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Field Report

Knowledge, attitudes, beliefs and practices of construction workers towards tetanus vaccine in Northern Italy

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Abstract: Construction workers (CWs) are both more exposed to tetanus and at higher risk to be inadequately immunized. Our aim was to evaluate tetanus immunization status and knowledge/attitudes towards tetanus vaccination in CWs in Italy. In this field report, the immunization status of 554 unskilled CWs (i.e. labourers). Immunization status was assessed recalling immunization booklets/certificates. Attitudes and knowledge were collected through a standardized questionnaire. In 240/554 CWs, immunization status was inadequate/not documented: in 184 subjects (33.2%), the last vaccination shot was older than 10 years, whereas basal immunization was incomplete in 20 cases, more frequently in foreign-born people (FBP) than in Italian born (IBP) (OR=7.116). In 198 cases (35.7%), an Occupational Physician (OPh) performed last booster, usually with monovalent (T, n=173) vaccine. The main reason for inadequate immunization was having forgotten the periodic booster (148/554; 26.7%), whereas 42 subjects (7.6%) deliberately avoided tetanus vaccine because of personal/religious beliefs, more frequently in FBP than in IBP (OR=3.182). In summary, the prevalence of inadequate immunization status was relatively high (43.4%): the high prevalence of "forgotten boosters" enlightens the key role of OPh in recalling and promoting vaccination policies. Moreover, the inappropriate use of Td vaccine points out the opportunity for educational campaigns in OPh.

Key words: Tetanus, Diphtheria-tetanus vaccine, Tetanus toxoid, Occupational health, Vaccination, Treatment refusal

Introduction

Tetanus is a vaccine-preventable severe acute non-communicable infectious disease, clinically characterized by generalized muscle spasm and cardiovascular instability, and caused by a neurotoxin produced by the spore-forming anaerobic bacteria *Clostridium tetani*[1–4].

C tetani spores are ubiquitous. They can enter the body through severe traumas, but also abrasions, wounds and minor scratches contaminated with soils, street dust, human/animal faeces[2, 5]. Global burden of neonatal tetanus reduced from over 600,000 cases in 1990 to fewer than 60,000 in 2008, but still remains a major cause of newborn and infant deaths in many developing countries[5]. Despite

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several improvements in the clinical treatment options, mortality rate remains significant: in developed countries it ranges from 20 to 50%, but without the full support of modern intensive care facilities it may be even higher than 80%[2, 4]. Therefore, tetanus prevention through vaccination and appropriate wound care remain the most important measures for an effective management[2, 4].

Tetanus remains a global health concern: it afflicts approximately 1 million people per year, with a mortality rate of 20–50%[2, 4]. In the European Union/European Economic Area countries, where vaccines containing tetanus toxoid has been part of the primary schedule since the 1960, tetanus has become a relatively uncommon with an annual incidence that in 2012 was 0.03/100,000[6, 7]. Since long-lasting immunity requires at least five immunizations (primary series plus two boosters) and also regular boosters (usually every 10 years) are necessary in order to sustain overtime protective antibody levels, to maintain in time high levels of immunity in the general population appears to be the main public health issue[2, 4, 8, 9].

In Italy, tetanus vaccination was introduced in 1938 for military personnel, becoming compulsory since 1963 for two-year-old children (and since 1968 for all newborns) and for workers engaged in activities considered to be at high risk (e.g. construction, farming, refuse collection and animal husbandry)[10]. Eventually, the reported tetanus incidence fell from 14/1,000,000 in the late 50's, to 5.0/1,000,000 in the 1970's to 2/1,000,000 in the 1990's with a case-fatality ratio falling from 68% to 39%[6, 10], but nonetheless results appear unsatisfactory. Not only since 2006 Italy reports the highest number of cases in Europa, but also the annual notification rate remains stable between 0.9–1.0/1,000,000[3, 7]. As tetanus is a disease of unvaccinated or not adequately vaccinated adults, unsurprisingly 90% of cases with known vaccination status reported between 1998 and 2000[11] and 90.1% of cases reported between 2001 and 2010[3] occurred in unvaccinated or incompletely vaccinated subjects.

