a

further step to understand the personality groupings that fall behind the KA-7C items that explained vaccine intention. Taking into account local cultures and group norms, creating chain effects within social networks could help normalize vaccination. Research on vaccine hesitancy should therefore increasingly address specific milieus, professional categories and social networks.

During this COVID-19 epidemic, confidence in national authorities in general has become an important individual characteristic dividing societies [14] and impacting adherence to epidemic control measures and vaccine intention. We addressed this aspect in two ways: confidence in authorities with regard to COVID-19 crisis management and perception of a vaccine recommendation from the employer. Several reports have suggested that negative perception of healthcare working conditions are related to flu vaccine uptake [22] and getting the flu vaccine is a strong indicator for vaccination in general [8,23]. HCW play a crucial role between public health officials and the general population. However, healthcare workers are not vaccinology experts and are aware of how little they know of the vaccine and the inability to answer some of the patients' questions [24].

As put by Ward et al, the relationship between public health authorities/agencies and healthcare workers have degraded over the last 30 years along with depleting funding for public hospitals in France have not helped the perception of the systems providing the vaccines [16]. While vaccination in the general population can be brought in distance to political power by insisting on the individual medical decision, ongoing discussions on vaccine mandates for HCW – often supported by hospital managers and medical doctors - can be seen as the solution or as an aggravating factor for the problem of suboptimal vaccine coverage among HCW. In the general American population, the regulation of mandatory vaccines varies by state and allows for exemption through religious beliefs [15]. One option that could be used is the structural intervention of "opting-out" rather than "opting-in" to target vaccination uptake specifically [20]. Aspects of the 7C psychological antecedents may always be at play in varying levels within the population's vaccine intent and uptake, but by using governmental systems to incorporate known human behavior and biases into the policies [20] items within the Confidence in Systems could lean towards positive vaccine uptake. Further research is needed to evaluate how far such general, not vaccine-related societal trust should be taken into account as a separate antecedent of hesitancy on other recommended vaccines. This leads to the question of ethics and ideology to be considered in the decision of making particular vaccines compulsory [20].

Knowledge items played a small role in explaining COVID-19 vaccine intention. Healthcare workers in our sample were a heterogeneous group with education ranging from below the French baccalaureate with specific professional training to 6 years of medical training.

The frequently observed gradient in flu vaccine uptake between professional categories has led to the conclusion that categories with short educational duration need more information on vaccines. Previous vaccine promotion among French healthcare workers therefore have focused on campaigns by organizing meetings to deliver scientific messages and answer any questions [25]. Continuing vaccine promotion through scientific messages in organised meetings should be maintained especially for the groups that might need more information. For example, in the more hesitant professional groups, such as nursing assistants, using the attitude that vaccination stops the epidemic through collective action and the fear of a side effect may be better targeted in continuation of these organised meetings. Since the meetings could take place in a professional setting, questions and incorrect information could be corrected in a group setting. Knowledge could help assuage the fear of the unknown, and these meetings could do that. However, it may also be better to continue the meetings with a mixed group of professions, so that one group would not feel targeted or perceive a negative form of peer pressure. In addition, public health experts tend to think that lack of knowledge might be conducive to VH among French healthcare workers [16], while attitudes may be more important-albeit also more challenging - to influence. Knowledge could actually be used to influence attitudes instead of VH directly, but a more practical use of this would need to be further studied to see the influence of using knowledge on attitudes as a feasible method towards VH and uptake.

In a previous study looking at the general population, better knowledge about the vaccine and less acceptance of conspiracy theories were associated with higher COVID-19 vaccine acceptance [23] while education level was not consistently associated with believing vaccine misinformation across countries [26]. However, social psychology research has been insisting on the fact that better knowledge alone does not lead to greater motivation for behavior change, but that attitude may be a stronger guide for behavior [27,28]. Social marketing research has addressed this problem and suggested that nudges could allow presenting information in a way that helps influencing attitudes.

We found a high overall capacity (64%) of this 7C-questionnaire to explain COVID-19 vaccine intention among healthcare workers. In comparison, socio- professional demographic differences explained a much smaller proportion of variation (14%), which is surprising given the observation that vaccine coverage against flu and currently COVID-19 consistently differs to large amounts between socio-professional groups. The KA-7C items explain COVID-19 vaccine intention more than the socio- professional demographic determinants.

