

## ORIGINAL ARTICLE

# Do HCWs adequately know about meningitis and 4CMenB vaccine and recommend its use to parents? A cross sectional analysis in Campania Region, Italy

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## Keywords

Healthcare workers • Vaccination strategy • Invasive meningococcal disease • Multicomponent meningococcal serogroup B vaccine • 4CMenB

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## Summary

*Invasive meningococcal disease (IMD) is a severe disease caused by various *Neisseria meningitidis* serogroups that represents a serious public health problem worldwide. In Italy, serogroups B and C are the major causes of IMD. On 14 January 2013, the European Medicines Agency authorized the use of the first vaccine available to protect against meningococcal serogroup B (4CMenB).*

*The aim of this study was to assess the IMD epidemiology knowledge and 4CMenB vaccine attitudes of healthcare workers (HCWs) with regard to recommending this vaccine for use, vaccine practices and infectious disease control in the Campania region in Italy. A cross-sectional study was conducted among 293 HCWs (49.5% physicians and 46.4% nurses) interviewed using a self-administered questionnaire.*

*The majority of the HCWs had sufficient knowledge about the disease incidence and lethality, but they were less informed about the higher risk age categories and the serogroups most frequently involved. Additionally, their knowledge about the vaccine was poor with regard to the targeted categories and side effects. Approximately 30.0% of the HCWs reported incidences of fever and pain and swelling at the injection site. Moreover, 32.8% of the HCWs knew that the risk of developing adverse reactions increases when the 4CMenB vaccine is co-administered with other vaccines.*

*Overall, all of the HCWs were convinced that vaccinations are an important instrument for preventing infectious diseases, and they were aware of their central role in promoting the 4CMenB vaccination and their need to be better informed.*

## Introduction

An invasive meningococcal disease (IMD) is a severe and a life-threatening disease caused by various *Neisseria meningitidis* serogroups, and it represents a serious public health problem worldwide, with an annual number of cases estimated to be at least 1.2 million [1-3]. In Europe, the USA and other industrialized regions, serogroups B and C are the major causes of IMDs [4, 5]. Approximately one in ten cases are fatal, and among those who survive, long-term sequelae, such as hearing loss, neurological defects or amputation, can occur [6, 7]. Vaccination practices (MenC and ACWY135 vaccines) have significantly changed the epidemiology of this disease, so that serogroup B is currently the predominant cause of IMDs in Europe, Latin America and North America [5, 8, 9]. In Italy, the IMD incidence is higher in children 0 to 4 years old than in the other age categories, particularly in infants less than 1 year old (IMD incidence = 4.01/100,000 in 2013) [10, 11]. The serogroup mainly involved in infants less than 1 year old is type B (IMD incidence = 3.44/100,000 in 2013), with the highest incidence among children younger than 24 months, peaking at 4-8 months [10, 12]. Between 2014 and 2016, the IMD incidence among individuals 15-24 years old

increased, from 0.30/100,000 in 2014 to 0.90/100,000 in 2016, and decreased in adults older than 25 years during the same time period [10].

In Italy, the IMD surveillance system based on laboratory-confirmed cases (almost 70%) revealed that between 2011 and 2017, serogroup B was the most common IMD-causing type [10], except between 2015 and 2016 when a hyper virulent meningococcal C strain was responsible for an unexpected increased IMD incidence in the Tuscany region. Following this episode, the Italian Health Authorities implemented immunization campaigns and enhanced IMD surveillance. On 14 January 2013, the European Medicines Agency authorized the use of the first vaccine available to protect against meningococcal serogroup B (Bexsero; GSK, Philadelphia, PA, USA) [13-16]. It is a multicomponent vaccine (4CMenB) composed of three purified recombinant antigenic proteins from *Neisseria meningitidis* serogroup B and the outer membrane vesicles of the bacterium. The 4CMenB vaccination schedule for infants consists of three doses: the first dose is given at three months old, the second dose is given between 1 and 2 months after the first dose, and the third "booster" dose is given at 13 months old. As with other vaccinations, the most common adverse reactions from the 4CMenB vaccina-

tion consist of fever, pain and swelling at the injection site, abnormal crying and irritability, eating disorders and gastrointestinal symptoms, sleepiness and a cutaneous rash. The uncommon adverse reactions consist of febrile or non-febrile convulsions and pallor, while the rarest adverse reactions are urticaria and Kawasaki syndrome [17].

The 4CMenB vaccination strategy differs across the European countries; for example, in Italy, the vaccination strategies are set out by different regions through the Regional Health Plan. This plan must respect the guidelines defined by the National Health Plan and the National Vaccine Prevention Plan (Piano Nazionale Prevenzione Vaccinale, PNPV) [18]. The latter defines the best vaccination policy to be carried out in each region in accordance with the best scientific evidence available. Each region can issue their own vaccination strategy in terms of the target population and costs that might be incurred by the citizens. This can lead to differences in the vaccine administration across Italian regions, resulting in heterogeneous vaccine coverage. The decreasing immunization adherence trend in Italy over recent years further compromises homogeneous and efficacious vaccine coverage, and this includes an unjustified fear of adverse reactions, scarce awareness regarding severe outcomes when not vaccinated, and the media's role in spreading incorrect information about vaccines. Many people's attitudes toward vaccinations may have been affected after an unverified association between the measles, mumps and rubella vaccine and autism was reported by the media, as well as after the Fluad case. The latter followed the withdrawal of the Novartis vaccine against influenza by the Italian Medicines Agency known as "Agenzia Italiana del Farmaco" after the occurrence of 3 deaths in 48 hours. Although there was prompt readmission of the Novartis vaccine, the media event had already affected people's attitudes towards vaccinations. These events have increased both citizens and healthcare workers' (HCWs) loss of faith in Italian institutions.