Actually, several serologic surveys have pointed out that nearly 30% of Italian population has an inadequate protection against tetanus, with levels of protection declining with increasing age as a consequence of failing boost doses, and such a setting may even deteriorate in the next decades[3, 12]. In the past decades and until 2003, when compulsory military service was suppressed, males received regular boost vaccinations at conscription, sustaining the rates of adequate protection in the younger decades[3, 10, 11]. Moreover, last decade experienced the re-emergence of the anti-vaccination movements and the increasing phenomenon of vaccination refusal, that in Italy were associated with increasing doubts about the legal sustainability of compulsory vaccinations[13].

In such a setting, the role of occupational physicians in the evaluation and monitoring of vaccine status during the medical surveillance has become critical[3, 6, 8–10].

Construction workers have been reputed to be among the higher risk groups for tetanus[6]. In Italy, more than 2 million people are employed as construction workers in 615,000 enterprises, with a variable degree of specialization (i.e. unskilled workers, specialized workers, carpenters, painters, crane operators etc.). A high prevalence of unskilled workers from low-income countries with an endemic low vaccination level (i.e. African and Eastern Mediterranean WHO regions, Eastern Europe), low socioeconomic status and personal education[14]. Being the latter well known risk factors for an inadequate vaccine coverage, unsurprisingly Rapisarda et al in their study on 5,275 construction workers in southern Italy identified a significant proportion of inadequate serologic protection against tetanus[6, 15, 16]. However, the study neither investigated the attitudes of the workers towards vaccinations nor which factors hindered the patients in complying with the vaccine schedule. Moreover, in Southern Italy the prevalence of immune subjects was previously stated as relatively low and may not be representative of the general Italian working population[3, 6].

Our primary objective was to investigate the adherence to the tetanus vaccine schedule in a population of construction workers in a geographic area (Emilia Romagna Region, Northern Italy) where the vaccine coverage is usually stated as higher[3, 11, 12], with a high prevalence of foreign-born workers. Our secondary objective was to investigate the personal attitudes towards tetanus immunization, focusing on the differences between Italian-born people (IBP) and Foreign-born people (FBP).

Subjects and Methods

Study design and setting

Between January 2010 and January 2012, all construction workers attending to one occupational health service from northern Italy were asked to participate. The study focused on construction workers performing unskilled manual labour (i.e. labourer) in order to obtain a more homogeneous sample in term of socio-economic status.

As required by Italian law (D.L. 81/08), construction workers are expected to undergoing preventive (i.e. before the work assignment), periodic (usually, every 12 months

basis) and extraordinary (i.e. readmission at workplace after a sick leave longer than 60 days, or more frequently workplace reassignment) occupational health surveillance. More specifically, articles n.278 and 279 of the D.L. 81/08 require that the occupational physician will inquiry vaccination history and recall the vaccination status, in order to identify the causes of an inadequate immunization status (either on medical/biological or personal basis), and inform the worker about the pros and cons of work-related recommended vaccinations. Tetanus vaccination has been defined as mandatory in several occupational settings (such as the construction setting; law 292/1963), but Italian Constitution otherwise recognizes the right to avoid forced medical treatment (with few exceptions not including vaccinations): therefore, inquiring the reasons for an inappropriate vaccination status is an unavoidable step for all professionals involved in the Preventive Medicine, including Occupational Physicians. In order to better recall all the information about the immunization status and the respective attitudes and knowledge, all data were collected by an occupational physician during the visit, using a standardized anonymous questionnaire. The questionnaire contained both demographic (age, gender, WHO region of origin, occupation history) and personal data, i.e. health-related knowledge and attitudes relative to tetanus vaccine, focusing on reasons for having it or not.