Through the mediation analysis, we found that the KA-7C items explained almost entirely some of the socio- professional demographic gradient of COVID-19 vaccine intention.

When compared to nurses, nurse assistants who are known as a hesitant group, could explain 96.2% of their lower COVID-19 vaccine intention through attitude items, vaccinating as a collective action to stop the epidemic and fear of an adverse effect. Likewise, among the ten items that explained 95.6% of the intention in medical professionals, nine were attitude items. Gender was explained by 3 items, and more benefits than risks with the vaccine might attest to the fact that men are more likely to take risks than women. Grouping HCW by these determinants can help public health specialists target populations by using psychological influences that could improve VH. This could guide health promotion to focus on targeting attitude items rather than knowledge items to promote vaccination.

Though our study focuses on French healthcare workers, taking into consideration cultures may influence the beliefs and attitudes towards vaccines, the epidemic, and the systems that distribute them. For example the idea of incentivization could tap into a reward mindset within the population. In the United States, some incentives that have been used to promote vaccination among the population targets the reward system. Things such as a free donut and coffee from Krispy Kreme [30] and the ability to no longer need a mask according to the Centers for Disease Control and Prevention's (CDC) new rules starting from the end of May [31] entice Americans who could have been hesitant to the vaccine. The incentives to remove the mask, travel, and return to social gatherings may need to be promoted more to remind people of the perks to taking the COVID-19 vaccine.

Morally speaking, incentives could border the line for coercion which could backfire [16]. With using a reward system, there often is a downfall with a sense of "punishment." For those who are not vaccinated for COVID-19, the liberty to partake in normal, social activities diminishes thereby enforcing a sense of exclusion [9]. Using incentives within hospitals for example or within professional groups could to an extent help, but may only prove to be effective in individual groups.

Another aspect within social marketing, could use psychological aspects to convince HCW and the rest of the population to discuss their vaccination behavior. For example, one study saw that people were more likely to vote in the US elections when they were aware that they would have to discuss their voting behavior [32]. Hence, the power of the "I voted" stickers were introduced to reward voters with a colorful memento to share to their social groups that they had partook in a socially acceptable behavior. Again, culture would play in part to how social marketing would target the population. In France, wearing badges that say "I'm vaccinated" was dissuasive on vaccine acceptance among HCWs [3]. Thus, the incentives that may work for one population may not work in another. Perhaps by changing the sentiments of

getting the COVID-19 vaccine towards a positive collective action, the incentive of being accepted could acknowledge both Social Conformism and Calculation and be more convincing.

Improving the relationship between the government and public health industries would take time and be more challenging to tackle. However, with improved communication, there could be a better connection between vaccine experts, healthcare professionals, and the governmental departments that execute the plans. Regarding the incentives, public health offices and the government can continue to send messages that focus on the positives in receiving the COVID-19 vaccine such as no longer needing to wear a mask and traveling to see loved ones.

Our study has some limitations. Firstly, the study evaluates COVID-19 vaccine intention, but not eventual uptake. A considerable gap between vaccine intention and uptake exists [33], even though attitude appears to be a strong predictor on intention [34]. Thus by looking at the factors that influence intention, we can at least contribute to explaining the thought process regarding health decisions as suggested in the Health Belief Model [17], the COM-B model [18] and the Theory of Planned Behavior [31]. In Theory of Planned Behavior, intention is a result of attitudes towards vaccination, social influences and self-efficacy [35]. Therefore, intention would still be a good indicator for eventual vaccine uptake. Secondly, there is selection bias since the participants who volunteered through the system would likely be favorable to receiving the COVID-19 vaccine. However, the study does not focus on prevalence of intent but on factors associated to it; this analysis is thus less prone to be impacted by selection bias [36]. Thirdly, the data collection took place at the start of the vaccine campaign in France, during a period of constant publication of new information regarding vaccine effectiveness and safety at national and international level. This aspect is likely of limited impact on our results, as our final model accounts for the periods of survey participation and no controversy or safety concern emerged during the study period. Furthermore, this is not an analysis of a psychological model, which would require different methodologies such as structural equation models or latent classes.