Previous studies have documented the strong influence that HCWs have on a patient's decision making process regarding whether or not to undergo vaccination [19-22]. However, some HCWs feel poorly informed and poorly trained on how to answer patient questions, and they often struggle when dealing with those who distrust the efficacy and safety of vaccines [23, 24]. Therefore, the aim of our study was to assess the knowledge and attitudes of HCWs involved in vaccination programs and infectious disease control with regard to recommending the 4CMenB vaccine in the Campania region of Italy.

## Methods

### PARTICIPANTS AND SETTING

Within each Local Health Service (Aziende Sanitarie Locali, ASL) that manages public healthcare, the communicable disease prevention is run by two departments, the Maternal Childhood Health Protection Department,

which delivers vaccines to children through its Maternal Childhood Operative Unit (Unità Operativa Materno Infantile, UOMI), and the Public Health Department, which looks at infectious disease surveillance and control through the Epidemiology Service (Servizio di Epidemiologia e Prevenzione) and Public Hygiene Service (Servizio di Igiene e Sanità Pubblica) and administers vaccines to adults and travellers through the Collective Prevention Operative Unit (Unità Operativa Prevenzione Collettiva).

A cross-sectional study was conducted from 1 January 2017 through 30 June 2017 at the ASLs in the metropolitan areas of Naples, Caserta and Salerno in the Campania region among the HCWs involved in the surveillance and control of infectious diseases or vaccine administration (the total number of HCWs at these ASLs was around 750). In each unit, a healthcare operator was identified as a reference contact, and they collaborated to explain the study objectives and raise awareness among the HCWs. In addition, this individual distributed the questionnaires and collected them immediately after they were completed anonymously by the participants. The questionnaires focused on the HCWs' knowledge about IMD epidemiology and preventability and their attitudes towards 4CMenB vaccine use. It consisted of 45 items gathered into 3 main topics described as follows:

1. Socio-demographic information (sex, age, marital status, how many children, any children < 5 years old, education, degree type and medical specialty) and professional characteristics (ASL, workplace, occupational category, type of activity and seniority).
2. Knowledge about serogroup B meningococcal disease and the 4CMenB vaccine (epidemiology of meningococcal meningitis in Italy and its lethality and mortality rate, knowledge about the 4CMenB vaccination and its side effects).
3. Attitudes toward vaccination practices, specifically toward the 4CMenB vaccination (opinions about the 4CMenB vaccine, its efficacy and safety, the opportunity to recommend it and make it mandatory; opinions about the reasons why parents do or do not vaccinate their children), and updating resources (self-evaluation of their own level of knowledge about the 4CMenB vaccine and updating resources used).

### SAMPLE SIZE

The number of HCWs needed was determined on the assumption that 75% of the HCWs had appropriate knowledge regarding IMDs and the 4CMenB vaccine, a confidence interval of 95% and a ratio unexp/exp 1:2. The results showed that a total number of 365 HCWs needed to be enrolled in the study.

### DATA ANALYSIS

The data was analysed using Stata: Data Analysis and Statistical Software version 10.1 (Stata Corp LLC, College Station, TX, USA). Following the descriptive analysis, a univariate analysis was performed using a chi-squared test to identify the associations between each independent variable and the outcomes of interest. Then,

only those variables with a *p* value < 0.25 in the univariate analysis were included in the final multivariate logistic regression models. The *p* values were assessed using two-sided tests, with the statistical significance for *p* defined at a value of ≤ 0.05.

The independent variables were the sex, age, number of children, education, occupational category, department type and activity type. The dependent variables were the knowledge about meningococcal meningitis (incidence, most common serogroup in Italy, lethality and mortality rate) and knowledge about the 4CMenB vaccine (vaccine recommended age groups, vaccinations schedule, inclusion or exclusion among recommended vaccinations by the PNPV in Italy and by the Regional Vaccine Prevention Plan in Campania, and risk for adverse reactions when the 4CMenB vaccine is co-administered with another vaccine).

**ETHICAL CONSIDERATIONS**

All of the participants were informed that the data was collected anonymously and stored in a confidential manner. None of the participants could be identified based on the material submitted, and no incentives were offered to the HCWs for their participation in this study.

**Results**

A total of 293 HCWs completed the survey, with a response rate of 80.3%. As shown in Table I, 63.8% were women, 65.9% were between 41 and 59 years old, 79.2% were married, 83.6% had at least one child, 6.1% had a child less than 5 years old, 55.6% had graduated, and 7.4% and 88.9% had graduated from nursing and medicine, respectively. Among those who were physicians, the majority were specialists in hygiene and preventive medicine (35.2%), 21.4% were in paediatrics and just a few of them were specialists in infectious diseases (4.8%). Moreover, 50.8% of the HCWs worked in ASLs in Naples, 51.9% worked in UOMIs, the majority were physicians (49.5%), 46.4% were nurses and only 4.1% were other types of HCWs, like medical assistants, biologists and professional educators. Additionally, 51.9% of the participants were directly involved in vaccination programs, 17.1% were in infectious disease surveillance and control, and 23.2% were involved in both activities. Table II shows the results of the IMD knowledge among the physicians and nurses with relative confidence intervals; 24.1% of the physicians and 17.7% of the nurses reported that the meningococcal meningitis incidence in Italy was not high, while 50.3% of the physicians and only 38.2% of the nurses identified serogroup B as the most common. Regarding the age groups at a higher risk of contracting meningococcal meningitis, 27.3% of the HCWs indicated < 1 year old, 30.6% indicated from 1-4 years old and 27.3% indicated from 15-24 years old; however, only 7.6% of the physicians and 4.4% of the nurses indicated all three age groups that were at a higher risk (data not shown). Moreover, 80.4% of the HCWs indicated that the meningococcal meningitis lethality

