

Knowledge of Healthcare Workers in the Central Bosnia Canton on Vaccination: Results of a Cross-Sectional Study

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Received: 09 Jul 2026; Accepted: 25 Aug 2026; Published: 08 Sep 2026

Citation: Stefani Šamija, Sead Karakaš. Knowledge of Healthcare Workers in the Central Bosnia Canton on Vaccination: Results of a Cross-Sectional Study. Nur Primary Care. 2026; 10(2): 1-6.

ABSTRACT

Background: Immunization is one of the most cost-effective public health interventions across countries of all income levels. The six vaccine-preventable diseases initially targeted by the Expanded Programme on Immunization (EPI) more than four decades ago laid the foundation for global immunization efforts, while the introduction of at least six additional vaccines has broadened protection and contributed to reducing morbidity and mortality throughout the lifespan.

Objective: The primary aim of this study was to assess the level of knowledge about vaccination among healthcare workers in the Central Bosnia Canton.

Methods: A total of 412 healthcare workers of both sexes, representing all age groups and professional categories employed in healthcare institutions across the Central Bosnia Canton, participated in this cross-sectional study.

Results: An intermediate level of vaccination knowledge was the most prevalent among both men (43%; $n = 52/122$) and women (49%; $n = 142/290$). The intermediate level of knowledge was also most common among healthcare workers with secondary-level professional education, representing 28.6% of the total study population. Among hospital employees, the largest proportion of respondents demonstrated an intermediate level of knowledge (54%), which was also the highest proportion compared with other healthcare institutions.

Keywords

Vaccination, Immunization, Healthcare workers, Knowledge.

Introduction

The development of the modern pharmaceutical industry has significantly advanced biochemical approaches to disease prevention and treatment, improving the understanding of interactions between microorganisms and their human hosts [1]. A primary objective of every healthcare system is the implementation of measures aimed at preventing and controlling acute infectious and parasitic diseases [2]. Following the introduction of vaccines and antibiotics, many experts anticipated that infectious diseases would cease to represent a major public health concern and would

be replaced by chronic non-communicable diseases. However, the emergence of novel human pathogens, the re-emergence of infectious diseases, and shortcomings in the control of endemic infections have confirmed that infectious diseases remain a substantial global public health challenge [3].

It is estimated that since 1974, vaccination has prevented approximately 154 million deaths, including 146 million among children under five years of age and more than 100 million among infants younger than one year. On average, each prevented death corresponds to an additional 66 years of healthy life, amounting to an estimated 10.2 billion healthy life-years gained. Following the successful eradication of smallpox, officially certified in 1980,

the World Health Organization (WHO) launched a global initiative aiming to vaccinate all children against smallpox, tuberculosis, diphtheria, tetanus, pertussis, poliomyelitis, and measles by 1990. Coverage with the third dose of the diphtheria–tetanus–pertussis vaccine (DTP3), a key indicator of immunization programme performance, increased from less than 5% in 1974 to 86% in 2019, immediately before the COVID-19 pandemic, and currently remains at 84% [4].

Vaccination has made an outstanding contribution to global health. Two major infectious diseases, smallpox and rinderpest, have been eradicated. Poliomyelitis is close to eradication, while substantial progress in measles control has made this disease another potential candidate for eradication. Despite these achievements, approximately 6.6 million children continue to die annually, with nearly half of these deaths attributable to infections such as pneumonia and diarrhoeal diseases that are largely preventable through vaccination. The eradication of rinderpest, officially recognized by the World Health Organization in 2011, has received less public attention than the eradication of smallpox but nevertheless represents another landmark achievement in the control of infectious diseases and a significant contribution to global public health [5].

Since the establishment of the Global Polio Eradication Initiative (GPEI) in 1988, wild poliovirus (WPV) types 2 and 3 have been eradicated, while WPV type 1 remains endemic only in Afghanistan and Pakistan. In November 2021, an outbreak of genetically linked WPV1 associated with Pakistan was detected in Malawi and subsequently spread to neighbouring Mozambique in 2022. In addition, circulating vaccine-derived polioviruses may emerge in under-immunized populations when attenuated strains of the oral poliovirus vaccine (OPV) undergo prolonged person-to-person transmission, allowing genetic mutation and recombination that can restore neurovirulence and result in paralytic disease. Achieving and maintaining high population immunity through routine childhood immunization programmes and supplementary immunization activities (SIAs) remains essential for global polio eradication. In 2022, the World Health Organization recommended vaccination of all children worldwide against all poliovirus serotypes. Global vaccination coverage by 12 months of age was estimated at 84% in 2022, compared with 81% in 2021 and 83% in 2020. During 2023, a total of 119 supplementary immunization activities were conducted in 30 countries worldwide. Case-based surveillance of acute flaccid paralysis (AFP) among children younger than 15 years remains the primary strategy for detecting WPV and cVDPV transmission, while environmental surveillance through wastewater testing complements AFP surveillance by identifying poliovirus circulation in the absence of clinical cases [6].

