ORIGINAL ARTICLE

Vaccination coverage in healthcare workers: a multicenter cross-sectional study in Italy

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Keywords

Healthcare workers • Vaccination coverage • Vaccines

Summary

Introduction. *In recent years, a phenomenon known as "vaccine hesitancy" has spread throughout the world, even among health workers, determining a reduction in vaccination coverage (VC).*
A study aimed at evaluating VC among healthcare workers (HCWs) in 10 Italian cities (L'Aquila, Genoa, Milan, Palermo, Sassari, Catanzaro, Ferrara, Catania, Naples, Messina) was performed.
Materials and methods. *Annex 3 of the Presidential Decree n. 445 of 28 December 2000 was used to collect information on the vaccination status of HCWs. The mean and standard deviation (SD) were calculated with regard to the quantitative variable (age), while absolute and relative frequencies were obtained for categorical data (sex, professional profile, working sector, vaccination status). The connection between VC and the categorical variables was evaluated by chi-square method (statistical significance at $p < 0.05$). The statistical analyses were performed by SPSS and Stata software.*
Results. *A total of 3,454 HCWs participated in the project: 1,236 males and 2,218 females.*
The sample comprised: physicians (26.9%), trainee physicians (16.1%), nurses (17.2%) and other professional categories (9.8%). Low VC was generally recorded. Higher VC was found with regard to polio, hepatitis B, tetanus and diphtheria, while coverage was very low for measles, mumps, rubella, pertussis, chickenpox and influenza (20-30%).
Conclusions. *This study revealed low VC rates among HCWs for all the vaccinations. Measures to increase VC are therefore necessary in order to prevent HCWs from becoming a source of transmission of infections with high morbidity and/or mortality both within hospitals and outside.*

Introduction

Although vaccination is widely considered to be an efficacious and cost-effective health technology, the phenomenon known as 'vaccine hesitancy' is spreading, not only among citizens, but also among healthcare workers (HCWs), with a consequent steady reduction in vaccine coverage (VC) [1-8]. This is a serious health problem, as HCWs may spread infections to patients, colleagues and relatives. Indeed, low VC among HCWs can lead to dangerous outbreaks of disease, reduce productivity and increase absenteeism [9-11]. HCWs are therefore a priority target group for vaccinations [12-14].
Inadequate vaccination coverage among HCWs is a major concern for all national healthcare organizations. The World Health Organization (WHO) estimates that approximately 59 million HCWs worldwide are potentially exposed to hazardous biological agents daily [13]. In Europe, the average VC among HCWs is very low [3]. As recommended by the WHO Strategic Advisory Group of Experts (SAGE), vaccine hesitancy, and thus VC, need to be evaluated both globally and locally [1, 2].
The 2017-2019 Italian National Immunization Prevention Plan (INIPP) strongly recommends that HCWs be vaccinated [14]. However, although data are not systematically available, VC among HCWs is estimated to be very low. Indeed, only few studies have been conducted on this issue, and these have concerned a limited number of hospitals and are clearly not representative of the national scenario in Italy. One systematic review regarding Italy revealed suboptimal VC for hepatitis B and measles, and very low VC for varicella (3.6%) and influ-

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enza (10-25%) [15]. Similarly, a study from the Puglia region found tetanus-diphtheria vaccination uptake to be only15.5% [16]. Another study, published in 2015, reported an influenza vaccination uptake of 16% among HCWs [17].
In 2017, in accordance with the INIPP, a committee of Italian experts drafted "The Pisa Charter of Vaccinations", which identified the main pillars of a strategy to boost VC among HCWs [18].
Law 119/2017, concerning "Urgent provisions on vaccination prevention, infectious diseases and disputes related to the administration of drugs" [19], and Ministerial Circular 25233 of 16 August 2017 required that data be collected on the vaccination status of workers in schools, healthcare and social care. Indeed, as required by Presidential Decree 445 of 28 December 2000, teachers, social workers and HCWs must submit a report of their vaccination status to the institutions for which they work. However, despite these legal measures, vaccinations have not become mandatory for HCWs. Hence, healthcare professionals are under no legal obligation to be vaccinated [20-22].
The aim of our study was to investigate the VC of HCWs at several academic hospitals in Italy.