CONCLUSION

Despite these limitations, our study provides evidence that including Social Conformity and Confidence in Systems to form a 7C-vaccine hesitancy antecedent model adds more precision in explaining vaccine intention even within professional groups and that knowledge items are not strong predictors. Future interventions to increase vaccination and decrease VH could use these psychological antecedents to better target respective audiences. Especially within HCW, professional categories that are more hesitant could have the items that affect their COVID-19 vaccine intention the most pinpointed using the results from this study. Possibly even

using incentives that better suit the population based on determinants in this study and eventually including other aspects such as culture and religion. Though knowledge has proved to not be as strong of an influence on vaccine intention as attitude items, psychologically known biases and still using knowledge to target those who are more prone to misinformation could still improve eventual uptake. The key would be to use knowledge as a part of the decision making process to take the vaccine. The results contribute to public health promotion for vaccines as the tactics can shift more towards influencing attitudes towards vaccines rather than solely focusing on knowledge. Though it may not be tangible to change attitudes, using knowledge as an indirect path to influencing attitudes could eventually lead to less vaccine hesitancy and higher uptake. These findings can help improve diagnostics of COVID-19 vaccine hesitancy among French healthcare workers, but possibly also in other population groups, countries and for other vaccines.

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Appendix

SM Table 1. Full KA-7C questionnaire in French with English Translations

Français	Anglais	Short name	Knowledge or attitude item	*Incorrect (0 points)*	*DNK (1 points)*	*Correct (2 points)*
1. J'ai peur d'avoir un effet secondaire grave après une vaccin.	I am afraid of having a severe side effect from the vaccination.	Fear of a severe side effect	A			
2. Des considérations économiques pourraient conduire à une recommandation de vaccins insuffisamment évalués.	Economic considerations could lead to a recommendation of insufficiently evaluated vaccines.	Economic reasons for insufficiently evaluated vaccines	A			
3. J'ai peur de faire une forme grave de Covid-19.	I am afraid of getting a severe form of COVID-19.	Fear of severe form of COVID-19	A			
4. En pratique, il me sera difficile de me faire vacciner.	In practice, it will be difficult for me to get the vaccine.	Difficult to access vaccine	A			
5. Je pense que la vaccination contre la Covid-19 aura plus de bénéfices que de risques pour moi.	I think that vaccination against COVID-19 will have more benefits than risks for me.	More benefits than risks with the vaccine	A			
6. Se faire vacciner sera aussi une action collective pour arrêter la crise liée à l'épidémie.	Getting vaccinated will also be a collective action to stop the crisis due to the epidemic.	Collective action to stop the crisis	A			

7. Si mon employeur m'incite à me faire vacciner, cela …	If my employer makes me get the vaccine...	Employer influence	A			
8. Dans votre entourage professionnel, comment décririez-vous l'opinion majoritaire envers la vaccination COVID-19?	In your professional environment, how would you describe the majority opinion towards COVID-19 vaccination?	Professional environment opinion	A			
9. Dans votre entourage familial et amical, comment décririez-vous l'opinion majoritaire envers la vaccination Covid-19?	In your familial and personal environment, how would you describe the majority opinion towards COVID-19?	Family environment opinion	A			
Les affirmations suivantes expliquent-elles la rapidité inhabituelle du développement des vaccins Covid-19 ?	*The next affirmations explain the unusually rapid development of COVID-19 vaccines?*					
10. Avec des nouvelles technologies génétiques, on peut facilement formuler de nouveaux vaccins.	With new genetic technology new vaccines can easily be developed.	Genetic technology (easily develop new vaccines)	K	FALSE	DNK	TRUE
11. La gravité de l'épidémie nécessite de disposer	The gravity of the epidemic requires	Severity of epidemic	K	FALSE	DNK	TRUE

rapidement d'un vaccin.	making vaccines quickly available.					
12. Des étapes d'évaluation (de contrôle) des nouveaux vaccins ont été supprimées à cause de la situation épidémique.	Some stages of vaccine development (control) have been skipped due to the epidemic emergency.	Skip control steps of vaccine development	K	TRUE	DNK	FALSE
13. En France, qui peut signaler un effet secondaire après vaccination	In France, who can report a side effect after vaccination?	Report side effects	K	Only Doctors	All health professionals	Both professionals & patients
Les affirmations suivantes sont-elles vrai ou faux?	*The next affirmations are true or false?*					
14. La sécurité des vaccins est surveillée non seulement au niveau national, mais aussi de façon collaborative entre les pays d'Europe	The security of vaccines is monitored not only at the national level, but also in collaboration between other European countries	EU monitoring vaccine security	K	FALSE	DNK	TRUE
15. Les effets secondaires graves peuvent se déclarer plus de six mois après la vaccination.	Severe side effects could appear beyond 6 months after vaccination.	Severe side effects past 6 months	K	TRUE	DNK	FALSE
Pour la fin d'année 2020, indiquez pour les situations suivantes le niveau	*For the end of the year 2020, indicate for the next situations the level*					

de risque de s'infecter avec le virus Sars-CoV-2. *of risk of infection with the SARS-COV-2 virus.*