Until the 1960s, the majority of deaths and severe illnesses caused by common vaccine-preventable childhood infectious diseases occurred in children living in developing countries, where vaccination coverage for diseases such as measles was often below 5% and largely limited to children from wealthier segments of

the population, despite the high risk of severe disease outcomes in all children [5]. It is estimated that vaccination with measles-containing vaccines (MCV) prevented approximately 60 million measles-related deaths between 2000 and 2023, while 42% of countries worldwide have achieved verified measles elimination. Nevertheless, an estimated 107,500 measles-related deaths still occurred in 2023, predominantly among children under five years of age. In recent years, progress has stalled, with a global increase in measles cases, a growing number of countries experiencing large outbreaks, and declining coverage with the first routine dose of measles-containing vaccine (MCV1), partly as a consequence of the COVID-19 pandemic [7].

In the Federation of Bosnia and Herzegovina, mandatory immunization includes vaccination against tuberculosis, hepatitis B, diphtheria, tetanus, pertussis, poliomyelitis, measles, rubella, mumps, and *Haemophilus influenzae* type b. Regardless of age, individuals travelling to countries with a high risk of infectious diseases are also required to receive vaccinations when mandated by the legislation of the destination country [2]. According to the Annual Report of the Institute of Public Health of the Federation of Bosnia and Herzegovina for 2025, the target immunization coverage was achieved for the BCG vaccine (93.3%) and the first dose of hepatitis B vaccine (95.8%). However, coverage with the remaining vaccines included in the mandatory immunization programme was considerably lower. Coverage with three doses of hepatitis B vaccine reached 67.5%, while 64.9% of children received all three doses of the pentavalent vaccine. The same coverage (64.9%) was reported for the primary three-dose series against diphtheria, tetanus, pertussis, poliomyelitis, and *Haemophilus influenzae* type b, with 10,435 of the planned 16,082 infants vaccinated. Coverage with the adult diphtheria–tetanus (dT) booster vaccine among school-aged children reached 66.3%. Particularly concerning was the low uptake of the MMR vaccine: only 42.1% of children in the target age group received the first dose, with an additional 2,505 children vaccinated outside the target cohort, while only 46.9% received the second dose at six years of age, along with 1,886 additional children vaccinated from other age groups [8].

National immunization policies differ among countries; however, the decision to vaccinate is also influenced by personal beliefs, values, risk perception, and attitudes. Healthcare workers may themselves have concerns or fears regarding vaccination that extend beyond the healthcare system. As trusted healthcare professionals, they play a pivotal role in promoting vaccination and influencing public confidence in immunization. Therefore, strengthening their engagement as advocates for vaccination is strongly recommended [9]. Low- and middle-income countries continue to face substantial challenges in achieving adequate vaccination coverage, with persistent disparities in vaccine access compared with high-income countries. Immunization services depend heavily on healthcare workers, yet the shortage of healthcare personnel in these settings significantly limits the delivery of routine healthcare services, including vaccination programmes. The World Health Organization estimates that an additional 18 million healthcare workers will be

required globally by 2030, primarily in low- and middle-income countries, to meet healthcare needs [10]. Healthcare workers who administer vaccines, care for infected patients, and educate the public in hospitals and primary healthcare settings substantially influence decisions regarding vaccine uptake and participation in immunization programmes. Their behaviour serves as a model for the wider community. Continuous professional education and strengthening the promotional role of healthcare workers as leaders and educators are essential for the success of preventive public health initiatives. Identifying the factors that influence patients' decisions to participate in vaccination programmes remains a key priority [11].

Objective

The aim of this study was to assess the level of vaccination knowledge among healthcare workers in the Central Bosnia Canton and to analyse the findings according to sex, age, years of professional experience, educational level, and department/service of employment.

Methods

Study design

A quantitative, descriptive, cross-sectional study was conducted to assess the level of vaccination knowledge among healthcare workers.

Setting and study period

The study was conducted in healthcare institutions across the Central Bosnia Canton, including the Institute of Public Health of the Central Bosnia Canton, Travnik General Hospital, Travnik Hospital for Pulmonary Diseases and Tuberculosis, and the primary healthcare centres in Bugojno, Donji Vakuf, Vitez, Busovača, and Kreševo. Data collection was carried out during the second half of 2025.