Materials and methods

A multicenter cross-sectional study was conducted from March to September 2018 in the following 10 cities: L'Aquila, Genoa, Milan, Palermo, Sassari, Catanzaro, Ferrara, Catania, Naples and Messina.
Ethical approval was obtained from the Ethics Committee of the University Hospital "AOU G. Martino di Messina". Written informed consent was obtained from all subjects before participation in the study.
Annex 3 of Presidential Decree n. 445 28 December 2000 was used to collect information on the vaccination status of HCWs [22]. Statistical analysis of the parameters considered relevant was performed. The mean and standard deviation (SD) were calculated with regard to the quantitative variable (age), while absolute and relative frequencies were obtained for categorical data (sex, professional profile, working sector, vaccination status). All possible associations between VC and the data collected (sex, professional profile, working sector, vaccination status were investigated; 2 x 2 contingency tables were constructed, and assumptions were tested by means of the chi-square method. Statistical significance threshold was set at $p = 0.050$; p-values of less than 0.050 on two-tailed tests were considered statistically significant. The summary and inferential statistics were analyzed by means of SPSS and Stata software.

Results

A total of 3,454 HCWs participated in the study: 1,236 males and 2,218 females.
The sample comprised physicians (26.9%), physicians in training (16.1%), nurses (17.2%) and other professional categories (9.8%). In 30% of cases, the respondents did not state their profession.
The mean age of the whole sample was 45.85 years (SD: 11.82; CI: 45.45-46.24; IQR: 21.8). The mean age of male subjects was 46.39 years (SD: 12.67; CI: 45.68-47.10; IQR: 24.6), and of females 45.55 years (SD: 11.32; CI: 45.08-46.02; IQR: 20.9). The sample was also stratified by age-group: 20-30 years (11.61%), 31-40 (24.2%), 41-50 (22.32%), 51-60 (28.31%), ≥ 61 (12.88%); 0.68% of the sample did not state their age.
The sample was divided into three working areas: clinical (32.7%), surgical (29.8%) and services (21.9%); 15.6% of the sample did not provide information on this item.
Regarding the provenance of the respondents: 6.5% were from the north of Italy, 1.1% from the central regions and 67.2% from the south; 873 subjects (25.3%) did not report their region of birth.
Evaluation of replies regarding immunization status revealed inadequate VC, i.e. below 95% for all vaccinations examined. Higher VC was found with regard to polio, hepatitis B, tetanus and diphtheria, while coverage was very low for measles, mumps, rubella, pertussis, chickenpox and influenza (20-30%); lower VC rates were found for vaccinations not specifically recommended for HCWs (i.e. herpes zoster, meningococcus). Many HCWs could not remember or did not report their immunization status (Tab. I).
The vaccinations that are not specifically recommended for HCWs were excluded from the next statistical analysis (*H. influenzae, Meningococcus C, Meningococcus B, Pneumococcus*, Hepatitis A, Papilloma virus, Herpes zoster, Tuberculosis).
Differences of coverage rates considering sex, age, working area and professional category were analyzed. For these analyses the category "not reported or not remember" was excluded.
Regarding to sex we did not find significant differences except to rubella, chickenpox and mumps. Men HCWs showed higher vaccine coverage than women.
Concerning age, we evaluated the difference of coverage rates for the following vaccines: polio, diphtheria, tetanus, hepatitis B, pertussis, measles, rubella, mumps, influenza considering five age-groups. Vaccination coverage by age is shown in Table II. Significant differences were found for poliomyelitis, tetanus, pertussis and influenza. 51-60 age-class showed higher VC for poliomyelitis, diphtheria and tetanus, while higher VC for influenza was detect in ≥ 61 years subjects.
Excluding HCWs who did not report their working sector, we evaluated the vaccination coverage for the following vaccines: polio, diphtheria, tetanus, hepatitis B, pertussis, measles, rubella, mumps, chickenpox and influenza (Tab. III). Significant differences were found only for hepatitis B vaccine.
Excluding HCWs who did not reported their professional profile, we evaluated the vaccination coverage for the following vaccines: polio, diphtheria, tetanus, hepatitis

Tab. I. Vaccination coverage and natural immunity reported by HCWs, broken down by type of vaccination.