**Tab. I.** Sociodemographic and professional characteristics of the healthcare workers (HCWs) (n = 293).

		n	%
Sex	98	33.5	98
	187	63.8	187
	8	2.7	8
	293	100.0	293
Age	≤ 40	8	2.7
	41–59	193	65.9
	≥ 60	84	28.7
	No response	8	2.7
	Total	293	100.0
Marital status	Married	232	79.2
	Unmarried	23	7.9
	Widow/Widower	4	1.4
	Separate/Divorced	11	3.7
	No response	23	7.8
	Total	293	100.0
Have children	Yes	245	83.6
	No	32	10.9
	No response	16	5.5
	Total	293	100.0
Children less than 5 years old <sup>a</sup>	Yes	15	6.1
	No	230	93.9
	Total	245	100.0
Type of degree <sup>b</sup>	Medicine	145	88.9
	Nursing	12	7.4
	Other	6	3.7
	Total	163	100.0
Medical specialty <sup>c</sup>	Hygiene and preventive medicine	51	35.2
	Paediatrics	31	21.4
	Infectious disease	7	4.8
	Other	17	11.7
	Not specialized	39	26.9
	Total	145	100.0

UOPC: Collective Prevention Operative Unit; UOMI: Maternal Childhood Operative Unit; SEP: Epidemiology Service; SISP: Public Hygiene Service; a Calculated only for the HCWs who reported at least one child (n = 245); b Calculated only for the HCWs who graduated (n = 163); c Calculated only for the physicians (n = 145).

rate was high, while 48.3% and 36.0%, respectively, indicated that the mortality rate was very low. The results from the HCWs' knowledge about the 4CmenB vaccine are described in Table III. Most of the participants (69.0%) had at least sufficient knowledge about the 4CmenB vaccine, and 79.4% had sufficient knowledge about its vaccination schedule. However, only 34.1% of the HCWs indicated < 1 year old as the targeted group for the 4CmenB vaccination, while 18.2% and 20.5% indicated 1-4 years old and immune-suppressed individuals, respectively. Only 2.7% of the physicians and 2.9% of the nurses correctly identified all three targeted groups (results not shown). In order to assess their knowledge about the vaccination schedule, the HCWs were asked about the number of doses, timing and whether a booster shot was needed. Only 31.0% of the physicians and 21.3% of the nurses knew the 4CmenB vaccination schedule for all of the age groups.

**Tab. II.** Healthcare workers' (HCWs) knowledge about the meningococcal meningitis epidemiology (n = 281).

		Physicians		Nurses		Total	
		%	(95% CI)	%	(95% CI)	n	%
In Italy the incidence of meningococcal meningitis is high, do you agree?	Strongly agree	3.4	(1.3-5.4)	4.4	(2.0-6.7)	11	3.9
	Somewhat agree	16.6	(12.3-20.8)	21.3	(16.6-25.9)	53	18.9
	Somewhat disagree*	53.8	(48.0-59.5)	45.6	(39.9-51.3)	140	49.8
	Disagree*	24.1	(19.2-29.0)	17.7	(13.3-22.0)	59	21.0
	Don't know/ No response	2.1	(0.4-3.7)	11.0	(7.4-14.5)	18	6.4
	Total	100.0		100.0		281	100
Which are the most common meningococcus serogroups in Italy?	Serogroup A	0.0		0.0		0	0.0
	Serogroup B*	26.2	(21.1-31.2)	19.1	(14.6-23.6)	64	22.8
	Serogroup B and C*	24.1	(19.2-29.0)	19.1	(14.6-23.6)	61	21.7
	Serogroup C	47.6	(41.8-53.3)	59.6	(53.9-65.2)	150	53.4
	Serogroup Y or serogroup W135	0.0		0.7	(-0.2-1.6)	1	0.3
	Don't know/ No response	2.1	(0.46-3.74)	1.5	(0.1-2.8)	5	1.8
	Total	100.0		100.0		281	100.0
Which are the age categories at higher risk in Italy? (more than one answer allowed)	< 1 year*	29.2	(23.9-34.4)	25.4	(20.4-30.3)	114	27.3
	1-4 years*	33.0	(27.6-38.3)	28.2	(23.0-33.3)	128	30.6
	5-14 years	10.5	(6.9-14.0)	8.1	(4.9-11.2)	39	9.3
	15-24 years*	22.0	(17.2-26.7)	32.6	(27.2-37.9)	114	27.3
	> 25 years	4.3	(1.9-6.6)	4.3	(1.9-6.6)	18	4.3
	Don't know/ No response	1.0	(-0.1-2.1)	1.4	(0.0-2.7)	5	1.2
	Total	100.0		100.0		418	100.0
Is meningococcal type B meningitis a lethal disease?	Yes*	82.1	(77.7-86.4)	78.7	(74.0-83.3)	226	80.4
	No	10.3	(6.8-13.7)	12.5	(8.7-16.2)	32	11.4
	Don't know/ No response	7.6	(4.5-10.6)	8.8	(5.5-12.0)	23	8.2
	Total	100.0		100.0		281	100.0
How high is the meningococcal type B meningitis mortality rate in Italy?	Very high	2.1	(0.4-3.7)	5.1	(2.5-7.6)	10	3.6
	High	30.3	(25.0-35.5)	28.0	(22.8-33.1)	82	29.2
	Low*	11.0	(7.4-14.5)	14.7	(10.6-18.7)	36	12.8
	Very low*	48.3	(42.5-54.0)	36.0	(30.5-41.5)	119	42.3
	Don't know/ No response	8.3	(5.1-11.4)	16.2	(11.9-20.4)	34	12.1
	Total	100.0		100.0		281	100.0

CI: confidence interval; \*Correct answer; a Calculated based on the total number of answers given by the HCWs (n = 418).