16. Prendre une pause déjeuner ou un apéritif entre collègues soignants dans le service.	Taking a lunch break or an apéro with colleagues in the service.	Lunch Risk	K	Low Risk	Medium Risk	High Risk
17. Toucher du matériel (ordinateur, téléphones) sans réaliser l'hygiène des mains.	Touching materials (computer, phone) without applying hand hygiene protocols.	Touch Risk	K	Low		Medium/High Risk
18. En cas d'accident d'exposition au sang.	In case of accidental exposure to blood.	Blood Risk	K	High Risk	Medium Risk	Low Risk
19. Assister à un évènement festif d'environ 30 personnes.	Assisting in a festive event of 30 people.	Event Risk	K	Low Risk	Medium Risk	High Risk
20. L'obésité est un facteur de risque de forme grave à tout âge	Obesity is a risk factor at all ages.	Obesity Risk	K	FALSE	DNK	TRUE
21. Le facteur de risque principal d'une forme grave est l'âge à partir de 50-60 ans.	The principal risk factor of a severe form of COVID is age beyond 50-60 years.	Age Risk	K	FALSE	DNK	TRUE
22. Des symptômes prolongés (fatigue, trouble d'odorat, anxiété) sont	Prolonged symptoms (fatigue, trouble smelling,	Long COVID-19	K	FALSE	DNK	TRUE

fréquemment rapportés.	anxiety) are frequently reported.						
23. A votre avis, pour une personne de 50 ans, le risque d'admission en réanimation ou de décès suite à une COVID-19 est d'environ.	In your opinion, someone over 50 years old has the risk of being admitted into the ICU.	ICU Risk for over 50	K	0.10%	DNK	1% & 10 %	
Concernant les vaccins contre la COVID-19 les plus avancés (en voie d'autorisation), les données scientifiques montrent que …	*Concerning vaccines against COVID-19, the most. advanced (in the process of authorization), scientific data shows that...*						
24. … l'efficacité de ces vaccins est plus élevée que celle des vaccins contre la grippe.	The efficacy of getting the vaccine for COVID-19 is higher than for the flu vaccine.	Higher efficacy than flu vaccines	K	FALSE	DNK	TRUE	
25. … pour les personnes avec facteur de risque, ces vaccins ont plus des bénéfices que de risques dans la situation épidémie actuelle.	For a person with risk factors, these vaccines have more benefits than risks in the current epidemic situation.	More benefits than risks for people with risk factors	K	FALSE	DNK	TRUE	
26. … ces vaccins bloquent la	The vaccine blocks transmission of the	Vaccine blocks transmissions	K	TRUE	DNK	FALSE	

transmission du virus à l'entourage en cas d'infection.	virus to those around you in case of infection.						
27. ... il faudra deux injections pour être vacciné(e).	It is necessary to have 2 injections to be vaccinated.	Necessary to have two doses	K	FALSE	DNK		TRUE
28. Connaissez-vous le pourcentage approximatif des soignants en France ayant l'intention de se faire vacciner contre la COVID-19, selon des sondages récents?	Do you know the approximate percentage of healthcare workers who will get the vaccine?	Vaccine coverage among HCWs	K	30%	DNK		60% & 90%
29. Sur une échelle de 0 à 10 : Globalement, l'épidémie de Coronavirus (COVID-19) en France vous inquiète-t-elle ?	Globally, the coronavirus (COVID-19) epidemic in France worries you?	Worry about the COVID-19 epidemic	A				
30. Sur une échelle de 0 à 10, quelle confiance accordez-vous aux autorités pour gérer la crise sanitaire et économique liée à la Covid-19?	On the scale from 0 – 10, how much confidence do you have in the authorities for managing the sanitary and economic crisis	Confidence in epidemic management	A				

linked to COVID-19?

A: attitude; K: knowledge.

SM Table 2. Distribution of responses to KAP by intention to get vaccinated (No & DNK vs Yes) at the start of the COVID-19 vaccine campaign among 5324 French healthcare workers.