	Not vaccinated (%, CI)	Vaccinated (%, CI)	Not reported (%, CI)	Natural immunity (%, CI)
Poliomyelitis	3.1 (2.55-3.71)	80.0 (78.69-81.36)	16.9 (15.55-18.04)	0.0
Diphtheria	6.2 (5.42-7.03)	72.4 (70.95-73.93)	21.3 (19.94-22.67)	0.0
Tetanus	5.9 (5.09-6.66)	76.8 (75.34-78.16)	17.3 (16.08-18.60)	0.0
Hepatitis B	9.6 (8.60-10.56)	77.3 (75.93-78.73)	12.5 (11.43-13.64)	0.6 (0.35-0.86)
Pertussis	33.9 (33.35-35.51)	29.5 (27.95-30.99)	31.6 (30.056-33.17)	5.0 (4.25-5.71)
Measles	27.5 (25.99-28.96)	30.3 (28.72-31.79)	27.4 (25.9-28.88)	14.8 (13.69-16.07)
Rubella	29.1 (27.61-30.64)	30.9 (29.35-32.43)	27.3 (25.79-28.76)	12.7 (11.60-13.82)
Chickenpox	32.6 (31.07-34.19)	16.4 (15.21-17.78)	28.5 (27.01-30.02)	22.5 (21.02-23.80)
Mumps	36.2 (34.59-37.79)	23.7 (22.26-25.10)	31.5 (29.98-33.08)	8.6 (7.66-9.53)
H. influenzae	56.1 (54.4-57.71)	4.1 (3.42-4.74)	39.7 (38.18-41.44)	0.1 (0.01-0.23)
Influenza	44.2 (42.53-45.84)	14.0 (12.87-15.18)	41.8 (40.14-43.43)	0.0
Meningococcus C	53.5 (51.81-55.14)	7.1 (6.24-7.95)	39.4 (37.8-41.06)	0.0
Meningococcus B	57.2 (55.59-58.89)	3.1 (2.49-3.64)	39.7 (38.06-41.32)	0.0
Pneumococcus	57.4 (55.73-59.03)	2.7 (2.18-3.26)	39.8 (38.18-41.44)	0.1 (0.01-0.23)
Hepatitis A	52.2 (50.50-53.84)	7.1 (6.31-8.03)	40.2 (38.56-41.83)	0.0
Papilloma virus	58.7 (57.00-60.29)	1.9 (1.53-2.46)	39.4 (37.79-41.05)	0.0
Herpes zoster	58.9 (57.30-60.58	0.7 (0.47-1.03)	40.0 (38.36-41.63)	0.4 (0.22-0.65)
Tuberculosis	41.5 (39.83-43.11)	24.5 (23.06-25.93)	33.8 (32.26-35.41)	0.3 (0.14-0.50

Tab. II. Vaccination coverage, by age.