Of the HCWs, 62.6% knew that the PNPV recommends the 4CMenB vaccine, while only 30.6% knew that the Regional Campania Vaccine Prevention Plan has not implemented the 4CMenB vaccine.

When assessed with regard to the 4CMenB-related adverse reactions (Tab. IV), 32.0% of the HCWs reported fever and 31.0% reported pain and swelling at the injection site. A few of the HCWs identified gastrointestinal disorders, headaches, somnolence, asthenia, convulsions, pallor, Kawasaki syndrome, malaise and arthralgia among the possible adverse reactions to the vaccine (data not shown). Only 32.8% of the HCWs knew that the risk of developing adverse reactions increases when the 4CMenB vaccine is co-administered with other vaccines. In addition, 40.0% of the physicians and 52.2% of the nurses knew that the 4CMenB vaccine must be administered several days after the other recommended vaccinations, while 36.2% of the physicians and only 15.5% of the nurses

knew that the main reason for this was the increased risk for adverse reactions. Most of the physicians (81.4%) and nurses (72.8%) disagreed with the idea that the inclusion of the 4CMenB vaccine in the vaccination schedule would reduce adherence to the other vaccinations.

As shown in Table V, 56.6% of the HCWs stated that the 4CMenB vaccine was extremely efficacious, and 65.5% stated that the vaccine was safe. Additionally, 90.4% of the HCWs stated that encouraging people to allow their children to receive the 4CMenB vaccine was their professional duty, and 53.4% would make it mandatory. The fear of the disease and its complications was the reason most often given by the HCWs (61.9%) to address why the parents chose to vaccinate their children, while the fear of severe adverse reactions (31.6%), disinformation (24.0%) and a poor perception of the disease severity (20.5%) were the most common reasons why the parents chose not to vaccinate their children. Almost all of the HCWs (91.5%) believed that the

Tab. III. Knowledge about the meningococcal serogroup B multicomponent (4CMenB) vaccine (n = 281).

		Physicians		Nurses		Total	
		%	(95% CI)	%	(95% CI)	n	%
What do you consider your overall knowledge about the 4CMenB vaccine to be?	Scarce	8.3	(5.1–11.4)	14.7	(10.6–18.7)	32	11.4
	Not sufficient	19.3	(14.7–23.8)	19.9	(15.3–24.4)	55	19.6
	Sufficient	36.6	(31.0–42.1)	30.1	(24.8–35.3)	94	33.5
	Good	30.3	(25.0–35.5)	35.3	(29.8–40.7)	92	32.7
	Excellent	5.5	(2.8–8.1)	0.0		8	2.8
	Total	100.0		100.0		281	100.0
Are you familiar with the 4CMenB vaccination schedule?	Yes	82.0	(77.6–86.4)	76.5	(71.6–81.3)	223	79.4
	No	18.0	(13.6–22.4)	23.5	(18.6–28.3)	58	20.6
	Total	100.0		100.0		281	100.0
Which age groups are recommended to receive the 4CMenB vaccination? (more than one answer allowed)	< 1 year*	34.9	(29.4–40.3)	33.2	(27.8–38.5)	199	34.1
	1-4 years*	20.5	(15.8–25.1)	15.5	(11.3–19.6)	106	18.2
	5-14 years	8.1	(4.9–11.2)	6.1	(3.3–8.8)	42	7.2
	15-24 years	14.7	(10.6–18.7)	16.3	(12.0–20.5)	90	15.4
	> 25 years	1.3	(0.0–2.6)	3.6	(1.4–5.7)	14	2.4
	Immunosuppressed*	19.5	(14.9–24.0)	21.7	(16.9–26.4)	120	20.5
	Don't know/No response	1.0	(-0.1–2.1)	3.6	(1.4–5.7)	13	2.2
	Total	100.0		100.0		584	100.0
Assessment of the HCWs' knowledge about the 4CMenB vaccination schedule for each of the following age groups:	Infants						
	Correct	47.6	(41.8–53.3)	36.8	(31.2–42.3)	119	42.3
	Incorrect	52.4	(46.6–58.1)	63.2	(57.6–68.7)	162	57.7
	Total	100.0		100.0		281	100.0
	Children						
	Correct	42.8	(37.1–48.4)	39.7	(34.1–45.3)	116	41.3
	Incorrect	57.2	(51.5–62.8)	60.3	(54.7–65.9)	165	58.7
	Total	100.0		100.0		281	100.0
	Teenagers						
	Correct	45.5	(39.8–51.2)	34.6	(29.1–40.0)	113	40.2
	Incorrect	54.5	(48.8–60.2)	65.4	(59.9–70.8)	168	59.8
	Total	100.0		100.0		281	100.0
	All ages						
	Correct	31.0	(25.7–36.3)	21.3	(16.6–25.9)	74	26.3
	Incorrect	69.0	(63.7–74.3)	78.7	(74.0–83.3)	207	73.7
Total	100.0		100.0		281	100.0	
Has the 4CMenB vaccination been included among those recommended by the National Vaccine Prevention Plan in Italy?	Yes*	64.2	(58.7–69.6)	61.0	(55.4–66.5)	176	62.6
	No	18.6	(14.1–23.0)	22.8	(18.0–27.6)	58	20.7
	Don't know	17.2	(12.8–21.5)	16.2	(11.9–20.4)	47	16.7
	Total	100.0		100.0		281	100.0
Has the 4CMenB vaccination been included in the Regional Campania Vaccine Prevention Plan in Campania?	Yes	40.7	(35.0–46.3)	33.8	(28.3–39.2)	105	37.4
	No*	27.6	(22.4–32.7)	33.8	(28.3–39.2)	86	30.6
	Don't know	31.7	(26.3–37.0)	32.4	(27.0–37.7)	90	32.0
	Total	100.0		100.0		281	100.0

CI: confidence interval, HCWs: healthcare workers; \* Correct answer; <sup>a</sup> Calculated based on the total number of answers given by the HCWs (n = 584).

distrust that the parents had with regard to vaccinating their children had no scientific basis.