Workers were guaranteed that questionnaire compilation would be on a strict voluntary basis, that all gathered data would be confidentially handled and collectively elaborated, having no other purpose than evaluation of vaccine attitudes and knowledge of participants, and would not change the attitudes of involved occupational physicians regarding the assessment of their fitness to work. Because the individual participants cannot be identified through the questionnaire, it is implausible that this study caused them any harm.

The study was performed as a part of the compulsory health assessment on the workplace (Italian Legislative Decree n.81, April 9th 2008): data were primarily collected only in order to fully assess the clinical status and the fitness to work of the workers, and had be performed even without the conduction of the study. Therefore, no preliminary evaluation by the Ethical Committee was reputed necessary. However, as clinical and personal data had been collected and elaborated, written and informed consent to the data collection, storage and procession according to Italian privacy law (D.L. 196/03) was collected, and subjects refusing their consent were excluded from the study population.

Because identification of immune status by anamnesis is highly sensitive but also scarcely specific[17], all workers were asked to exhibit their personal certificate of vaccination/prophylaxis (i.e. vaccine booklet): data about the vaccine preparations used (either booster containing only tetanus toxoid or combined with diphtheria toxoids, respectively T and Td), the setting of the last vaccination shot (either as a programmed/elective or an emergency shot performed after a penetrating injury), who actually performed the last vaccination shot (i.e. General Practitioner, Occupational Physician, Paediatrician, or a medical professional from a Local Health Unit service, Emergency Department, Military Service) were collected.

The worker unable to show the vaccine booklet during the visit had 7 days to provide a copy or a substitutive certificate, usually acquired from the competent service of the Local Health Unit. All patients unable to demonstrate their immunization status (i.e. "unknown vaccination history"), not vaccinated or without a complete basal vaccination program (three doses of tetanus antitoxin) were remitted the Local Health Unit in order to confirm the status through serologic exams and/or perform recommended missing immunizations.

An "adequate protection" was acknowledged for all patients who had received the last tetanus vaccination booster <10 years before the visit.

Patients who had received the last booster ≥ 10 years before the visit were informed about the risks associated with tetanus infection, and offered to perform a new booster with Td vaccine directly at occupational medical service.

In all cases where vaccine status was defined as inadequate (either for missing data or shots), workers were re-evaluated 6 months after the first medical surveillance in order to assess whether tetanus immunization had been actually performed.

Statistical analysis

A descriptive analysis was performed using means, standard deviation (S.D.) and proportion as appropriate. Continuous variables were compared among Italian Born People (IBP) and Foreign Born People (FBP) through Student's t test or ANOVA when appropriate. Analysis of discrete variables (i.e. ethnicity, WHO region of origin, age categories, items derived from anonymous questionnaires and from the vaccine booklet) was conducted using the chi-square test and their associations were initially expressed as odds ratios (OR) with their 95% confidence intervals (95% CI) and then assessed by stepwise lin-