	20-30 y (%, CI)	31-40 y (%, CI)	41-50 y (%, CI)	51-60 y (%, CI)	61+ y (%, CI)	p <
Poliomyelitis	77.89 (73.97-81.37)	78.51 (75.51-81.23	78.89 (75.94-81.56)	83.16 (80.68-85.38)	79.84 (75.45-83.61)	0.05
Diphtheria	70.04 (65.81-73.96)	72.69 (69.48-75.69)	71.23 (68.02-74.25)	74.64 (71.81-75.61)	71.24 (66.43-75.61)	N.S.
Tetanus	76.03 (72.02-79.63)	76.61 (73.53-79.43)	74.57 (71.45-77.45)	79.36 (76.70-81.79)	75.54 (70.91-79.64)	0.05
Hepatitis B	78.26 (74.36-81.72)	79.90 (76.96-82.55)	75.80 (72.73-78.63)	76.90 (74.15-79.44)	75.81 (71.19-79.89)	N.S.
Pertussis	23.14 (19.60-27.11)	29.37 (26.29-32.64)	32.47 (29.33-35.77)	29.98 (27.18-32.93)	30.91 (26.42-35.80)	0.01
Measles	30.17 (26.24-34.41)	32.24 (29.07-35.58)	29.01 (25.99-32.24)	29.98 (27.18-32.93)	30.65 (26.17-35.52)	N.S.
Rubella	28.51 (24.66-32.70)	31.23 (28.09-34.54)	32.10 (28.97-35.40)	30.80 (27.98-33.77)	31.45 (26.93-36.35)	N.S.
Mumps	21.28 (17.86-25.16)	24.78 (21.89-27.91)	23.46 (20.66-26.50)	24.23 (21.64-27.02)	23.92 (19.86-28.53)	N.S.
Influenza	8.26 (6.12-11.07)	14.16 (11.90-16.77)	14.94 (12.64-17.56)	15.30 (13.17-17.70)	15.59 (12.25-19.64)	0.001

Tab. III. Vaccination coverage, by working sector.

	Clinical sector (%, CI)	Surgical sector (%, CI)	Service sector (%, CI)	p <
Poliomyelitis	81.40 (79.02-83.56)	82.78 (80.35-84.97)	81.82 (78.91-84.40)	N.S.
Diphtheria	72.98 (70.32-75.50)	73.54 (70.76-76.15)	73.39 (70.12-76.41)	N.S.
Tetanus	75.38 (72.78-77.80)	76.75 (74.07-79.23)	77.34 (74.22-77.88)	N.S.
Hepatitis B	73.76 (71.11-76.25)	77.24 (74.57-79.70)	79.71 (76.70-82.42)	0.05
Pertussis	28.01 (25.47-30.71)	30.45 (27.71-33.33)	31.09 (27.90-34.48)	N.S.
Measles	27.81 (25.27-30.50)	28.99 (26.29-31.84)	28.72 (25.61-32.05)	N.S.
Rubella	28.61 (26.05-31.32)	31.03 (28.27-33.93)	30.57 (27.39-33.94)	N.S.
Mumps	21.97 (19.65-24.48)	24.32 (21.79-27.04)	22.00 (19.20-25.09)	N.S.
Chickenpox	18.60 (16.44-20.98)	17.61 (15.40-20.06)	18.18 (15.60-21.09)	N.S.
Influenza	17.54 (15.43-19.87)	13.62 (11.65-15.86)	13.70 (11.43-16.34)	N.S.

B, pertussis, measles, rubella, mumps, chickenpox and influenza (Tab. IV). Significant differences were found for polio, diphtheria, hepatitis B, rubella and chickenpox. Physicians showed significant higher coverage than nurses and other healthcare workers for hepatitis B and rubella.

Regarding to influenza vaccination the highest coverage was found in other professional categories respect to physicians and nurses.

Discussion and conclusions

This study revealed low VC rates among HCWs for all the vaccinations. Such coverage rates are totally inadequate in terms of preventing not only disease transmission by susceptible HCWs, but also nosocomial outbreaks, an example being the recent outbreaks of measles in Italy [23, 24] confirming data from previous studies at the national and international levels [3, 7, 8, 12, 16, 17, 25, 26].

Tab. IV. Vaccination coverage reported by different categories of HCWs.

	Physicians (%, CI)	Nurses (%, CI)	Other healthcare workers (%, CI)	p <
Poliomyelitis	78.38 (76.22-80.41)	81.96 (78.65-84.85)	82.60 (78.18-86.27)	0.05
Diphtheria	71.92 (69.58-74.15)	72.51 (68.78-75.96)	74.04 (69.11-78.43)	0.05
Tetanus	78.05 (75.87-80.08)	76.73 (73.15-79.96)	76.40 (71.58-80.62)	N.S.
Hepatitis B	79.45 (77.31-81.43)	76.56 (72.98-79.80)	72.57 (67.57-77.06)	0.01
Pertussis	28.08 (25.85-30.42)	31.20 (27.59-35.04)	29.59 (24.96-34.67)	N.S.
Measles	32.73 (30.39-35.16)	30.86 (27.27-34.70)	30.68 (26.00-35.80)	N.S.
Rubella	31.87 (29.53-34.27)	31.70 (28.08-35.56)	31.56 (26.83-36.71)	0.05
Mumps	24.58 (22.45-26.84)	23.10 (19.88-26.67)	25.96 (21.57-30.89)	N.S.
Chickenpox	13.94 (12.27-15.80)	19.93 (16.88-23.31)	16.81 (13.20-21.18)	0.001
Influenza	11.38 (9.86-13.10)	14.00 (11.43-17.03)	17.40 (13.73-21.82)	0.001