Of the participants, 98.9% stated that HCWs must constantly be updated on vaccination-related scientific evidence, and 85.8% stated that they needed better information. In addition, the HCWs reported courses and conferences (30.5%) and the internet (26.2%) as their major sources of information about the 4CMenB vaccine.

Table VI shows the results of the multivariate models for which significant associations were identified between the variables and the outcomes of interest. The knowledge about the most common serogroup was lower among those HCWs who were < 50 years old [odds ratio (OR) = 2.02, 95% confidence interval (CI) = 1.1-3.6, *p* = 0.022]. Moreover, the HCWs who worked in the Public Health Department and those who were

**Tab. IV.** Knowledge about the risks related to the meningococcal serogroup B multicomponent (4CMenB) vaccine (n = 281).

			Physicians		Nurses		Total	
			%	(95% CI)	%	(95% CI)	n	%
How frequently occurring are the following 4CMenB vaccine side effects?	Fever	Correct	34.5	(29.0-39.9)	29.4	(24.1-34.6)	90	32.0
		Incorrect	65.5	(60.0-70.9)	70.6	(65.3-75.8)	191	68.0
		Total	100.0		100.0		281	100.0
	Pain and swelling at the injection site	Correct	32.4	(27.0-37.7)	29.4	(24.1-34.6)	87	31.0
		Incorrect	67.6	(62.2-72.9)	70.6	(65.3-75.8)	194	69.0
		Total	100.0		100.0		281	100.0
	Irritability	Correct	26.2	(21.1-31.2)	21.3	(16.6-25.9)	67	23.8
		Incorrect	73.8	(68.7-78.8)	78.7	(74.0-83.3)	214	76.2
		Total	100.0		100.0		281	100.0
	Cutaneous rash	Correct	6.9	(4.0-9.8)	8.1	(4.9-11.2)	21	7.5
		Incorrect	93.1	(90.2-96.0)	91.9	(88.7-95.0)	260	92.5
		Total	100.0		100.0		281	100.0
Does the risk of developing an adverse reaction increase when the 4CMenB vaccine is co-administered with another vaccine?	Yes*	34.5	(29.0-39.9)	30.9	(25.6-36.1)	92	32.8	
	No	46.2	(40.4-51.9)	48.5	(42.7-54.2)	133	47.3	
	Don't know	19.3	(14.7-23.8)	20.6	(15.9-25.2)	56	19.9	
	Total	100.0		100.0		281	100.0	
Must the 4CMenB vaccine be administered several days after any other vaccination?	Yes*	40.0	(34.3-45.6)	52.2	(46.4-57.9)	129	45.9	
	No	28.3	(23.1-33.4)	22.8	(18.0-27.6)	72	25.6	
	It makes no difference	20.7	(16.0-25.3)	10.3	(6.8-13.7)	44	15.7	
	Don't know	11.0	(7.4-14.5)	14.7	(10.6-18.7)	36	12.8	
	Total	100.0		100.0		281	100.0	
Why must the 4CMenB vaccine be administered several days after any other vaccination? (more than one answer allowed) <sup>a</sup>	To avoid an increased risk for adverse reactions*	36.2	(30.7-41.7)	15.5	(11.3-19.6)	32	24.8	
	Vaccination schedule is too busy	15.5	(11.3-19.6)	22.5	(17.7-27.2)	25	19.4	
	To better assess adverse reactions	10.4	(6.9-13.9)	4.3	(1.9-6.6)	9	7.0	
	To improve patient compliance	6.9	(4.0-9.8)	5.6	(2.9-8.2)	8	6.9	
	To avoid hyperstimulation of immune system	6.9	(4.0-9.8)	1.4	(0.0-2.7)	5	3.9	
	To reduce parents' anxiety	0.0		2.8	(0.9-4.6)	2	1.4	
	No response	24.1	(19.2-29.0)	47.9	(42.1-53.6)	46	35.6	
	Total	100.0		100.0		129	100.0	
In your opinion, would any other vaccination be refused if the 4CMenB vaccination was added to the vaccination schedule?	Yes	2.1	(0.4-3.7)	7.4	(4.4-10.4)	13	4.6	
	No	81.4	(76.9-85.8)	72.8	(67.7-77.9)	217	77.2	
	Don't know	16.5	(12.2-20.7)	19.8	(15.2-24.3)	51	18.2	
	Total	100.0		100.0		281	100.0	
If yes, which of the following vaccinations would be refused? (more than one answer allowed) <sup>b</sup>	Trivalent vaccine	16.7	(12.4-20.9)	43.8	(38.1-49.4)	8	36.4	
	Pneumococcus	33.3	(27.9-38.7)	25.0	(20.0-29.9)	6	27.3	
	Hexavalent vaccine	16.7	(12.4-20.9)	25.0	(20.0-29.9)	5	22.7	
	Meningococcal C	33.3	(27.9-38.7)	6.2	(3.4-8.9)	3	13.6	
	Total	100.0		100.0		22	100.0	

CI: confidence interval; \* Correct answer; <sup>a</sup> Calculated based on the total number of answers given by the healthcare workers (n = 129); <sup>b</sup> Calculated based on the total number of answers given by the healthcare workers who answered yes to the previous question (n = 22).

**Tab. V.** Healthcare workers' (HCWs) attitudes toward the meningococcal serogroup B multicomponent (4CMenB) vaccine use and updating sources (n = 281).