Long questionnaire version reduced from the original 5-point to a 3-point Likert scale for simplicity of presentation.

KAP 7-C		Intention COVID-19		Bivariate	Individual item models adjusting for determinants
		No/DNK	Yes	(Yes vs DNK/No)	(Yes vs DNK/No)
		N (%)	N (%)	OR (95% CI)	OR (95% CI)
Confidence in Vaccine					
I am afraid of having a severe side effect of vaccination.	Disagree	372 (14.6)	2172 (85.4)	4.51 (3.81 - 5.34)**	3.63 (3.04 - 4.33)**
	Undecided	418 (43.6)	541 (56.4)	0.18 (0.15 - 0.22)**	0.21 (0.17 - 0.25)**
	Agree	1401 (80.9)	330 (19.1)	ref	ref
With new genetic technology new vaccines can easily be developed.	False (i)	409 (75.7)	131 (24.3)	ref	ref
	DNK	1068 (56.0)	840 (44.0)	2.46 (1.98 - 3.05)**	2.54 (2.00 - 3.21)**
	True (c)	714 (25.6)	2072 (74.4)	9.06 (7.31 - 11.23)**	7.58 (6.01 - 9.58)**
In France, who can report a side effect after vaccination?	Only Doctors (i)	242 (49.7)	245 (50.3)	ref	ref
	All Health Professionals	217 (37.4)	363 (62.6)	1.65 (1.29 - 2.11)**	1.19 (0.97 - 1.46)
	Everyone (c)	1732 (41.6)	2435 (58.4	1.39 (1.15 - 1.68)**	1.16 (0.88 - 1.52)
	False (i)	79 (85.9)	13 (14.1)	ref	ref

The security of vaccines is monitored not only at the national level, but also in collaboration between other European countries.	DNK	596 (69.7)	259 (30.3)	2.64 (1.44 - 4.83)**	2.70 (1.41 - 5.16)**
	True (c)	1516 (35.4)	2771 (64.6)	11.11 (6.16 - 20.04)**	10.63 (5.65 - 20.02)**
Severe side effects could appear beyond 6 months after vaccination.	False (c)	179 (18.8)	773 (81.2)	6.11 (5.05 - 7.38)**	1.16 (0.88 - 1.52)
	DNK	1028 (39.5)	1574 (60.5)	2.16 (1.91 - 2.45)**	1.22 (0.96 - 1.54)
	True (i)	984 (58.6)	696 (41.4)	ref	ref
Confidence in Systems					
Economic considerations could lead to a recommendation of insufficiently evaluated vaccines.	Disagree	494 (25.7)	1432 (74.4)	ref	ref
	Undecided	679 (41.5)	956 (58.5)	0.49 (0.42 - 0.56)**	0.26 (0.22 - 0.30)**
	Agree	1018 (60.9)	655 (39.2)	0.22 (0.19 - 0.26)**	0.64 (0.55 - 0.75)**
If my employer incites me to get vaccinated, this …	Dissuades me	247 (90.2)	27 (9.9)	ref	ref
	Has no effect	1695 (49.7)	1714 (50.3)	9.25 (6.18 - 13.84)**	7.61 (4.97 – 11.63) ***
	Motivates me	249 (16.1)	1302 (84.0)	47.83 (31.44 - 72.79)**	45.05 (28.90 – 70.22) ***
Some stages of vaccine development (control) have been skipped due to the epidemic emergency.	False (c)	721 (75.2)	238 (524.8)	14.07 (11.73 - 16.89)**	13.55 (11.11 - 16.53)**
	DNK	1071 (52.9)	952 (47.1)	2.69 (2.27 - 3.19)**	3.34 (2.76 - 4.03)**
	True (i)	399 (17.7)	1853 (82.3)	ref	ref
Confidence in epidemic meanagement	Low	917 (64.4)	506 (35.6)	ref	ref
	Medium	951 (43.9)	1217 (56.1)	2.32 (2.02 - 2.66)**	2.69 (2.30 - 3.14)**
	High	323 (19.7)	1320 (80.3)	7.41 (6.29 - 8.72)**	7.81 (6.51 - 9.37)**

