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# KNOWLEDGE, ATTITUDES, BELIEFS AND PRACTICES OF OCCUPATIONAL PHYSICIANS TOWARDS VACCINATIONS OF HEALTH CARE WORKERS: A CROSS SECTIONAL PILOT STUDY IN NORTH-EASTERN ITALY

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**Abstract**

**Objectives:** This study aims to characterize personal attitudes and knowledge of a sample of Italian occupational physicians (OPhs) towards immunization practice in the case of healthcare workers (HCWs). **Material and Methods:** A total of 90 OPhs (42.2% of males, 57.8% of females, mean age of 50.1±8.3 years old) compiled a structured questionnaire through a telephonic interview. They were asked about the official Italian recommendations for HCWs, their general knowledge of vaccine practice, their propensity towards vaccines (both in general and about specific immunizations), their risk perception about the vaccine-preventable infectious diseases. Eventually, a regression analysis was performed in order to identify factors predictive for vaccine propensity. **Results:** Only 12 out of 90 subjects correctly identified all the 7 recommended immunizations. The hepatitis B virus (HBV) vaccine was correctly identified by 95.6% of the sample, and was also associated with the more positive attitude and the more accurate risk perception. Influenza vaccine had the lowest acceptance (75.9%). Eventually, pertussis, measles, parotitis and varicella vaccines were insufficiently recognized as

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recommended ones (all cases < 50% of the sample). General knowledge of vaccine and knowledge of official recommendations were significantly correlated with the attitude towards immunization practice (r = 0.259, p = 0.014 and r = 0.438, p < 0.0001). In the regression analysis general knowledge (unstandardized coefficient (B) = 0.300, 95% confidence interval (CI): 0.090–0.510, p = 0.006) and risk perception (B = 0.579, 95% CI: 0.155–1.003, p = 0.008) were significant predictors of the propensity to vaccinate. **Conclusions:** Vaccinations gaps in HCWs may found their roots in OPhs incomplete knowledge of evidence-based recommendations. Specific training programs and formations courses should then be planned. Int J Occup Med Environ Health 2017;30(5):775–790

**Key words:**
**Occupational infection, Healthcare workers, Immunization, Occupational physician, Vaccination recommendation, Vaccine hesitancy**

## INTRODUCTION

Healthcare workers (HCWs) are at increased risk of acquiring and transmitting communicable diseases due to their occupational exposure to patients and bodily fluids [1]. As many of these diseases may transmit during the incubation period, or manifest with atypical symptoms, vaccines remain the most cost-effective available preventive measure. Specific vaccination policies of HCWs are therefore justified in order to protect both the workers and their patients against several biologic risk agents [2–7], delivering significant cost savings for healthcare organizations [8–10].

Vaccination policies for HCWs should then be integrated in all the healthcare settings. In Italy, for instance, specific recommendations for HCWs are issued by the Ministry of Health issues through the National Immunization Prevention Plan (Piano Nazionale di Prevenzione Vaccinale – PNPV), a guidance document for immunization policies [11]. These recommendations provide advice regarding the vaccinations recommended for HCWs (i.e., hepatitis, influenza, pertussis, measles, mumps, rubella, varicella) as well as the duration of protection after vaccination and need for booster vaccinations [11]. Application of immunization policies for the workplaces is a main issue for Occupational Physicians (OPhs). With specificities stemming from the respective national legislations, OPhs are the medical professionals responsible for health promotion in the workplaces, and contribute to immunizations programs both directly applying and tailoring official recommendations (i.e., PNPV in Italy, Standing Committee on Vaccination (Ständigen Impfkommission – STIKO) in Germany, etc.) as appropriate vaccination policies. This is of particular importance for some vaccine preventable diseases (VPD); e.g., diphtheria, tetanus and pneumococcal disease), the risk of which for HCWs is usually reputed not greater than in the general population, although some healthcare settings (i.e., acute-care hospitals, intensive-care units, nursing homes, and more specifically HCWs caring subjects vulnerable to severe or complicated infections) may require additional precautions, in particular for respiratory pathogens such as pneumococcus [2,3,11,12].

Moreover, OPhs are directly involved in the communication of risk, participating in the information and formation of the workers [12]: in Italy, Occupational Health and Safety Legislation [13] requires that the OPhs will inquiry vaccination history, recall the vaccination status, and inform the workers about the pros and cons of recommended vaccinations.

Unfortunately, vaccination levels of HCWs in high income countries remain largely insufficient, particularly in Italy [11,14–17]. Assessing the beliefs, attitudes and knowledge of specific occupational groups regarding vaccination may therefore be useful in order to tailor vaccination campaigns and improving vaccination rates [18]. Although numerous studies have assessed why HCWs do not receive the recommended vaccinations [16–20], knowledge, attitudes and practices (KAP) of the OPh have been scarcely investigated [12]. This is a critical issue, as OPhs are not only HCWs themselves (being therefore directly involved in the potential chain of transmission) but they also per-

form and promote vaccinations, and may implement acceptance and knowledge among other HCWs [12]. Appropriate interventions on OPhs may then maximize the consent for vaccination programs, contributing to overcome the mutual misunderstanding between public health professionals and vaccine hesitant individuals or even vaccine objectors.

Therefore, the main endpoint of this study is to assess KAP of OPhs about vaccinations and vaccination policies. In particular, we explored both general and specific recommendations for HCWs, and how KAP relate to these recommendations. Moreover, as several uncertainties still remain regarding the implementation of pneumococcus vaccination among HCWs, this topic has been specifically evaluated. Eventually, our results may be useful in order to identify areas that may be targeted for improvement through specific informative and educative campaigns dedicated to OPhs.