		Physicians		Nurses		Total	
		%	(95% CI)	%	(95% CI)	n	%
Is the 4CMenB vaccine efficacious in preventing bacterial meningitis?	Extremely efficacious	55.9	(50.2-61.5)	57.4	(51.7-63.0)	159	56.6
	Efficacious	40.0	(34.3-45.6)	39.7	(34.1-45.3)	112	39.9
	Scarcely efficacious	4.1	(1.8-6.3)	2.9	(0.9-4.8)	10	3.5
	Inefficacious	0.0		0.0		0	0.0
	Total	100.0		100.0		281	100.0
Is the 4CMenB vaccine safe?	Extremely safe	28.3	(23.1-33.4)	30.9	(25.6-36.1)	83	29.6
	Safe	66.2	(60.7-71.6)	64.7	(59.2-70.1)	184	65.5
	Scarcely safe	5.5	(2.8-8.1)	1.5	(0.1-2.8)	10	3.5
	Not safe	0.0		2.9	(0.9-4.8)	4	1.4
	Total	100.0		100.0		281	100.0
Do you consider encouraging people to get the 4CMenB vaccination to be an HCWs' professional duty?	Yes	91.7	(88.5-94.8)	89.0	(85.4-92.5)	254	90.4
	No	2.1	(0.4-3.7)	2.9	(0.9-4.8)	7	2.5
	Don't know	6.2	(3.4-8.9)	8.1	(4.9-11.2)	20	7.1
	Total	100.0		100.0		281	100.0
Would you agree to make the 4CMenB vaccination mandatory?	Yes	56.5	(50.8-62.1)	50.0	(44.2-55.7)	150	53.4
	No	26.9	(21.8-31.9)	27.9	(22.7-33.0)	77	27.4
	Don't know	16.6	(12.3-20.8)	22.1	(17.3-26.8)	54	19.2
	Total	100.0		100.0		281	100.0
Why do people decide to vaccinate their children? (more than one answer allowed) <sup>a</sup>	Fear of the disease and its complications	60.7	(55.1-66.2)	63.3	(57.7-68.8)	245	61.9
	Vaccination is mandatory	25.6	(20.6-30.6)	24.9	(19.9-29.8)	100	25.3
	Vaccine is safe	10.4	(6.9-13.9)	9.7	(6.3-13.0)	40	10.1
	Correct information provided by HCWs	1.4	(0.0-2.7)	0.5	(-0.3-1.3)	4	1.0
	Trust the source that recommends the vaccination	0.5	(-0.3-1.3)	0.5	(-0.3-1.3)	2	0.4
	Increased number of new cases within the community	0.5	(-0.3-1.3)	0.0		1	0.3
	Don't know	0.9	(-0.1-1.9)	1.1	(0.0-2.2)	4	1.0
	Total	100.0		100.0		396	100.0
Why do people decide not to vaccinate their children? (more than one answer allowed) <sup>b</sup>	Fear of adverse reactions	31.8	(26.4-37.1)	31.3	(25.9-36.6)	208	31.6
	Disinformation	21.3	(16.6-25.9)	26.9	(21.8-31.9)	158	24.0
	Poor perception of disease severity	22.4	(17.6-27.1)	18.4	(13.9-22.8)	135	20.5
	Vaccine is not mandatory	11.1	(7.5-14.7)	10.4	(6.9-13.9)	71	10.8
	Fear of unknown long-term effects	8.2	(5.0-11.3)	8.9	(5.6-12.1)	56	8.5
	Vaccination schedule is too busy	4.0	(1.7-6.2)	3.2	(1.1-5.2)	24	3.6
	Costs	0.3	(-0.3-0.9)	0.6	(-0.2-1.4)	3	0.4
	Advertisement campaigns on websites	0.6	(-0.2-1.4)	0.0		2	0.3
	Don't know	0.3	(-0.3-0.9)	0.3	(-0.3-0.9)	2	0.3
	Total	100.0		100.0		659	100.0
Do you consider the parents' choice not to vaccinate their children to be scientifically based?	Yes	1.4	(0.0-2.7)	1.5	(0.1-2.8)	4	1.4
	No	93.8	(91.0-96.5)	89.0	(85.4-92.5)	257	91.5
	Don't know	4.8	(2.3-7.2)	9.5	(6.1-12.8)	20	7.1
	Total	100.0		100.0		281	100.0
Must HCWs be constantly updated on vaccination-related scientific evidence?	Yes	99.3	(98.3-100.2)	98.5	(97.1-99.8)	278	98.9
	No	0.0		0.0		0	0.0
	Don't know	0.7	(-0.2-1.6)	1.5	(0.1-2.8)	3	1.1
	Total	100.0		100.0		281	100.0
Do you need to be better informed about the 4CMenB vaccine?	Yes	82.1	(77.7-86.4)	89.7	(86.2-93.1)	241	85.8
	No	13.1	(9.2-16.9)	7.3	(4.3-10.2)	29	10.3
	Don't know	4.8	(2.3-7.2)	3.0	(1.0-4.9)	11	3.9
	Total	100.0		100.0		281	100.0

continues

Tab. V. *follows.*

How did you get informed about the 4CMenB vaccine? (more than one answer allowed) c	Updating courses/congresses	7.6	(4.5–10.6)	11.4	(7.7–15.0)	46	9.3
	Internet	9.7	(6.3–13.0)	5.0	(2.5–7.5)	38	7.7
	National journals	1.5	(0.1–2.8)	7.8	(4.7–10.8)	21	4.2
	Pharmaceutical promoters	0.7	(-0.2–1.6)	3.2	(1.1–5.2)	9	1.8
	International journals	0.0		3.6	(1.4–5.7)	8	1.6
	Television	0.4	(-0.3–1.1)	0.5	(-0.3–1.3)	2	0.4
	Vaccine information leaflets	2.2	(0.5–3.8)	3.6	(1.4–5.7)	14	2.8
	Colleagues	1.1	(0.0–2.2)	1.4	(0.0–2.7)	6	1.2
	National health plan	100.0		100.0		496	100.0
	No source of updating	7.6	(4.5–10.6)	11.4	(7.7–15.0)	46	9.3
	No response	9.7	(6.3–13.0)	5.0	(2.5–7.5)	38	7.7
	Total	1.5	(0.1–2.8)	7.8	(4.7–10.8)	21	4.2