Complacency

I am afraid of getting a severe form of COVID-19.	Disagree	1201 (45.6)	1432 (54.4)	ref	ref
	Undecided	488 (39.9)	734 (60.1)	1.26 (1.10 - 1.45)**	1.33 (1.14 - 1.55)**
	Agree	502 (36.4)	877 (63.6)	1.47 (1.28 - 1.68)**	1.60 (1.38 - 1.86)**
The gravity of the epidemic requires making vaccines quickly available.	False (i)	331 (80.5)	80 (19.5)	ref	ref
	DNK	387 (75.4)	126 (24.6)	1.35 (0.98 - 1.85)	1.32 (0.94 - 1.87)
	True (c)	1473 (34.2)	2837 (65.8)	7.97 (6.19 - 10.25)**	7.40 (5.63 - 9.74)**
Taking a lunch break or an apéro with colleagues in the service.	Low Risk (i)	169 (63.1)	99 (37.0)	ref	ref
	Med Risk	641 (47.8)	700 (52.2)	1.86 (1.42 - 2.44)**	1.81 (1.34 - 2.46)**
	High Risk (c)	1381 (38.1)	2244 (61.9)	2.77 (2.14 - 3.59)**	2.70 (2.02 - 3.62)**
Touching materials (computer, phone) without applying hand hygiene protocols.	Low Risk (i)	272 (38.6)	433 (61.4)	ref	ref
	Med Risk (c)	772 (38.1)	1255 (61.9)	1.02 (0.86 - 1.21)	1.26 (1.03 - 1.53)*
	High Risk (c)	1147 (45.8)	1355 (54.2)	0.74 (0.63 - 0.88)**	1.02 (0.84 - 1.24)
In case of accidental exposure to blood.	Low Risk (c)	1465 (38.6)	2326 (61.4)	1.66 (1.42 - 1.94)**	1.30 (1.09 - 1.54)**
	Med Risk	340 (49.5)	347 (50.5)	1.06 (0.87 - 1.31)	1.06 (0.85 - 1.33)
	High Risk (i)	386 (51.1)	370 (48.9)	ref	ref
Assisting in a festive event of 30 people.	Low Risk (i)	53 (73.6)	19 (26.4)	ref	ref
	Med Risk	189 (59.4)	129 (40.6)	1.90 (1.08 - 3.37)*	2.30 (1.22 - 4.34)*
	High Risk (c)	1949 (40.2)	2895 (59.8)	4.14 (2.45 - 7.02)**	5.71 (3.17 - 10.27)**
Obesity is a risk factor at all ages.	False (i)	28 (53.9)	24 (46.2)	ref	ref
	DNK	71 (67.6)	34 (32.4)	0.56 (0.28 - 1.10)	0.74 (0.35 - 1.58)
	True (c)	2092 (41.2)	2985 (58.8)	1.66 (0.96 - 2.88)	1.64 (0.88 - 3.03)

The principal risk factor of a severe form of COVID is age beyond 50-60 years.	False (i)	922 (44.2)	425 (20.4)	ref	ref
	DNK	236 (50.0)	115 (24.4)	0.79 (0.65, 0.97)	0.87 (0.70 - 1.09)
	True (c)	1033 (38.6)	498 (18.6)	1.26 (1.12 - 1.41)	1.22 (1.07 - 1.39)**
Prolonged symptoms (fatigue, trouble smelling, anxiety) are frequently reported.	False (i)	29 (26.9)	79 (73.2)	ref	ref
	DNK	96 (52.8)	86 (47.3)	0.33 (0.20 - 0.55)	0.44 (0.25 - 0.78)**
	True (c)	2066 (41.8)	2878 (58.2)	0.51 (0.33 - 0.79)	0.68 (0.42 - 1.09)
Which is the risk for someone 50 years or older, of being admitted to the ICU or dying in case of COVID-19?	0.1% (i)	342 (43.6)	443 (56.4)	ref	ref
	DNK	732 (44.1)	929 (55.9)	0.98 (0.83 - 1.16)	1.28 (1.05 - 1.54)*
	1% & 10% (c)	1117 (40.1)	1671 (59.9)	1.15 (0.98 - 1.36)	1.41 (1.18 - 1.69)**
The efficacy of vaccines against COVID-19 is higher than for the flu vaccine. *	False (i)	462 (60.9)	297 (39.1)	ref	ref
	DNK	1301 (50.7)	1265 (49.3)	1.51 (1.28 - 1.78)**	1.51 (1.27 - 1.81)**
	True (c)	428 (22.4)	1481 (77.6)	5.38 (4.49 - 6.45)**	3.85 (3.17 - 4.69)**
Worry about epidemic	Low	344 (63.9)	194 (36.1)	ref	ref
	Medium	793 (50.2)	788 (49.8)	1.76 (1.44 - 2.16)**	0.96 (0.64 - 1.43)
	High	1054 (33.8)	2061 (66.2)	3.47 (2.86 - 4.20)**	1.26 (0.84 - 1.88)
Convenience					
In practice, it will be difficult for me to get vaccinated.	Disagree	1382 (36.2)	2433 (63.8)	ref	ref
	Undecided	436 (57.0)	329 (43.0)	0.43 (0.36 - 0.50)**	2.13 (1.70 - 2.66)**
	Agree	373 (57.0)	281 (43.0)	0.43 (0.36 - 0.51)**	4.42 (3.66 - 5.49)**
	False (i)	98 (61.6)	61 (38.4)	ref	ref
	DNK	372 (71.0)	152 (29.0)	0.66 (0.45 - 0.95)*	0.64 (0.43 - 0.95)*