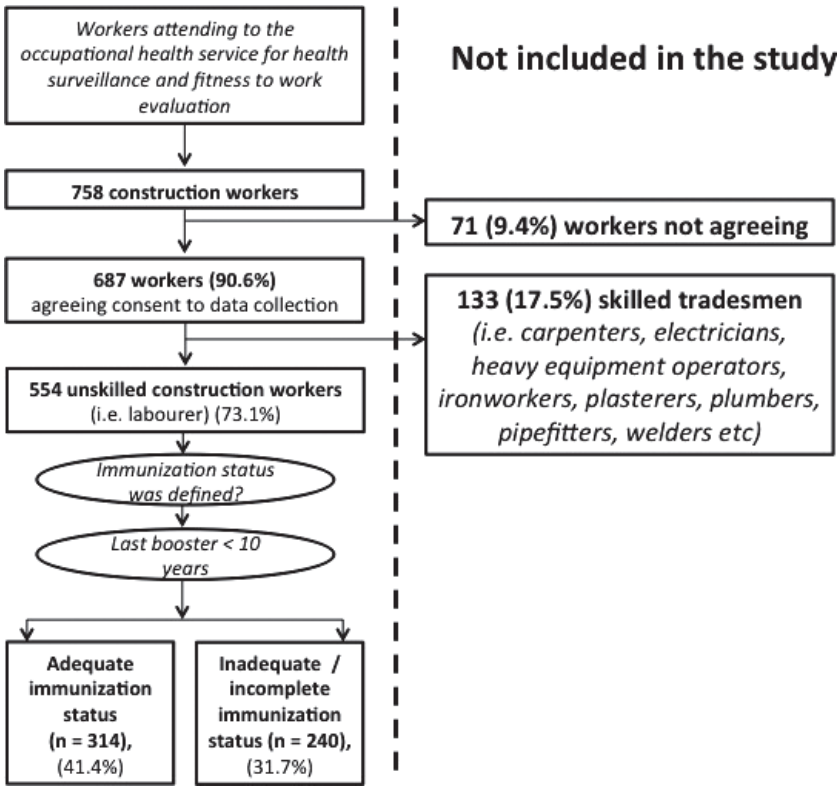

Fig. 1. Flow-chart explaining selection of the study sample.

ear regression analysis as adjusted OR (adjOR) with the respective 95% CI[18]. All tests were two-tailed, and statistical significance was set at $p<0.05$.

All statistical analyses were performed using IBM SPSS Statistics 22.0 for Macintosh (IBM Corp. Armonk, NY).

Results

During the study period, a total of 758 workers attended to the occupational health service: 687 of them (90.6%) agreed their consent to the data collection. Of them, 554 workers (73.1% of the original sample) were unskilled workers, of male sex (Fig. 1).

Of them, 398 (71.8%) were IBP and 156 FPB (Table 1), with a mean age of 38.0 ± 11.2 years. IBP were significantly older than FBP (38.9 ± 11.4 vs 33.2 ± 9.0 years, $p<0.0001$): 157/398 IBP (39.4%, and 28.3% of total population) were born before 1968, compared to 25/156 (16.0%, and 4.5% of total population) of FBP ($p<0.0001$).

In general, vaccination status was defined in 510 subjects (92.1%). A total of 240 subjects presented with an inadequate tetanus immunization status (43.3%) and the prevalence of inadequate vaccine status was eventually similar in IBP and FBP (176/398 vs 64/156; $p=0.495$, OR 1.140 95% CI 0.783 – 1.659) (Table 1). In 184 subjects (33.2%) last booster was performed 10 or more years before the sampling, and 46 of them (8.3%) had a last documented booster older than 20 years. Eventually, an incomplete basal immunization program with one or more tetanus vaccine shots missing was identified in 20 cases (2.9%). The latter status was significantly more frequent in FBP than in IPB (adjOR 11.134 95% CI 3.345 – 37.059) (Table 2).

In general, a mean delay of 8.68 ± 8.04 years from the last vaccination booster was identified, significantly greater in IBP (9.18 ± 8.69 years) than in FBP (7.28 ± 5.63 years, $p=0.004$). Among FBP, workers from World Health Organization (WHO) Eastern Mediterranean Region (EMR) presented with delay wider (10.34 ± 8.08 years) than subjects from WHO European Region (EUR, 7.52 ± 5.75 years), and in particular from WHO African Region (AFR, 5.41 ± 3.49 years, ANOVA post hoc Tukey's test p value = 0.024) and SEA (4.45 ± 2.84 years, ANOVA post hoc Tukey's test p value = 0.024).

Assuming IBP as the referent ones, increased risk for inadequate vaccine status was eventually similar in all WHO regions of origin at univariate analysis (in all cases, $p>0.05$, Table 1): when a stepwise model including age and length of stay in Italy was included, however, a signifi-

Table 1. Demographic data of subjects with an inadequate tetanus immunization status. Adjusted estimated of OR (adjOR) were calculated by means of stepwise linear regression analysis and taking in account ethnicity (expressed as WHO region of origin: i.e. EUR=European Region; EMR=Eastern Mediterranean Region; AFR=African Region; SEA=South-East Asia) for age groups, and age at visit associated with length of Italian stay for geographic origin.