## MATERIAL AND METHODS

### Study design

In this cross-sectional questionnaire study, OPhs operating in the Autonomous Province (AP) of Trento, Italy, were asked about their knowledge and attitudes towards vaccination [21,22]. In particular, we tested specific knowledge and attitudes of OPhs regarding vaccinations recommended for HCWs by the PNPV 2012–2014 [11].

### Study population

A seminar on occupational health took place in the AP of Trento in October 2015. All participating OPhs with specialization in occupational medicine (N = 106), and assisting at least one healthcare provider in the AP of Trento were asked whether they would agree to participate in a survey about knowledge and attitudes towards vaccinations. The collected sample included 95 professionals, representing the 39.7% of all OPh operating in the AP of Trento by December 2015 (N = 239, 183 males, 56 females; age (mean (M) ± standard deviation (SD)) = 51.6±10.6 years old). All subjects agreeing to participate were informed they would receive a telephonic interview in the following weeks.

### Ethical considerations

Before they gave their consent, participants had been informed that all information would be gathered anonymous and handled confidentially. Participation was voluntary, and the questionnaire was collected only from subjects who had expressed consent for study participation. As individual participants cannot be identified based on the presented material, this study caused no plausible harm or stigma to participating individuals. Eventually, no preliminary evaluation by the Ethical Committee was reputed necessary.

### Questionnaire

Two specifically formed healthcare professionals compiled a structured questionnaire through a telephonic interview. All surveys were conducted between November and December 2015.

As duties and responsibilities of OPhs are substantially similar in Italy and Germany, and also National recommendations for vaccinations in HCWs are quite similar, our inquiry was performed through an adapted and translated version of the utility previously developed by Zingg and Siegrist, and then reformulated for German OPhs by Betsch and Wicker [12,22,23]. The questionnaire comprised some general demographic information (i.e., age, sex, country of origin) and 22 items divided in 4 areas of inquiry.

#### Knowledge of official vaccination recommendations

Sixteen vaccine preventable diseases were presented (i.e., diphtheria, tetanus, pertussis, poliomyelitis, viral hepatitis A, viral hepatitis B, influenza, pneumococcus, *Haemophilus influenzae*, measles, rubella, parotitis, varicella,

meningococcus, human papillomavirus (HPV), tuberculosis). For each disease, participants indicated whether they thought that PNPV 2012–2014 recommends vaccination for HCWs (possible answers: "yes," "no," "don't know"). Knowledge regarding the official vaccination recommendations was calculated as the sum of correctly and incorrectly marked recommendations: when the occupational physicians correctly indicated a vaccination as recommended or not recommended by PNPV, +1 was added to a sum score, whereas a wrong indication or a "don't know" answer added –1 to the sum score. The National Immunization Prevention Plan 2012–2014 recommends 7 vaccinations for HCWs: pertussis, viral hepatitis B, influenza, measles, rubella, parotitis, varicella [11].

### General knowledge

The original knowledge test developed by Zingg and Siegrist [23] contains true-false statements such as "vaccinations increase the occurrence of allergies" (false) covering some typical misconceptions on vaccination. Both the original test and the revised version applied by Betsch and Wicker interpreted the sum of all incorrect answers as the degree of misconceptions held by the participant [12,21–23]. In fact, this test successfully predicted influenza risk perceptions and vaccination intentions in previous studies [12,21–23]. Briefly, a total of 14 statements were presented, and general knowledge was then calculated as the sum of correctly and incorrectly marked recommendations: when the occupational physicians correctly answered, +1 was added to a sum score, whereas a wrong indication or a missing/"don't know" answer added –1 to the sum score.

### Risk perception

In their previous study about attitudes and knowledge of OPh about vaccinations in the case of HCWs, Betsch and Wicker defined perceived risk as a function of the perceived probability of an event and its expected consequences, and therefore assessed as the mathematical product of subjective probability and disease severity [12,21–24]. We inquired the risk perception of OPh about 8 infectious diseases usually associated with HCWs (i.e., pertussis, viral hepatitis B, influenza, pneumococcus, measles, rubella, parotitis, varicella), that is the 7 vaccinations recommend by PNPV 2012–2014 and the vaccination for pneumococcus, the introduction of which in the future recommendations was debated at the time of the survey. In particular, we asked the OPh about the probability of a) presented infections in HCWs and b) vaccine-related adverse effects, and whether they perceived the severity c) of the natural infections and d) of vaccine-related adverse effects. In order to summarize the results, we used a fully labeled 7-point scale (i.e., "almost zero," "low," "rather low," "moderate," "rather high," "high," "very high"). The risk perception score was calculated as cumulative score (i.e., sum) for the 7 vaccines recommended to the HCWs by the PNPV 2012–2014 (i.e., pertussis, viral hepatitis B, influenza, measles, rubella, parotitis, varicella), and for the 7 recommended vaccines plus pneumococcus vaccine. Calculation was obtained through the formula:

$$\text{risk perception} = I^{INF} \times C^{INF} - I^{VAC} \times C^{VAC} \quad (1)$$

where:

$I^{INF}$ – perceived probability of infection in the case of HCWs,
$C^{INF}$ – perceived consequence of infection in the case of HCW,
$I^{VAC}$ – perceived probability of vaccine-related adverse effects,
$C^{VAC}$ – perceived consequence of vaccine-related adverse effects.