Participants

The study included 412 healthcare workers of both sexes, representing all age groups and professional categories employed in the Central Bosnia Canton. Data were collected using a self-administered questionnaire developed specifically for this study. The questionnaire consisted of 18 questions presented in both paper-based and online formats using Google Forms. Knowledge about vaccination was assessed using six questions. Knowledge levels were classified according to the number of correct responses: 0–3 correct answers indicated a low level of knowledge, 4–5 correct answers indicated an intermediate level of knowledge, and 6–7 correct answers indicated a high level of knowledge.

Statistical analysis

Statistical significance was assessed using the chi-square (χ^2) test, with a significance level of $p < 0.05$. Data were analysed using Microsoft Excel, Epi Info 7, and Statistica 8. The results are presented in tables and figures as frequencies and percentages.

Results

Among the total number of healthcare workers included in the study (N=412), the proportion of female participants was higher than that of male participants. The largest number of respondents belonged to the age group ≤ 30 years and had secondary vocational education. The majority of participants reported working in primary healthcare centers. The highest number of respondents belonged to the “Other” group, which included various healthcare services with smaller numbers of participants, while among individual healthcare fields, family medicine was the most represented. The most common response regarding years of professional experience was 6–15 years.

Table 1: Sociodemographic characteristics.

GENDER	N	%
Male	122	30
Female	290	70
AGE		
≤ 30	130	32
31 – 40	105	25
41 – 50	101	25
51 – 60	54	13
≥ 61	22	5
PROFESSIONAL CATEGORY		
General practitioner	28	7
Specialist physician	39	9
Healthcare worker with secondary education	218	53
Healthcare worker with higher education	127	31
TYPE OF HEALTHCARE FACILITY		
Institute of Public Health	32	8
Hospital	174	42
Primary healthcare center	206	50
DEPARTMENT/SERVICE		
Family medicine	94	22,8
Pediatrics/Neonatology;	68	16,5
Gynecology/Maternity ward		
Surgery	33	8
Pulmonology	33	8
Other	184	44,7
YEARS OF PROFESSIONAL EXPERIENCE		
≤ 5	121	29
6 – 15	137	33
16 – 30	107	26
≥ 31	47	11
TOTAL	412	100

Source: Authors, 2026.

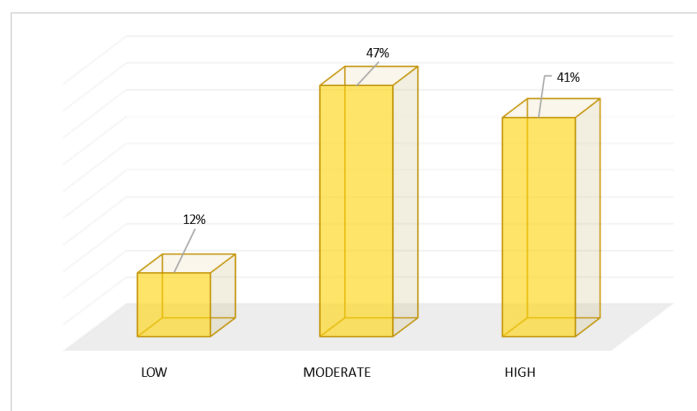
Which diseases can be prevented through the mandatory vaccination programme in the Federation of Bosnia and Herzegovina?

Table 2 presents the questions and responses used to assess the level of vaccination knowledge among healthcare workers.

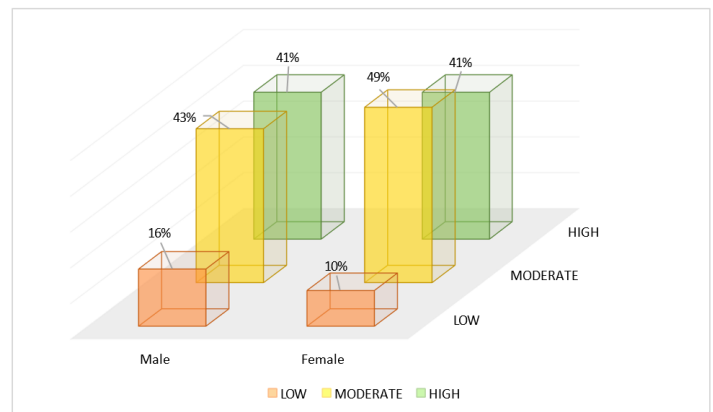
Table 2: Responses to questions assessing vaccine knowledge.