	Inadequate tetanus immunization		OR	95%CI		adjOR	95%CI	
	N#	% on total (n=554)		Lower limit	Upper limit		Lower limit	Upper limit
Age (years)								
<25	16/ 68	2.9	1.000	Reference			Reference	
25–34	60/156	10.8	2.031	1.064	3.877	2.003	1.047	3.829
35–44	89/170	16.1	3.571	1.890	6.746	3.517	1.859	6.654
45–54	52/112	9.4	2.871	1.438	5.517	2.692	1.369	5.293
≥55	23/ 48	4.2	2.990	1.348	6.632	2.845	1.272	6.365
Born before 1968								
All subjects	90/182	16.2	1.226	0.894	1.682		–	–
IBP	78/157	14.3	1.222	0.853	1.750		–	–
Geographic origin								
Italian-born people	176/398	44.2	1.000	Reference		1.000	Reference	
Foreign-born people	64/156	41.0	1.140	0.783	1.659	1.057	0.713	1.566
EUR	31/ 71	43.7	0.978	0.588	1.626	1.379	0.799	2.380
EMR	22/ 37	59.5	1.850	0.932	3.672	2.203	1.087	4.465
AFR	9/ 36	33.3	0.420	0.193	0.917	0.451	0.203	1.007
SEA	2/ 12	16.7	0.252	0.055	1.166	0.371	0.077	1.872

Table 2. Settings of performed tetanus vaccination shots among people where vaccination status was identified (n=510). Adjusted estimated of OR (adjOR) were calculated by means of stepwise linear regression analysis.

	Ethnicity of workers		OR	95%CI		adjOR	95%CI	
	Foreign-born People (n=133)	**Italian-born People** (n=377)		Lower limit	Upper limit		Lower limit	Upper limit
Incomplete basal immunization	14 (2.7%)	6 (1.2%)	7.116	2.676	18.925	11.134	3.345	37.059
Last shot older than 5 years	79 (15.5%)	241 (47.3%)	0.801	0.534	1.203	0.924	0.548	1.557
Last shot older than 10 years	39 (7.6%)	145 (28.4%)	0.652	0.452	1.000	0.780	0.444	1.373
Vaccination performed after penetrating injury	6 (1.2%)	57 (11.2%)	0.262	0.110	0.623	0.341	0.138	0.846
Last shot with Td rather than T	46 (9.0%)	73 (14.3%)	2.173	1.400	3.372	1.433	0.877	2.340
Last vaccine shot was performed by…								
Occupational physician	53 (10.4%)	145 (28.4%)	1.000	(Reference)		1.000	(Reference)	
General Practitioner	12 (2.4%)	45 (8.8%)	0.719	0.354	1.464	0.594	0.287	1.229
Paediatrician	19 (3.7%)	9 (1.8%)	5.696	2.426	13.373	3.619	1.455	8.999
Emergency Departments	4 (0.8%)	51 (10.0%)	0.212	0.073	0.614	0.233	0.079	0.687
Military Service (at conscription)	4 (0.8%)	66 (12.9%)	0.164	0.057	0.471	0.143	0.049	0.416
Local Health Unit, Public Health services	41 (8.0%)	61 (12.0%)	1.875	1.128	3.116	1.446	0.852	2.453

Table 3. T/Td vaccine preparation identified in the vaccination booklet as the last shot by professional actually performing the procedure (n=506/510). In the regression analysis model, Occupational Physicians were identified as the referent ones; adjusted estimated of OR (adjOR) were calculated by means of stepwise linear regression analysis, and by taking in account the delay since the last vaccine shot and WHO region of origin.