### Attitudes

Attitudes towards vaccinations were assessed both in general and in particular. Initially, participants were asked about their immunization status. Completed and up-to-date vaccination was defined as follows: one shot for rubella, Bacillus Calmette-Guérin (BCG), *H. influenzae*, pneumococcus, meningococcus, and seasonal influen-

za, 2 shots for measles, mumps, varicella, or hepatitis A, 4 shots for poliomyelitis, and 3 shots for HPV, hepatitis B (all shots within the appropriate time schedule for each disease), and one booster shot against pertussis and tetanus-diphtheria within the last 10 years. Subsequently, OPh rated their general attitudes towards vaccinations through a 7-point scale (i.e., "absolutely against vaccinations," "strongly against vaccinations," "somewhat against vaccinations," "neutral," "somewhat in favor of vaccinations," "strongly in favor of vaccinations," "absolutely in favor of vaccinations"). Finally, participants rated their specific propensity towards the 16 vaccine-preventable diseases previously presented (i.e., diphtheria, tetanus, pertussis, poliomyelitis, viral hepatitis A, viral hepatitis B, influenza, pneumococcus, *H. influenzae*, measles, rubella, parotitis, varicella, meningococcus, HPV, tuberculosis) through a 5 points on Likert scale (i.e., 1 – strongly disagree; 2 – disagree; 3 – neutral; 4 – agree; and 5 – strongly agree). A cumulative score (i.e., "propensity score") was calculated as the sum of the single attitudes: in general (all presented vaccines), for HCWs recommended vaccines, and for the 7 HCWs recommended vaccines plus pneumococcus vaccine, in order to directly compare the risk perception and attitude toward these vaccinations.

### Data analysis

Two independent researchers, one of whom read the responses from each questionnaire while the other researcher reviewed the entered data, ensured the accuracy of data entry. The primary investigator examined unclear responses to determine the correct answer. We calculated the described indices for general knowledge, knowledge about PNPV, risk perception and general knowledge, which assess the extent to which physicians pass on official recommendations to their patients. In order to more easily compare the scales, all results were normalized to unity (min. 0.0, max 1.0).

Continuous variables were expressed as M±SD. Categorical variables were reported as per cent values. Univariate confrontation between proportions were evaluated through the $Chi^2$ test (with continuity correction) whereas continuous variables were performed through Student's t-test for unpaired data or ANOVA when appropriate. Comparisons of propensity and risk perception scores through ANOVA required the *post hoc* Dunnett's test. Since hepatitis B virus (HBV) vaccine has been repetitively recognized as well accepted, and the potential consequences of HBV infection are similarly well known among HCWs, attitudes and risk perception regarding this specific immunization have been assumed as the referent ones. Relations between the continuous variables were explored through the calculation of the Pearson product-moment correlation coefficient (i.e., Pearson's r). In regression analyses (SPSS 23, IBM Corp. Armonk, USA), we assessed the relative influence of attitudes, including self-reported immunization status, general knowledge, and knowledge about recommendations on both the recommendation score and the reported vaccinations. In the analyses, we controlled for age, sex and ethnicity (i.e., Italian born vs. non-Italian born people). Significance level was 5%.

## RESULTS

### Descriptive analysis

Eventually, 90 out of 95 OPh (94.7%; 89.6% of the original sample) participated to the inquiry: 38 (42.2%) were males, and 52 (57.8%) females, with a mean age of 50.1±8.3 years.

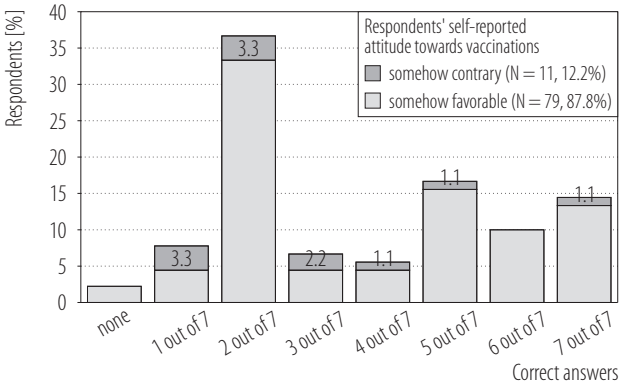
### Assessment of Vaccine Knowledge

After normalization, the mean Vaccine Knowledge score was 0.57±0.18 (range 0.06–1.00) (Table 1). Overall, 12/90 (13.3%) recalled all the 7 recommended vaccines, and 35/90 (38.9%) were able to identify at least 5 out of 7 recommended HCWs immunizations. Eventually, 42/90 (46.7%) recalled only 2 or even less of the recommended vaccines (Figure 1). The most frequently recalled recommended vaccination was HBV (86/90, 95.6%), followed by

**Table 1.** Italian occupational physicians' (OPhs) knowledge of the vaccinations recommended by PNPV 2012–2014 for healthcare workers (HCWs), 2015

| Vaccination | Official PNPV 2012–2014 recommendation regarding HCWs | Respondents' answers (N = 90) [n (%)] | | |
|---|---|---|---|---|
| | | correct | incorrect | no answer/ don't known |
| Diphtheria | not recommended | 49 (54.5) | 35 (38.9) | 6 (6.7) |
| Tetanus | not recommended | 24 (26.7) | 64 (71.1) | 2 (2.2) |
| Pertussis | recommended | 26 (28.9) | 57 (63.3) | 7 (7.8) |
| Poliomyelitis | not recommended | 50 (55.6) | 35 (38.9) | 5 (5.6) |
| Viral hepatitis A | not recommended | 62 (68.9) | 23 (25.6) | 5 (5.6) |
| Viral hepatitis B | recommended | 86 (95.6) | 2 (2.2) | 2 (2.2) |
| Influenza | recommended | 80 (88.9) | 8 (8.9) | 2 (2.2) |
| Pneumococcus | not recommended | 62 (68.9) | 20 (22.2) | 8 (8.9) |
| *Haemophilus influenzae* | not recommended | 65 (72.2) | 11 (12.2) | 14 (15.6) |
| Measles | recommended | 40 (44.4) | 45 (50.0) | 5 (5.6) |
| Rubella | recommended | 37 (41.1) | 48 (53.3) | 5 (5.6) |
| Parotitis | recommended | 37 (41.1) | 47 (52.2) | 6 (6.7) |
| Varicella | recommended | 22 (24.4) | 62 (68.9) | 6 (6.7) |
| Meningitis | not recommended | 63 (70.0) | 19 (21.1) | 8 (8.9) |
| Human papillomavirus | not recommended | 80 (88.9) | 2 (2.2) | 8 (8.9) |
| Tuberculosis | not recommended | 38 (42.2) | 48 (53.3) | 4 (4.4) |

PNPV – Piano Nazionale di Prevenzione Vaccinale (National Immunization Prevention Plan) [11].