	N	%
Influenza	186	45
Hepatitis B	336	82
Hepatitis C	78	19
Diphtheria	281	68
Smallpox (<i>Variola vera</i>)	165	40
What does "herd immunity" mean in the context of vaccination?		
When a large proportion of the population becomes immune, reducing the spread of disease and providing protection to unvaccinated individuals as well.	356	86,4
When all members of society receive all available vaccines.	55	13,3
When a disease no longer occurs in a community due to high mortality caused by the infection.	1	0,2
What are the general contraindications to vaccination?		
Acute illnesses	356	86,4
Autism	34	8,3
Family history of seizures	22	5,3
Which vaccine do you consider to have the highest vaccination coverage rate?		
DiTePer	58	14
MRP	29	7
BCG	255	62
Hepatitis B vaccine	70	17
Have you heard of the HPV vaccine?		
Yes	399	97
No	13	3
Is the HPV vaccine available in your canton?		
Yes	295	72
No	117	28

Source: Authors, 2026.

**Figure 1:** Level of vaccination knowledge among healthcare workers. Source: Authors, 2026.

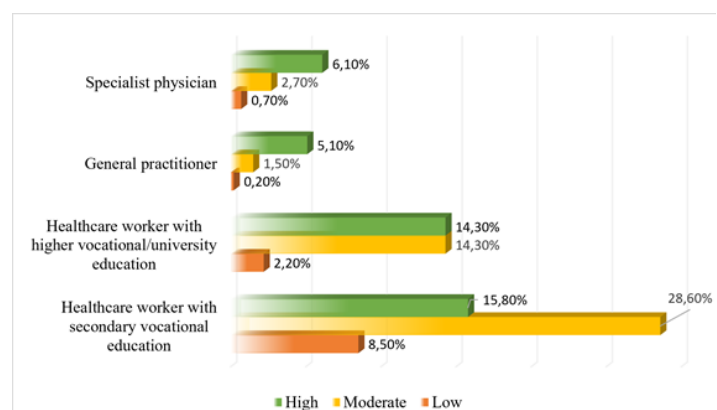
A moderate level of vaccination knowledge was observed in the highest proportion among both genders, accounting for 43% among males (N=52/122) and 49% among females (N=142/290) (Figure 2). Analysis of the responses presented in Table 2 showed that healthcare workers in the Central Bosnia Canton demonstrated a moderate level of vaccination knowledge (N=194), accounting for 47% of the total sample.

**Figure 2:** Vaccination knowledge levels by gender Source: Authors, 2026.**Table 3:** Vaccination knowledge levels by age group.

KNOWLEDGE LEVEL									
Age group	Age	Low		Moderate		High		Total	
		N	%	N	%	N	%	N	%
	≤ 30	11	2,7	60	14,6	59	14,3	130	31,6
	31 - 40	15	3,6	47	11,4	43	10,4	105	25,5
	41 - 50	11	2,7	50	12,1	40	9,7	101	24,5
	51 - 60	8	1,9	28	6,8	18	4,4	54	13,1
	≥ 61	3	0,7	9	2,2	10	2,4	22	5,3
	TOTAL							412	100

Source: Authors, 2026.

A moderate level of knowledge was the most prevalent across all age groups. The highest proportion of participants with a moderate level of knowledge belonged to the age group ≤30 years (14.6%), while the lowest proportion was observed in the oldest age group ≥61 years (2.2%). No statistically significant difference was found in knowledge levels between participants aged ≤40 years and those aged ≥40 years ($p>0.05$) (Table 3).

**Figure 3:** Vaccination knowledge levels according to participants' professional qualifications Source: Authors, 2026.

No statistically significant difference in knowledge levels was found between general practitioners and specialist physicians ($p>0.05$), whereas a statistically significant difference was observed between healthcare workers with secondary vocational education and those

with higher education levels ($p<0.05$) (Figure 3).

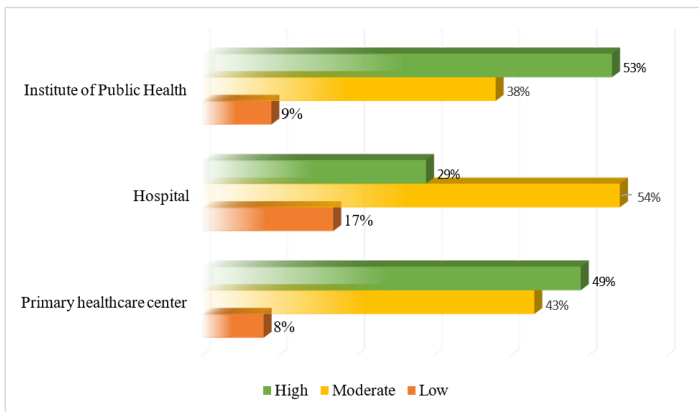


Figure 4: Vaccination knowledge levels among healthcare workers by workplace setting Source: Authors, 2026.