	Td (n=119)	T (n=387)	OR	95%CI		adjOR	95%CI	
				Lower limit	Upper limit		Lower limit	Upper limit
Occupational Physician	25 (4.9%)	173 (33.9%)	1.000	Reference		1.000	Reference	
General Practitioner	12 (2.4%)	45 (8.8%)	1.845	0.861	3.956	1.669	0.764	3.643
Paediatrician	12 (2.4%)	16 (3.1%)	5.190	2.201	12.240	1.914	0.714	5.128
Emergency Departments	11 (2.2%)	44 (8.6%)	1.730	0.791	3.784	1.938	0.873	4.306
Military Service	4 (0.8%)	66 (12.9%)	0.419	0.141	1.251	0.411	0.135	1.247
Local Public Health Services	59 (11.6%)	43 (8.4%)	9.495	5.433	16.869	8.033	4.462	14.462

cantly increased risk for inadequate immunization status was identified in subjects from EMR (adjOR 2.203 95% CI 1.879–4.465).

Focusing on age groups, subjects younger than 25 years showed the lower rate of inadequate vaccine status (16/68, 23.5% of age group and 2.9% of total sample), the latter peaking in the 35–44 age group (OR 3.571 95% CI 1.890–6.746), as confirmed also at regression analysis when ethnicity was taken in account (adjOR 3.517 95% CI 1.859–6.654) (Table 1).

In general, a vaccine booster was required in 90/182 subjects born before 1968 and in 150/372 subjects born after 1968 (OR 1.226 95% CI 0.894–1.682), and also in IBP the prevalence of inadequate vaccine status was similar in both groups (78/157 vs 98/241, OR 1.222 95% CI 0.853–1.750).

In the 510 cases where vaccination status was characterized, also the medical professional performing the last shot was identified. As expected, the medical professionals most frequently involved were Occupational Physicians (198/510, 38.8% of total), followed by professionals from Public Health Services (102/510, 20%), Military (70/510, 13.7%), General Practitioner (57/510, 11.2%) (Table 2). In regression analysis model, assuming Occupational Physicians as the referent ones, FBP had more frequently received the last vaccine booster by Paediatrician (adjOR 3.619 95% CI 1.455–8.999), whereas less frequently than in IBP was the last vaccine booster performed by either at conscription (adjOR 0.143 95% CI 0.049–0.416) or by professionals from Emergency Departments (adjOR 0.233 95% CI 0.079–0.687). Unsurprisingly, also emergency shots after penetrating injuries were less frequently performed in FBP than in IBP (adjOR 0.341 95% CI 0.138–0.846).

In 506/510 subjects where vaccination booklet was available the vaccine preparation was identified, and only 119 of (23.3%) had received the last vaccine shot as a Td preparation, with similar rates in IBP and FBP (adjOR 1.433 95% CI 0.877–2.340). Interestingly enough, the choice of vaccine preparation differed significantly among the involved professionals (Table 3): assuming Occupational Physicians as referent ones, on the one hand Public Health Services (OR 9.495 95% CI 5.433–16.869) and Paediatricians (OR 5.190 95% CI 2.201–12.240) more frequently performed the last vaccine shot with Td preparation, whose choice was on the other hand less diffuse among General Practitioner, Military services and Emergency Departments. When results were adjusted for the delay and the WHO region of origin, association of Td with Public Health Services still remained significant (adjOR 8.033 95% CI 4.462–14.462).

The most frequent reason associated with an incomplete/inadequate/undefined vaccine status was “forgetting” the periodic booster (148/240, 58.3% of the group and 26.7% of total sample), with similar prevalence in IBP and FBP (OR 0.616 95% CI 0.345–1.101, Table 4). Among subjects with inadequate vaccine protection, 69 subjects did not performed vaccine booster assuming as “sufficient” the doses received in infancy and adolescence, and 34 subjects (6.1% of total) had refused the required boosters fearing the side effects, with similar prevalence in IBP and FBP.

Eventually, 42 workers (7.6%) declared that refused tetanus vaccine for personal or religious beliefs, a statement more frequently associated with FBP than IBP status (adjOR 3.620 95% CI 1.293–10.132).

Among subjects with adequate vaccine status, the most

Table 4. Workers attitude toward tetanus vaccination: main reason given for acceptance of tetanus vaccine among all responders (including vaccinated and non-vaccinated subjects). Percentage values are expressed in reference of total sample (n=554). Adjusted estimated of OR (adjOR) were calculated by means of stepwise linear regression analysis.