PNPV – Piano Nazionale di Prevenzione Vaccinale (National Immunization Prevention Plan) [11].

**Fig. 1.** Italian occupational physicians (OPhs) (N = 90) who correctly recalled vaccinations recommended by PNPV 2012–2014 for healthcare workers (HCWs), 2015

influenza (80/90, 88.9%) whereas less than half of the sample (42/90, 46.7%) knew that there was no special recommendation for the vaccination against tuberculosis. Moreover, around 20% of the sample incorrectly indicated that there were recommendations to vaccinate HCWs against pneumococcus (20/90, 22.2%) and meningococcus (19/20, 21.1%).

After normalization, the range of the General Knowledge score was 0.18–0.89, with a mean of 0.71±0.15. In particular, 47/90 (52.2%) failed to identify the vaccine additives as not dangerous for human health, with several subjects causatively associating vaccines with neurological diseases such as subacute sclerosing panencephalitis (27/90, 30%), lethargic encephalitis (17/90, 18.9%), and even au-

tism (16/90, 17.8%), and autoimmune diseases in general (23/90, 25.6%), the latter including in particular multiple sclerosis (12/90, 13.3%). Moreover, around a third of the sample exhibited misconceptions regarding vaccine practices, as 37/90 (41.1%) believed that many vaccinations were administered too early, and 27/90 (30%) that the immune system may be overwhelmed by the high number of vaccines identified by the vaccine schedules.

**Assessment of attitudes**

In general, 79/90 OPhs self-rated their attitude towards vaccinations as somehow favorable (Figure 2). The Table 2 shows self-reported vaccination rates among OPh. In details, highest vaccination rates were reported against poliomyelitis (98.8%), tetanus (97.8%) and HBV (86.7%) whereas the lowest were identified for pneumococcus (5.6%) and HPV (3.8% of female subjects). Attitudes to-

**Table 2.** Attitude of the Italian occupational physicians (OPhs) towards vaccinations in general (5 points Likert scale), 2015

| Vaccination | Respondents somehow favorable towards vaccinations (N = 90) [n (%)] | Propensity score[c] (0.0–1.0) | | Respondents with self-assessed immunization status (N = 90) [n (%)] | | |
|---|---|---|---|---|---|---|
| | | M±SD | min.–max | positive | negative | not determined |
| Diphtheria | 82 (91.1)** | 0.944±0.159 | 0.200–1.000 | 64 (71.1) | 16 (17.8) | 10 (11.1) |
| Tetanus | 88 (97.8) | 0.978±0.076 | 0.600–1.000 | 88 (97.8) | 2 (2.2) | – |
| Pertussis | 72 (80.0)** | 0.860±0.202 | 0.200–1.000 | 37 (41.1) | 36 (40.0) | 17 (18.9) |
| Poliomyelitis | 86 (95.6) | 0.964±0.118 | 0.200–1.000 | 89 (98.8) | 1 (1.1) | – |
| Viral hepatitis A | 69 (76.7)* | 0.827±0.185 | 0.200–1.000 | 24 (26.7) | 61 (67.8) | 5 (5.6) |
| Viral hepatitis B | 84 (93.3) | 0.940±0.139 | 0.400–1.000 | 78 (86.7) | 10 (11.1) | 2 (2.2) |
| Influenza | 62 (68.9)** | 0.758±0.257 | 0.200–1.000 | 39 (43.3) | 49 (54.4) | 2 (2.2) |
| Pneumococcus | 65 (72.2) | 0.820±0.201 | 0.200–1.000 | 5 (5.6) | 76 (84.4) | 9 (10.0) |
| *Haemophilus influenzae* | 63 (70.0) | 0.791±0.212 | 0.200–1.000 | 8 (8.9) | 77 (85.6) | 5 (5.6) |
| Measles | 78 (86.7) | 0.871±0.195 | 0.200–1.000 | 31 (34.4) | 49 (54.4) | 10 (11.1) |
| Rubella[a] | 82 (91.1) | 0.902±0.159 | 0.200–1.000 | 26 (50.0) | 24 (46.2) | 2 (3.8) |
| Parotitis | 74 (82.2)* | 0.860±0.198 | 0.200–1.000 | 20 (22.2) | 60 (66.7) | 10 (11.1) |
| Varicella | 67 (74.4) | 0.809±0.210 | 0.200–1.000 | 15 (16.7) | 68 (75.6) | 7 (7.8) |
| Meningitis | 81 (90.0) | 0.887±0.153 | 0.400–1.000 | 10 (11.1) | 74 (82.2) | 6 (6.7) |
| Human papillomavirus[a] | 62 (68.9) | 0.796±0.212 | 0.200–1.000 | 2 (3.8) | 48 (92.4) | 2 (3.8) |
| Tuberculosis | 77 (85.6) | 0.827±0.183 | 0.200–1.000 | 53 (58.9) | 30 (33.3) | 7 (7.8) |
| All vaccines | – | 0.865±0.135 | 0.325–1.000 | – | – | – |
| All HCWs recommended vaccinations[b] | – | 0.857±0.161 | 0.314–1.000 | – | – | – |

M – mean; SD – standard deviation; min. – minimal value; max – maximal value.