It is necessary to have 2 injections to be immunized. *	True (c)	1721 (37.8)	2830 (62.2)	2.64 (1.90 - 3.66)**	1.54 (1.08 - 2.19)*

Calculation

I think that vaccination against COVID-19 will have more benefits than risks for me.	Disagree	1040 (89.2)	126 (10.8)	ref	ref
	Undecided	841 (74.0)	295 (26.0)	2.90 (2.31 - 3.64)**	2.95 (2.32 - 3.74)**
	Agree	310 (10.6)	2622 (89.4)	69.81 (56.10 - 86.92)**	59.87 (47.57 - 75.36)**
For a person with risk factors, these vaccines have more benefits than risks in the current epidemic situation. *	False (i)	124 (83.8)	24 (16.2)	ref	ref
	DNK	700 (80.0)	175 (20.0)	1.29 (0.81 - 2.06)	1.16 (0.71 - 1.88)
	True (c)	1367 (32.5)	2844 (67.5)	10.75 (6.91 - 10.72)**	6.94 (4.38 - 11.00)**

Collective Responsibility

Getting vaccinated will also be a collective action to stop the crisis due to the epidemic.	Disagree	528 (92.5)	43 (7.5)	ref	ref
	Undecided	620 (90.4)	66 (9.6)	1.31 (0.88 - 1.95)	1.44 (0.94 - 2.20)
	Agree	1043 (26.2)	2934 (73.8)	34.54 (25.11 - 47.51)**	37.16 (26.42 - 52.27)**
The vaccine blocks transmission of the virus to those around you in case of infection. *	False (c)	1095 (41.7)	1531 (58.3)	0.76 (0.65 - 0.90)**	0.63 (0.52 - 0.76)**
	DNK	820 (44.9)	1007 (55.1)	0.67 (0.56 - 0.80)**	0.62 (0.51 - 0.75)**
	True (i)	276 (35.3)	505 (64.7)	ref	ref

Social Conformism

In your professional environment, how would you describe the majority	Skeptical	1085 (64.5)	597 (35.5)	ref	ref
	Both skeptical and favorable	860 (42.7)	1155 (57.3)	2.44 (2.14 - 2.79)**	1.98 (1.72 - 2.20)**

opinion towards COVID-19 vaccination?	Favorable	246 (16.0)	1291 (84.0)	9.54 (8.05 - 11.29)**	5.65 (4.70 - 6.80)**
Among your family and friends, how would you describe the majority opinion towards COVID-19?	Skeptical	1283 (72.4)	490 (27.6)	ref	ref
	Both skeptical and favorable	701 (42.4)	952 (57.6)	3.56 (3.08 - 4.10)**	2.87 (2.47 - 3.34)**
	Favorable	207 (11.5)	1601 (88.6)	20.25 (16.94 - 24.20)**	13.49 (11.19 - 16.26)**
Do you know the approximate percentage of healthcare workers who intend to get the vaccine?	30% (i)	906 (52.0)	837 (48.0)	ref	ref
	DNK	937 (45.4)	1127 (54.6)	1.30 (1.15 - 1.48)**	1.11 (0.97 - 1.28)
	60% & 90% (c)	348 (24.4)	1079 (75.6)	3.36 (2.88 - 3.91)**	2.23 (1.88 - 2.64)**