	Adequate tetanus coverage		**OR**	**95%CI**		**adjOR**	**95%CI**	
	Foreign-born people N=92	**Italian-born people** N=222		Lower limit	Upper limit		Lower limit	Upper limit
Be protected against tetanus	26 (4.7%)	126 (22.7%)	0.300	0.177	0.508	0.323	0.184	0.566
Recommended by my General Practitioner or by the Occupational Physician	26 (4.7%)	68 (12.3%)	0.892	0.522	1.525	0.833	0.456	1.521
Required on the workplace	26 (4.7%)	67 (12.1%)	0.911	0.533	1.559	1.042	0.554	1.961
Mandatory on the workplace	39 (7.0%)	109 (19.7%)	0.884	0.578	1.351	0.494	0.258	0.944
Recommended by Public Health Services of Local Health Unit	30 (5.4%)	27 (4.9%)	3.495	1.931	6.325	3.741	1.850	7.568
	Inadequate tetanus coverage		**OR**	**95%CI**		**adjOR**	**95%CI**	
	Foreign-born people N=64	**Italian-born people** N=176		Lower limit	Upper Limit		Lower limit	Upper limit
Forgot the periodic booster	34 (6.1%)	114 (20.6%)	0.616	0.345	1.101	0.801	0.401	1.602
Useless: paediatric doses are sufficient	21 (3.8%)	48 (8.7%)	1.302	0.702	2.417	0.881	0.379	2.044
Fear of side effects	11 (2.0%)	23 (4.1%)	1.087	0.511	2.357	0.471	0.135	1.637
Personal/Religious beliefs	20 (3.6%)	22 (4.0%)	3.182	1.593	6.357	3.620	1.293	10.132

frequently reported reason for get the vaccine was "to be protected against tetanus" (152/314, 48.4% and 27.4% of total sample), significantly less frequent among FPB than IBP, even after adjustments (adjOR 0.323 95% CI 0.184–0.566). Moreover, 148/314 subjects with adequate immunization status acknowledged as a reason to be regularly vaccinated against tetanus the vaccine as "mandatory on the workplace", and also this statement was more frequent in IBP than in FBP (109/222 vs 39/92, respectively). Conversely, more frequently in FBP (30/92, 32.6%) than in IBP (27/222, 12.2%), vaccination was recommended by Public Health Services of Local Health Unit, as confirmed by multivariate analysis (adjOR 3.741 95% CI 1.850–7.568).

Discussion

Tetanus immunization in Italy is a long-lasting problem[3, 6, 10–12]. A recent serological survey suggests that around 19% of Italian population is actually susceptible to tetanus and 10% of total population has a basic, inadequate protection[3]. Several reports hint that immunization rate should be higher in northern regions and in younger age groups[3, 11, 12]. In the occupational settings, a previous observational study on the serology of 5,275 construction workers found that around 22% of subjects had an inadequate protection[6]. Our study found an even higher prevalence of subjects reputed to have an inadequate tetanus immunization status (43.3%). These results may actually overestimate the actual prevalence. First, our definition of inadequate immunization status was primarily based on the 10 years interval for Td booster in Italy[19], but this recommendation is not unquestioned. According to some researches, wider intervals could be equally efficient: intervals of 20 years may be eventually more cost-effective and represent a better estimate of physiological reduction of antibody levels[20–25]. Second, inadequate tetanus immunization status was arbitrarily assumed when no documentation was available, but the absence of a documented vaccination doesn't necessarily means the absence of the vaccination[26, 27].

A specific endpoint of this study was to assess the attitudes of construction workers towards tetanus vaccine. Most of studies on attitudes towards vaccines come from healthcare settings, encompassing subjects that come from a medium-high socio-economic status, and are expected to show at least a basic knowledge of vaccines and vac-

cinations[28–31], whereas construction workers usually show lower socio-economic status and education level[6, 32, 33], being therefore at higher risk for misconceptions and hesitancy[29, 34].