[a] Self-assessed immunization status was determined only in subjects of female sex (N = 52).

[b] Pertussis, viral hepatitis B, influenza, measles, rubella, parotitis, varicella.

[c] Cumulative score (i.e., propensity score) was calculated as the sum of the single attitudes.

* Correlation between vaccine status and propensity towards vaccination: $p < 0.05$.

** Correlation between vaccine status and propensity towards vaccination: $p < 0.01$.

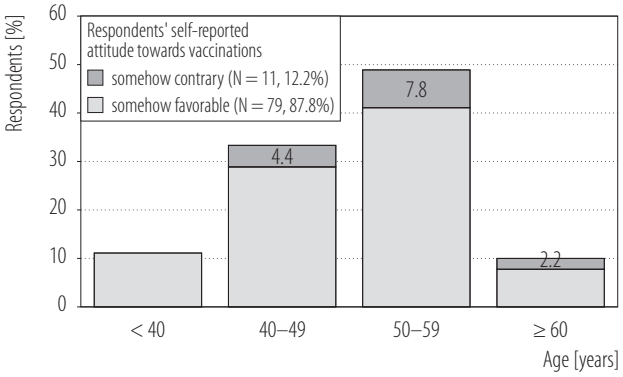



**Fig. 2.** Italian occupational physicians' (OPhs) (N = 90) self-rated attitude towards vaccinations in general by age groups, 2015

wards vaccines for diphtheria, pertussis, influenza (in all cases, $p < 0.001$), hepatitis A virus (HAV) and parotitis ($p < 0.05$) were significantly correlated with self-reported immunization status, with increasing vaccination rates in subjects exhibiting a more positive approach to the aforementioned immunization.

Normalized mean propensity score for HCWs recommended vaccines, was 0.857±0.161 and for all vaccines 0.865±0.135 – when single vaccinations were taken into account, higher propensity score was associated with HBV (0.940±0.139) and rubella (0.902±0.159) whereas influenza vaccine had the lower acceptance (0.758±0.257), and immunizations against measles (0.871±0.195), pertussis (0.860±0.202), tuberculosis (TBC) (0.827±0.183), pneumococcus (0.820±0.201), and varicella (0.809±0.210) having intermediates values (Table 2).

The correlation between general knowledge and attitudes and between knowledge of PNPV recommendations and attitudes was $r = 0.259$ ($p = 0.014$) and $r = 0.438$ ($p < 0.0001$), respectively. In other words, greater the knowledge (i.e., less misconceptions and/or less personal attitudes guiding the vaccine decisions), more favorable was the attitude towards vaccinations. Moreover, declared propensity was significantly correlated with calculated propensity for all the presented vaccines ($r = 0.665$, $p < 0.0001$) and also for immunizations recommended to HCWs ($r = 0.630$, $p < 0.0001$).

**Assessment of the risk perception**

Participants identified similar perception for the frequency and severity of vaccine-related adverse effects for the presented immunizations (mean score: 2.576±1.001 and 2.571±1.208, respectively; in both cases, ANOVA p value > 0.05). Conversely, focusing on the perceived probability of infections, OPhs identified influenza and HBV as the more probable (score of 4.256±1.370 and 3.811±1.437, respectively), followed by pneumococcus (3.244±1.327) and measles (2.898±1.457) whereas infections by HBV and pneumococcus were associated with the most severe perceived consequences (4.300±1.249 and 4.133±1.342, respectively) (Figure 3). In terms of cumulative risk perception score, OPh perceived HBV as the most relevant disease (0.597±0.099), and the risk perception scores for influenza (0.579±0.092) and pneumococcus (0.574±0.078) were not significantly different in ANOVA analysis with Dunnett's *post hoc* test (all cases $p > 0.05$). Conversely, all other presented immunizations were associated with a significantly lower score, in particular for pertussis (0.521±0.076) and varicella (0.519±0.098) (Table 3). Risk perception was significantly associated with knowledge of PNPV ($r = 0.302$, $p = 0.004$), general knowledge of vaccines ($r = 0.347$, $p = 0.001$) and in particular with the propensity score ($r = 0.426$, $p < 0.0001$).

**Regression analysis**

In fact, the regression analysis identified general knowledge (unstandardized coefficient (B) = 0.300, 95% CI: 0.090–0.510, $p = 0.006$) and the risk perception (B = 0.579, 95% CI: 0.155–1.003, $p = 0.008$) as significant predictors of propensity score for recommended vaccines in HCWs whereas knowledge of PNPV 2012–2014 was not (B = 0.118, 95% CI: –0.055–0.291, $p = 0.178$) (Figure 4). Focusing on the specific immunizations, simi-