CI: confidence interval; <sup>a</sup> Calculated based on the total number of answers given by the HCWs (n = 396); <sup>b</sup> Calculated based on the total number of answers given by the HCWs (n = 659); <sup>c</sup> Calculated based on the total number of answers given by the HCWs (n = 496).

involved in the surveillance and control of the disease (OR = 0.29, 95% CI = 0.1–0.5,  $p = 0.000$  and OR = 0.35, 95% CI = 0.1–0.8,  $p = 0.015$ , respectively) were more likely to have this knowledge. Being male and being involved in the surveillance and control of the disease (OR = 0.51, 95% CI = 0.2–0.9,  $p = 0.034$  and OR = 0.34, 95% CI = 0.1–0.8,  $p = 0.014$ , respectively) were associated with greater knowledge about the meningococcal B meningitides mortality rate.

Working in the Public Health Department (OR = 3.31, 95% CI = 1.6–6.7,  $p = 0.001$ ) was the only variable associated with knowledge about the 4CMenB vaccination schedule. Additionally, knowledge about the National Health Plan was lower among those who worked in the Public Health Department (OR = 3.22, 95% CI = 1.8–5.5,  $p = 0.000$ ). Being involved in the surveillance and control of the disease (OR = 2.83, 95% CI = 1.2–6.3,  $p = 0.012$ ) was associated with lesser knowledge about the Regional Health Plan, while this knowledge was higher among the HCWs who worked in the Public Health Department (OR = 0.36, 95% CI = 0.2–0.6,  $p = 0.001$ ). Not having children and working in the Public Health Department (OR = 0.41, 95% CI = 0.1–0.8,  $p = 0.020$  and OR = 1.76, 95% CI = 1.0–2.9,  $p = 0.037$ , respectively) were associated with knowledge about the increased risk for adverse reactions when the 4CMenB vaccine was co-administered with another vaccine.

## Discussion

This study was conducted after the 4CMenB vaccine was placed on the market. This vaccine specifically prevents serogroup B meningitis, which is the serogroup most frequently involved in this disease, and against which no traditionally made vaccines were previously available. Since its approval for use, many concerns about the most appropriate vaccination strategy have been raised within the international and national scientific communities [17]. In fact, in the years following the 4CMenB vaccine being placed on the market, the scientists and public health advisors in charge of health policies have had different opinions on how to provide the 4CMenB

vaccine to the general population [14]. Therefore, the aim of the present study was to assess HCWs' knowledge about the 4CMenB vaccine and its vaccination strategy, while considering the role HCWs play in implementing vaccination coverage (whatever their position) within operative or decision-making units.

The present analysis determined that the majority of HCWs have sufficient knowledge about the lethality of the disease, but they are less informed about the incidence, higher risk age categories and most frequent serogroups involved. Many of them are confused about what is meant by mortality and lethality, and they mistakenly consider this disease to have a high mortality rate in the general population. The majority of the HCWs considered their knowledge about the vaccine and its vaccination schedule to be good, but only a few identified all of the targeted categories. This is particularly evident when considering immunosuppressed individuals, who are considered by the scientific community to be the group at highest risk and the most appropriate to receive the vaccine; however, they were identified as a target category by few of the HCWs. Moreover, some of the HCWs' answers were not consistent. For instance, one-third of the nurses believed that administering the 4CMenB vaccine with another vaccine enhanced the risk for adverse reactions, but only 15.0% indicated that the 4CMenB vaccine must be administered several days after another vaccine in order to reduce the risk for adverse reactions. Interestingly, those HCWs involved in surveillance and control activities had more knowledge about the epidemiological characteristics of the disease when compared with those working in the UOMI, where the HCWs are mainly involved in administering the vaccine to children. However, the HCWs working in the UOMI had better knowledge about the 4CMenB vaccination strategy and adverse reactions.

It was unexpected that only a few of the HCWs knew about the PNPV (60.0% of the HCWs) and Campania Vaccine Prevention Plan (30.0% of the HCWs) indications about 4CMenB vaccine use, considering that both of these documents represent reference tools for HCWs. One limitation of this study was that the questionnaire was self-administered; therefore, we cannot be sure that

Tab. VI. Knowledge about the meningococcal meningitis epidemiology and meningococcal serogroup B multicomponent (4CMenB) vaccine.