Interestingly enough, only 12.5% of the sample retained the tetanus vaccination as useless, and even less subjects (6.1%) addressed their hesitancy to the fear of side effects. Actually, most of patients with an inadequate vaccine status simply "forgot" the booster dose, a problem previously stated by several other studies[3, 9, 10]. As Italian immunization rates appear to be largely unsatisfactory when confronted with other countries where similar, or even larger intervals between booster doses are enforced[25, 35, 36], it should be addressed that the 10 years interval is not by itself a sufficient explanation.

Since an inadequate immunization status in our study was associated with older age groups, where previous contacts with General Practitioner or Occupational Physicians is highly probable, a more proactive role for these health professionals may be advocated[37, 38], and every contact with a physician used to check vaccination status[15]. Persons receiving a professional advice not only feel better informed about the benefits but also about the risks of vaccination in general, vaccination consultation eventually resulting to be a strong enabling factor for higher vaccine uptake[15, 29, 34].

Unfortunately, several studies suggest that the knowledge of General Practitioner and Occupational Physicians about vaccines and the respective vaccine-preventable disease are not regularly based upon scientific evidence, quite frequently residing on personal disbeliefs and misconceptions[38]. In effect, subjects from our study having received the last shot by the General Practitioner or Occupational Physicians had also a similarly high risk for vaccine booster with T rather than the recommended Td vaccine preparation (Table 3), the latter being more frequently used by Local Public Health Services, suggesting that modern vaccine policies were irregularly received by private practitioners[39].

Another important finding of our study was the referral of personal or religious beliefs as a basis for vaccine hesitancy. Actually, religious objection to vaccination is neither a new or an uncommon issue in Europe or North America, but is a relatively unusual finding for Italian physicians, either private or operating in the National Health Service[40, 41]. Despite the rates of religious objects were relatively low in both IBP and FBP having an inadequate vaccine uptake (respectively, 22/176 and 20/64), the latter appeared associated with a significantly higher risk (Table 4).

The present study is associated with several limits. First at all, the operative definition of inadequate vaccination status. As previously stated, a $\geq$10 years interval between the vaccine booster is a diffuse but arbitrary cut-off, and also the lack of vaccine booklet should not be automatically addressed as the lack of previous vaccinations. Therefore, our figures should be more cautiously interpreted as a proxy of the vaccine status.

Second, the study population included in our study was not randomly selected, as included workers who were enlisted for the compulsory medical surveillance. Moreover, the enlisted workers were all from Northern Italy: as Italy is very heterogeneous in terms of tetanus vaccination rate, our results should be cautiously interpreted as representative of the National level[3, 6].

Third, National setting of Italy on Occupational Health and Safety law is neither typical or representative of all developed countries. As Italian law enforces both occupational health surveillance, with occupational health services ultimately available to all workers, and tetanus vaccination as mandatory, our results cannot be generalized.

However, this study is of public health interest as evaluated the personal attitudes a category at high risk for tetanus but also infrequently addressed by similar studies. In fact, as construction workers are usually drawn from people of lower socio-economic and education status, despite the aforementioned limits about the study population and the occupational settings, these results are not only of specific interest for Occupational Physicians, but also enlighten a category of subjects very heterogeneous with respect of previous studies about personal attitudes, misconceptions and disbeliefs about vaccines (i.e. health care workers, students, etc).

Eventually, our results suggest the opportunity for a more active role for General Practitioner and Occupational Physicians in promoting vaccination and in monitoring vaccine status of their patients, the latter being a critical aspect for a vaccination with very long recommended between-shots intervals. Therefore, it is also crucial to provide General Practitioner and Occupational Physicians with up-to-date information about vaccines, assuring that they will be able to adequately advice and inform patients regarding vaccinations. Moreover, all health care workers involved in vaccination practice and policies should be addressed about the possible increasing problem represented by vaccine religious objection, still relatively uncommon in southern Europe countries as Italy.

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