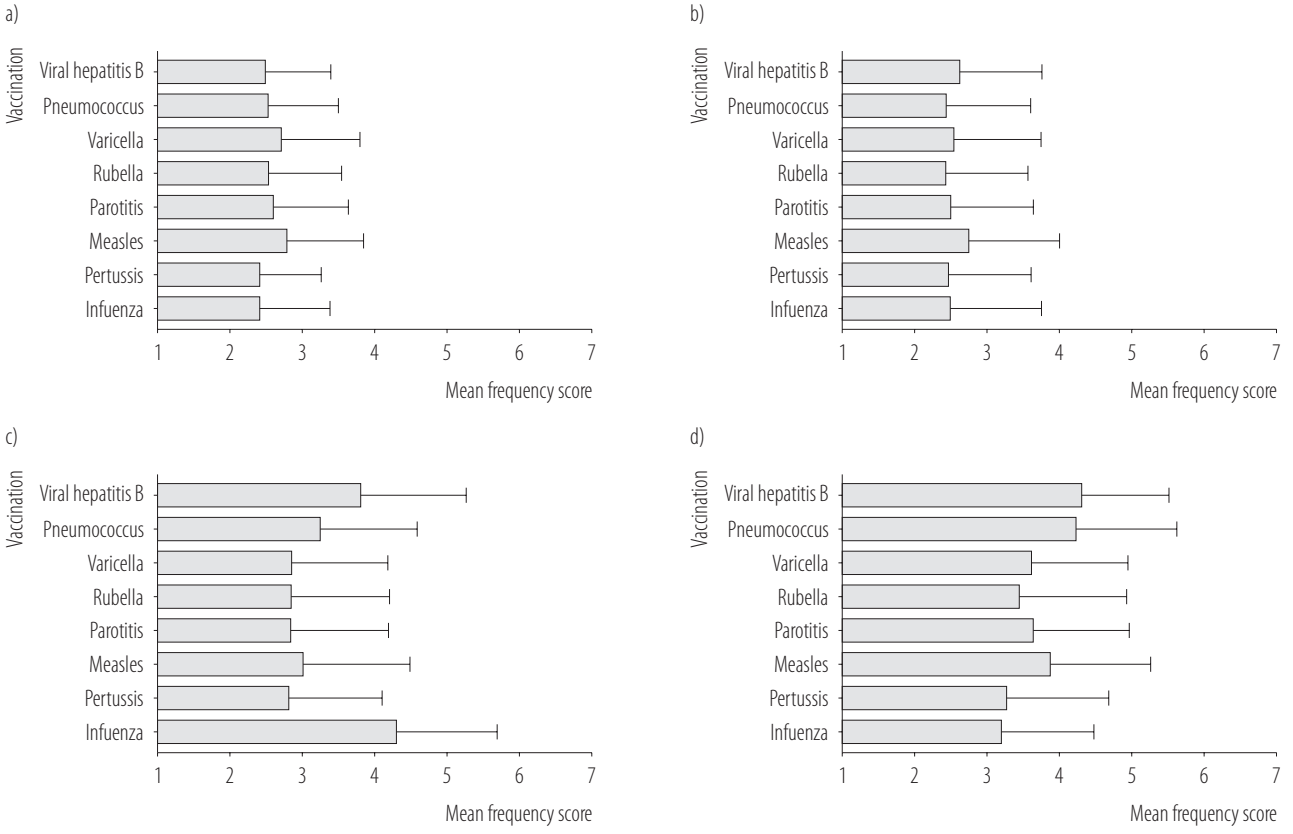
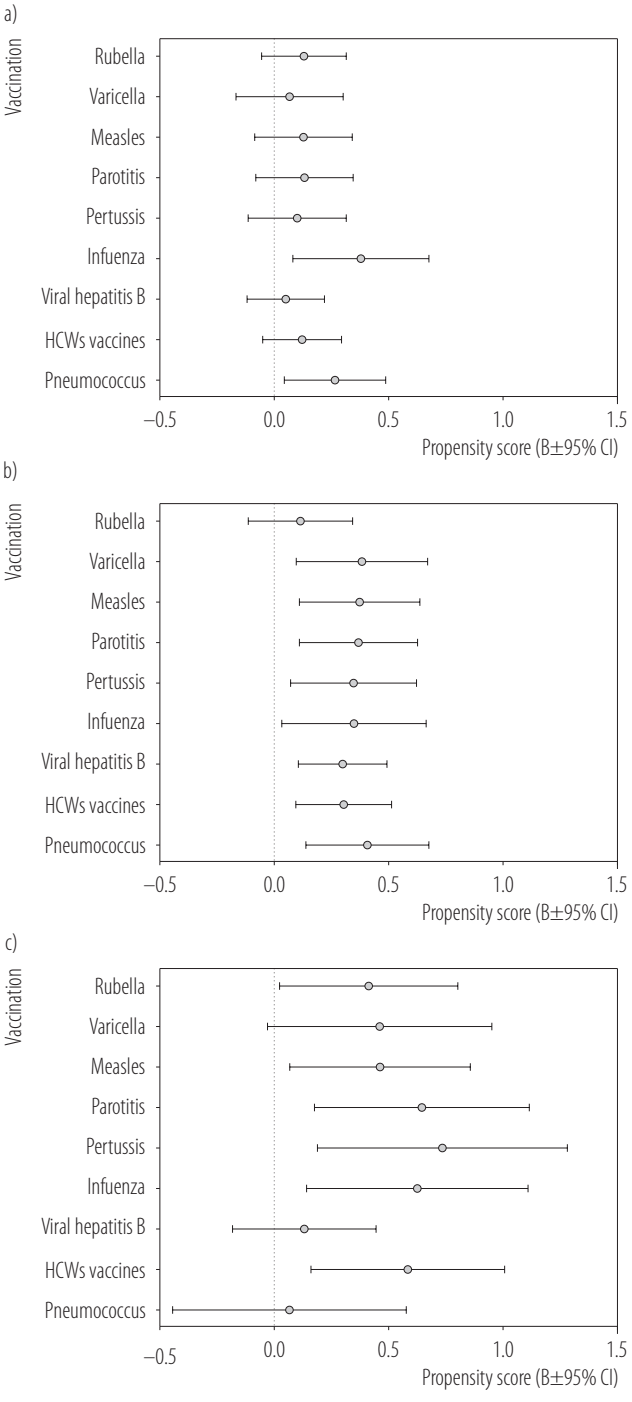