A high level of knowledge was predominant among healthcare workers employed at the Institute of Public Health and primary healthcare centers in the Central Bosnia Canton, whereas a moderate level of knowledge was predominant among healthcare workers employed in hospitals.

A moderate level of knowledge was predominant across all categories of participants according to years of professional experience. No statistically significant difference in knowledge levels was found between participants with up to 15 years of professional experience and those with 16 or more years of professional experience ($p>0.05$).

Table 4: Vaccination knowledge levels by years of professional experience.

KNOWLEDGE LEVEL									
Years of professional experience		Low		Moderate		High		Total	
	Age	N	%	N	%	N	%	N	%
	≤ 5	9	2,2	56	13,6	56	13,6	121	29,4
	6 – 15	18	4,4	65	15,8	54	13	137	33,2
	16 - 30	14	3,4	52	12,6	41	10	107	26
	≥ 31	7	1,7	21	5,1	19	4,6	47	11,4
	TOTAL							412	100

Source: Authors, 2026.

Discussion and Conclusion

This study was conducted with the aim of assessing the level of knowledge regarding vaccination among healthcare workers in the Central Bosnia Canton. A total of 412 healthcare workers participated in the study, and the results showed that the most prevalent level of vaccination knowledge was moderate. A moderate level of knowledge was observed among both genders, across all age groups, and in all healthcare institutions, indicating a relatively consistent level of information among the participants.

The authors of a study published in Italy in 2020 identified gaps in healthcare workers' knowledge regarding recommended vaccines

and emphasized the importance of continuous educational programs aimed at improving knowledge levels and vaccination coverage [12]. Similar knowledge deficiencies were reported in a study conducted in Austria, where only 21.9% of healthcare workers stated that they were familiar with national vaccination guidelines for healthcare personnel. Although almost all participants (98.2%) recognized hepatitis B vaccination as recommended, knowledge regarding other recommended vaccines was considerably lower, with fewer than one-quarter of respondents recognizing recommendations for measles, mumps, rubella, diphtheria, poliomyelitis, pertussis, and varicella vaccines [13].

A study conducted in Canada among healthcare workers involved in immunization delivery found that nurses achieved a higher level of vaccination knowledge compared with physicians (83.7% versus 72.8%; $p < 0.001$). A higher level of knowledge was associated with additional immunization training outside formal education, with the majority of nurses and more than half of physicians reporting participation in such educational activities. These findings emphasize the importance of continuous professional development of healthcare workers in the field of immunization [14].

A systematic review published in 2013 indicated a predominance of moderate knowledge levels, highlighting the need for further professional education and training of healthcare workers.

Available evidence suggests that an adequate level of knowledge represents an important factor in developing positive attitudes toward vaccination and in more active vaccine recommendation practices among healthcare workers [15].

In the present study, healthcare workers with higher educational attainment demonstrated a higher level of vaccination knowledge, indicating the importance of education level in acquiring and maintaining vaccination-related competencies. Similar findings were reported in a study conducted in Croatia among 178 healthcare professionals, where participants with higher levels of professional education demonstrated better knowledge about vaccination compared with those with lower educational levels [16].

Regarding hepatitis B vaccination, a study conducted among 352 healthcare workers in Serbia showed that a higher level of education was statistically significantly associated with better knowledge about hepatitis B vaccination ($\rho = 0.377$; $p < 0.001$). The mean knowledge score was 22.9 ± 4.8 points out of a maximum of 30 points, with healthcare workers vaccinated against hepatitis B achieving significantly higher knowledge scores compared with unvaccinated participants (23.9 ± 3.7 versus 20.9 ± 5.8 points; $p < 0.001$). These findings highlight the importance of knowledge and education among healthcare workers in promoting hepatitis B prevention and vaccine acceptance [17].

Vaccination represents one of the greatest achievements in the

history of public health, transforming once devastating diseases into preventable and, in some cases, eradicated diseases. Despite these achievements, vaccination continues to generate controversy in the modern era, where misinformation, vaccine hesitancy, and unequal access remain persistent challenges to global health progress.

The present study provided a better understanding of the level of immunization-related knowledge among healthcare workers in the Central Bosnia Canton, emphasizing their role as key providers of health promotion and preventive activities. The predominance of moderate knowledge levels indicates the need for further improvement of knowledge through structured and continuous educational programs.

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