Higher coverage was observed among men than women; this is in contrast with the literature data, where the higher rates in women are due to the prevention of risks related to some infections in pregnant women [27, 28, 29]. Our finding may be linked to the high percentage of HCWs who filled "not remember" or did not reported their vaccination status.

As regards age, the youngest showed higher rates of vaccination against hepatitis B although no significance difference was found. The seasonal influenza vaccination coverage was higher in ≥ 61 years subjects ($p < 0.001$) although VC was very far from the minimum recommended level. These findings are in line with the literature [8, 9, 17, 30-40].

The international literature reports higher VC rates of physicians than other healthcare workers [33-35, 41, 42], however we find this only for hepatitis B and rubella. This result could be explained on the hand with high percentage of physicians who did not declared their vaccination status, on the other hand with the high percentage of HCWs who did not report their professional profile. The highest coverage rates were found in pediatric workers (data not shown) but the differences between these and other clinical groups were not statistically significant. Although international literature data on vaccination coverage among pediatricians are limited, higher coverage rates and more positive attitudes towards vaccinations have been reported [7, 12, 36, 43].

Limited differences were found based on the working sector, higher rates of VC were found among staff working in services than among workers in either surgical or medical departments only for hepatitis B.

The low vaccination coverage for all vaccines could be explained by the fear of adverse effects, despite the fact that many scientific studies, systematic reviews and meta-analyses of the literature have shown such fears to be groundless [44-47]. In order to combat "vaccine hesitancy" among HCWs, it is essential to promote clear and effective communication regarding vaccinations and to adopt innovative strategies (e.g. promoting vaccination via social networks and the mass media, training HCWs, providing vaccination in the workplace) [48, 49].

Vaccine-hesitant HCWs might also deter patients' vaccination uptake [49]. Another issue detected in our study was the high percentage of HCWs who declared not recalling what vaccinations they had received; this probably reflects a lax attitude and a lack of confidence in vaccination. HCWs should understand that all vaccines are safe and useful; they should regard vaccination both as a right and as a duty, in order to protect themselves and their patients [37].

A major strength of the present study is that it was a multicenter study involving several centers located in northern, central and southern regions of Italy and used an official form to collect data on vaccination status. By contrast, the fact that the data were self-reported constitutes a limitation. Indeed, many HCWs, especially in the older age-groups, may not have recalled which vaccinations they had received or might have declared that they did not remember, in order to avoid incurring legal action. Further, it was not possible evaluating the differences on propensity to vaccines between HCWs residing in North Centre and South Italy as about 30% of HCWs did not report their residence and about 40% were residents in the major islands of Italy (Sicily and Sardinia).

In conclusion, the question of vaccination among HCWs is challenging and fraught with ethical issues. Mandatory measures may be needed in order to achieve better coverage, such as those implemented by the regional Laws of Emilia Romagna, Marche and Puglia [50-52]. Mandatory policies are currently under debate in several countries, and high-quality studies would help policymakers and stake-holders to shape evidence-based initiatives and programs to improve VC and the control of infectious diseases through the correct application of guidelines on prevention [53, 54].

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Conflict of interest statement

None declared.

Authors' contributions

GC and RS conceived the study. GT verified the analytical methods. All authors contributed to data acquisition. GC, RS, RS, GI, DP, IA and MP contributed to the interpretation of the results. GC and RS wrote the manuscript, with input from all authors.

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