**Fig. 3.** Italian occupational physicians (OPhs) risk perception score: a) perceived probability and b) consequences of vaccine-related adverse effects, c) perceived probability and d) consequences of infections in healthcare workers (HCWs), 2015

**Table 3.** Risk perception by the Italian occupational physicians (OPhs) concerning 7 vaccinations recommended by PNPV 2012–2014 for healthcare workers (HCWs) and the vaccination for pneumococcus, 2015

| Vaccination | Propensity score (0.0–1.0) | | p |
|---|---|---|---|
| | M±SD | min.–max | |
| Viral hepatitis B | 0.597±0.099 | 0.392–0.938 | reference |
| Pneumococcus | 0.574±0.078 | 0.394–0.862 | > 0.05 |
| Varicella | 0.519±0.098 | 0.103–0.814 | < 0.0001 |
| Rubella | 0.523±0.098 | 0.124–0.804 | < 0.0001 |
| Parotitis | 0.528±0.087 | 0.165–0.804 | < 0.0001 |
| Measles | 0.533±0.103 | 0.319–0.883 | < 0.001 |
| Pertussis | 0.521±0.076 | 0.351–0.773 | < 0.0001 |
| Influenza | 0.579±0.092 | 0.223–0.787 | > 0.05 |
| All HCWs recommended vaccinations[b] | 0.547±0.074 | 0.312–0.751 | |

Abbreviations as in Tables 1 and 2.




PNPV – Piano Nazionale di Prevenzione Vaccinale (National Immunization Prevention Plan) [11].
HCW – health care worker; B – unstandardized coefficient; CI – confidence interval.

**Fig. 4.** Regression analysis was controlled for age at inquiry, sex and ethnicity (i.e., Italian born vs. non-Italian born).

lar results were obtained for measles (B = 0.368, 95% CI: 0.105–0.631, p = 0.007 and B = 0.460, 95% CI: 0.065–0.855, p = 0.023), pertussis (B = 0.343, 95% CI: 0.067–0.619, p = 0.015 and B = 0.733, 95% CI: 0.187–1.279, p = 0.009), parotitis (B = 0.364, 95% CI: 0.105–0.623, p = 0.006 and B = 0.641, 95% CI: 0.172–1.110, p = 0.008), and pneumococcus vaccine (B = 0.262, 95% CI: 0.040–0.484, p = 0.021 and B = 0.405, 95% CI: 0.136–0.673, p = 0.004) whereas knowledge of PNPV was identified as the main predictor for the propensity towards influenza and HBV vaccines (B = 0.374, 95% CI: 0.077–0.651, p = 0.014 and B = 0.295, 95% CI: 0.102–0.488, p = 0.003, respectively).

## DISCUSSION

Given its potential to lead to vaccine delays and refusals, vaccine hesitancy has become a growing focus of attention and concern, and HCWs are not exempted [25–27]. Although there is no strong evidence for a single best strategy to address vaccine hesitancy and refusal [28], several previous reports consistently identified healthcare providers as pivotal in enhancing vaccine acceptance among people who are vaccine hesitant or even refuse vaccinations, and achieving vaccine acceptance and high vaccination rates [29]. Occupational physicians may be understood, regarding immunization practices in the workplace, as healthcare providers of other healthcare providers, and therefore their intervention may be of particular relevance not only for improval of vaccine acceptance among HCWs but also in general population [12].

Unfortunately, with the notable exception represented by HBV vaccination, immunization rates appeared as somehow unsatisfying. In particular, seasonal influenza vaccination coverage was well under 50% of the sample (43.3%). Similarly low vaccination rates for influenza, but also VPD such as measles, pertussis, rubella and varicella, were previously reported in other surveys performed in HCWs across Western Europe [30–39]. For instance, influenza vaccination coverage in HCWs in European Countries

still remains between 14% and 50%, far below the target objective of 75% identified by European Centers for Disease Control and the Prevention [40–43]. In Italy, where nationwide updated data was not available, the mean vaccination coverage rate against influenza for HCWs was around 11.5% in the period 2006–2008, presumptively declining in the following seasons [43].

Low self-assessed vaccination rates were associated with largely positive attitudes towards vaccinations, both in general and regarding vaccines recommended by PNPV 2012–2014 [11]. More specifically, recommendations towards HBV and influenza vaccines were accurately recalled by a significant proportion of the sample (95.6% and 88.9%, respectively), with propensity towards HBV approaching the maximum (0.940±0.139), and even the attitude towards influenza suggested an adequate tough more conditioned acceptance (0.758±0.257).

Also measles, pertussis, parotitis and rubella vaccines were associated with relatively high or even very high propensity but were correctly identified as recommended ones by less than 30% of the sample. These specific VPD have recently re-emerged in the European Union (EU) as the result of sub-optimal immunization levels, and an increasing number of official recommendations points towards the implementation of these vaccinations not only in the case of HCWs but also in the general adult schedule [44,45]. Therefore, these results may presumptively be interpreted as the consequent of a communicative and informative gap of OPhs about such vaccinations in HCWs [46–48], and more in general regarding up-to-date medical evidence regarding the morbidity and even the epidemiology of VPD [15,37,46]. As a sound evidence suggests that better awareness and greater knowledge of HCWs regarding vaccines increase the propensity to vaccine and to be vaccinated [12,47–50], and also our results suggest general knowledge and risk perception as the main predictors for the vaccination propensity in OPhs, several results from our survey sustain this specific interpretation.

First of all, around 50% of the sample failed to identify tuberculosis vaccination as not recommended for HCWs despite an active surveillance strategy replaced mandatory vaccination policy for HCWs since 1998 [51] and nearly a fifth of our sample indicated that there were official recommendations towards meningitis and pneumococcus immunizations in the case of HCWs (21.1% and 22.2%, respectively). Moreover, propensity score for the latter immunization was also relatively high (i.e., 0.887±0.153), greater than measles (0.871±0.195), parotitis (0.860± 0.198), varicella (0.809±0.210) and even influenza.