	Univariate		Multivariate	
	OR (95% CI)	p	OR (95% CI)	p
<b>HCWs' knowledge about the most common meningococcal serogroup in Italy</b>				
Sex (Male vs. Female*)	0.76 (0.4-1.2)	0.284	n.v.	
Age (< 50 vs. ≥ 50*)	1.74 (1.0-2.9)	0.037	2.02 (1.1-3.6)	0.022
Children (No vs. Yes*)	1.28 (0.6-2.7)	0.513	n.v.	
Degree (No vs. Yes*)	1.90 (1.1-3.1)	0.010	1.68 (0.4-6.3)	0.440
Profession (Doctor vs. Nurse*)	0.58 (0.3-0.9)	0.023	1.62 (0.4-6.0)	0.474
Department (Public health vs. Maternal childhood*)	0.17 (0.1-0.2)	0.000	0.29 (0.1-0.5)	0.000
Activity (Surveillance and control vs. Vaccination program*)	0.18 (0.0-0.3)	0.000	0.35 (0.1-0.8)	0.015
<b>HCWs' knowledge about the meningococcal meningitis mortality rate</b>				
Sex (Male vs. Female*)	0.47 (0.2-0.8)	0.005	0.51 (0.2-0.9)	0.034
Age (< 50 vs. ≥ 50*)	1.54 (0.9-2.6)	0.108	1.15 (0.6-2.0)	0.645
Children (No vs. Yes*)	1.09 (0.5-2.3)	0.811	n.v.	
Degree (No vs. Yes*)	1.43 (0.8-2.3)	0.145	1.28 (0.3-4.5)	0.704
Profession (Doctor vs. Nurse*)	0.71 (0.4-1.1)	0.149	1.59 (0.4-5.8)	0.481
Department (Public health vs. Maternal childhood*)	0.54 (0.3-0.8)	0.013	0.80 (0.4-1.4)	0.464
Activity (Surveillance and control vs. Vaccination program*)	0.36 (0.1-0.7)	0.005	0.34 (0.1-0.8)	0.014
<b>HCWs' knowledge about the 4CMenB vaccination schedule</b>				
Sex (Male vs. Female*)	0.98 (0.5-1.7)	0.932	n.v.	
Age (< 50 vs. ≥ 50*)	0.77 (0.4-1.4)	0.389	n.v.	
Children (No vs. Yes*)	0.69 (0.3-1.5)	0.358	n.v.	
Degree (No vs. Yes*)	1.53 (0.8-2.6)	0.133	0.90 (0.1-4.6)	0.901
Profession (Doctor vs. Nurse*)	0.60 (0.3-1.0)	0.066	0.32 (0.0-1.6)	0.174
Department (Public health vs. Maternal childhood*)	2.95 (1.6-5.2)	0.000	3.31 (1.6-6.7)	0.001
Activity (Surveillance and control vs. Vaccination program*)	2.04 (0.9-4.6)	0.087	1.40 (0.5-3.6)	0.487
<b>HCWs' knowledge about the 4CMenB vaccination being included among those recommended by the National Vaccine Prevention Plan</b>				
Sex (Male vs. Female*)	1.78 (1.0-2.9)	0.026	1.52 (0.8-2.6)	0.138
Age (< 50 vs. ≥ 50*)	0.99 (0.5-1.6)	0.983	n.v.	
Children (No vs. Yes*)	0.51 (0.2-1.1)	0.118	0.46 (0.1-1.1)	0.086
Degree (No vs. Yes*)	1.18 (0.7-1.9)	0.515	n.v.	
Profession (Doctor vs. Nurse*)	0.88 (0.5-1.4)	0.590	n.v.	
Department (Public health vs. Maternal childhood*)	3.04 (1.8-5.0)	0.000	3.22 (1.8-5.5)	0.000
Activity (Surveillance and control vs. Vaccination program*)	1.07 (0.5-2.0)	0.842	n.v.	
<b>HCWs' knowledge about the 4CMenB vaccination not being included among those implemented by the Regional Vaccine Prevention Plan in Campania</b>				
Sex (Male vs. Female*)	0.81 (0.4-1.3)	0.446	n.v.	
Age (< 50 vs. ≥ 50*)	0.93 (0.5-1.6)	0.811	n.v.	
Children (No vs. Yes*)	1.42 (0.6-3.3)	0.413	n.v.	
Degree (No vs. Yes*)	0.85 (0.5-1.4)	0.536	n.v.	
Profession (Doctor vs. Nurse*)	1.34 (0.8-2.2)	0.257	n.v.	
Department (Public health vs. Maternal childhood*)	0.50 (0.3-0.8)	0.010	0.36 (0.2-0.6)	0.001
Activity (Surveillance and control vs. Vaccination program*)	1.56 (0.7-3.2)	0.238	2.83 (1.2-6.3)	0.012
<b>HCWs' knowledge about the increased risk for adverse reactions when the 4CMenB vaccine is co-administered with another vaccine</b>				
Sex (Male vs. Female*)	1.02 (0.6-1.7)	0.931	n.v.	
Age (< 50 vs. ≥ 50*)	0.97 (0.5-1.6)	0.919	n.v.	
Children (No vs. Yes*)	0.44 (0.2-0.9)	0.030	0.41 (0.1-0.8)	0.020
Degree (No vs. Yes*)	1.03 (0.6-1.7)	0.923	n.v.	
Profession (Doctor vs. Nurse*)	0.85 (0.5-1.4)	0.521	n.v.	
Department (Public health vs. Maternal childhood*)	1.78 (1.0-2.9)	0.025	1.76 (1.0-2.9)	0.037
Activity (Surveillance and control vs. Vaccination program*)	1.38 (0.6-2.7)	0.368	n.v.	

OR: odds ratio; CI: confidence interval; HCWs: healthcare workers; n.v.: not valuated (p > 0.250 in the univariate analysis); \* Reference category

the participants responded without having first been informed about the topics of interest. However, the results from the present analysis did show that the HCWs' knowledge was often partial and incorrect.

Overall, it must be noted that all of the HCWs were still convinced that vaccinations are important instruments for infectious disease prevention, and they were aware of the key role that they play in promoting 4CmenB vac-

cinations, as well as other vaccines, and their need to be better informed.

## Conclusions

This study highlights the importance of and need to implement professional training courses for HCWs with interactive teaching methods. These should be suitable for an audience of experienced HCWs, as focus group, specific to the epidemiological aspects of meningococcal disease and the 4CMenB vaccine. These interventions would be useful for ensuring that HCWs are able to correctly answer patients' questions about the vaccine risks and benefits, because they represent the interface between public institutions and citizens [23].

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## Conflict of interest statement

None declared.

## Authors' contributions

EA conceived the study and revised it critically for important intellectual content; DP participated in its design and coordination, in interpretation data and wrote the manuscript; MGC revised the manuscript and contributed to data interpretation; AD has been involved in acquisition data and performed data entry and statistical analysis and contributed to data interpretation.

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