Likewise, the high vaccination rate for HBV self-referred by OPhs should be underlined, despite these professionals are usually not exposed to invasive procedures at increased risk for blood-borne pathogens. These results are consistent with the previous survey of Betsch and Wicker on OPhs [12], and may be similarly and collectively interpreted in terms of inadequate, incomplete or even inappropriate postgraduate medical education with subjects reporting “common-sense” rather than “evidence based” recommendations. Actually, HBV, tuberculosis, staphylococcal pneumonia and epidemic cerebrospinal meningitides are universally acknowledged as severe and potentially life-threatening infectious diseases, whereas measles, parotitis, varicella and even seasonal influenza are more frequently assumed to be relatively indolent pediatric disorders [12,15,37,46–50], and also in our sample we assessed a relatively lower risk perception (Table 3), in turn determined by a lower severity score for those diseases in confront with pneumococcus and HBV (Figure 3c and 3d).

Regarding seasonal influenza vaccination, our results show a probably more complex habit. Despite the risk perception for influenza infection was relatively high, and similar to the scores reported for HBV and pneumonia, propensity score was conversely low. Focusing on the 4 components of the risk perception score (i.e., perceived probability and severity of infection and vaccine-related adverse effects), influenza infection in HCWs was

perceived as highly probable, but its potential severity was not similarly well appreciated. Moreover, it is possible that these results have been affected by the diffuse misunderstandings about the efficacy of the vaccine in disease prevention [16,17], a critical point is well described in previous studies investigating KAP of HCWs towards seasonal influenza vaccine [18,19,39,52–57].

In this regard, the prevalence of false beliefs and misconceptions about vaccines and their side-effects was surprisingly high, in particular for healthcare professionals. The warnings about causative association between vaccines and autoimmune diseases (e.g., multiple sclerosis, diabetes, asthma, etc.; referred by 23/90 sampled OPhs, 25.6%), and also between MPR vaccine and neurological disorders such as autism (16/90, 17.8%) and subacute sclerosing panencephalitis (27/90, 30%), and influenza vaccine and lethargic encephalitis (17/90, 18.9%), were raised in the previous decades, received diffuse emphasis on the information media, but were criticized or ultimately disproved in the following years [7,47]. As vaccine acceptance is significantly influenced by emotional cognitive and social distortions or biases affecting judgment [58], this low propensity towards such vaccinations may be explained not only as a consequence of an incomplete awareness that measles, varicella, influenza and pertussis still remain diseases that may eventually result in severe complications such as acute respiratory failure, encephalitis or even death, and that a significant number of European HCWs are susceptible therefore posing themselves, their patients or colleagues at risk, but also as the sum of alarming misconceptions and poor knowledge of vaccine's benefits and safety [7,34,46,47,49].

Several limits of our study should be accurately stressed. First of all, the study population in our study was relatively small (around 1.4% of all licensed OPhs in Italy) and not randomly selected. Moreover, we may expect that the "convenience sampling" we applied, including professionals participating to a continuous medical education event, ultimately overestimate both knowledge and attitudes of OPhs towards immunizations. Finally, Italy has been repetitively acknowledged for very heterogeneous vaccination rates [11]: therefore, our results should be cautiously interpreted as representative of the National level. However, as our sample included the 39.7% of all OPhs operating in the AP of Trento, it may be interpreted as representative of a local area characterized by a very high degree of socioeconomic development. In fact, our results are consistent with previous studies about HCWs performed in other high income countries, and in particular with the survey on OPhs recently performed by Betsch and Wicker [12].

In this regard, our study may be of particular interest as the latter study focused mainly on influenza vaccine, with more general evaluation of other vaccines, and encompassed a relatively heterogeneous population of 135 OPh: 56.4% of subjects had a full 5-year residency whereas 40% had a minor specialization with 2-year residency and 3.6% had not yet completed their residency.

On the contrary, we described a sample of OPhs with current expertise in healthcare settings, relatively homogeneous in terms of demography and geographic area of professional activity.

Finally, despite the shared EU directives and guidelines representing the very foundations of all the National legislation, National setting of Italy on Occupational Health and Safety law is neither typical or representative of all developed countries. In this regard it should be stressed that Italian law enforces occupational health surveillance, with occupational health services ultimately available to all HCWs, and their duties specifically include the surveillance for the immunization status [59,60].

Moreover, despite duties and activities of OPhs in continental EU countries are substantially analogous, academic and post-graduate formation of OPhs is not so comparably similar. For instance, in Italy qualification as OPhs is obtained through specialization in occupational medicine but also specialists in hygiene and public health or in legal/forensic medicine may obtain such qualification through fur-

ther post-degree courses because of a partially shared training [58,59]. For this reason, in our sample only subjects specialized in occupational medicine were actually included.

## CONCLUSIONS

In conclusion, our results confirm a generally positive attitude of OPhs towards vaccines and immunization practices. However, the inconsistent attitude towards vaccines against measles, parotitis, varicella and rubella, the high degree of misconceptions eventually reported by the sample, and the relatively low acceptance of influenza vaccine recommend that specific training and educative programs should be targeted in order to achieve a better knowledge of evidence-based recommendations. In particular, transparent communications targeting diffuse false beliefs and misconceptions, and the OPh-tailored interventions could help to build increased trust in the effectiveness and safety of vaccines and in the vaccine policy, ultimately enhancing the contribute of OPhs to increase vaccination rates and building vaccine acceptance and resiliency in face of the anti-vaccine lobby in HCWs and, subsequently, in general population.

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