

Applying the 7-C Protocol to analyze the implementation of Mass- Vaccination Policy against COVID-19 in Shoushtar, Iran

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Article

Keywords: COVID-19, Vaccination, Mass Vaccination, 7-Protocol, Epidemic, Health Worker, Healthcare Facility

Posted Date: September 14th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10016864/v1>

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Additional Declarations: No competing interests reported.

Abstract

Vaccination protects public health, stops COVID-19 transmission, and saves lives. However, mass vaccination campaigns face supply, distribution, storage, prioritization, and logistics challenges. This study aimed to analyze the implementation of the Mass Vaccination Policy against SARS-CoV-2 using the 7-C Protocol. In 2023, a cross-sectional study was conducted among 134 healthcare workers at primary healthcare facilities in Shoushtar County, Iran. Participants were selected through mixed sampling methods. Data were collected using a questionnaire based on the 7C policy analysis model and analyzed in STATA _{v14.2}. Healthcare workers rated the overall mass vaccination process favorably, with a 3.9 (3.4 to 4.4) median score. The domains of content, commitment, capacity, communication, and coordination and collaboration all had positive median scores of 4.0. However, contextual factors (3.4 [3.0 to 4.0]) and coalition and clients (3.5 [3.0 to 4.0]) received slightly lower scores. Univariable Poisson regression indicated a statistically significant difference between physicians and non-physician staff ($P < 0.05$), though the association was weak ($PR = 0.94$; 95% CI: 0.90 to 0.98). Sensitivity analysis for effect of healthcare facility types on vaccination implementation in different adjusted models showed robust results. Approximately 95% of healthcare workers reported that the COVID-19 mass vaccination program was effectively implemented. Given the financial and non-financial challenges healthcare staff face during epidemics, managers must offer adequate incentives and support to motivate personnel.

Introduction

Numerous infectious diseases have been identified in the modern world, each contributing to various complications and pathogenic processes, either directly or indirectly(1,2). Since the emergence of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), millions of individuals have contracted the virus, and its spread continues, leading to ongoing clinical and epidemiological impacts(3,4). Like many other nations, Iran has experienced the severe economic and social consequences of the global COVID-19 pandemic(5). Iran reported its first case of COVID-19 on February 19, 2020. Since then, the country has experienced eight waves of outbreaks, and by October 13, 2024, a total of 7,627,863 cases and 146,837 deaths had been recorded(6).

COVID-19 is a global public health issue that presents a severe risk to the environment, human health, and economic recovery efforts worldwide(7). The pandemic has negatively impacted the mental health of Iranian society (8,9), created problems in accessing follow-up care and treatment services during COVID-19(10), and led to severe economic losses (11). Managing the crisis was challenging for health policymakers and practitioners due to the disease's unknown nature, high transmissibility, mortality, and limited resources(12,13). Patient and healthcare workers' well-being suffers from the increasing number of patients, insufficient staffing, and longer working hours (14).

Non-pharmaceutical interventions and many strict public health measures like physical distancing, mask-wearing, teleworking, isolation, and quarantines were implemented to control and slow the spread

of COVID-19(15,16). However, these behavioral measures have led to unintended effects, including psychological distress, major depression, and adverse mental health outcomes(17). In numerous instances, the disconnect between public health objectives and political or economic priorities must be clarified for policy decisions regarding controlling the pandemic, saving lives, minimizing social disruption, and safeguarding the economy(18). Vaccination is a crucial tool for ensuring public safety, halting the transmission of COVID-19, and protecting people's lives and health, mainly if "herd immunity" is achieved(19–21). Mass vaccination programs have lessened the strain on healthcare systems, hospitals, intensive care units, and the economy by mitigating the impact of targeted diseases(22).

A safe and effective vaccination campaign is critical to the national strategy for COVID-19 response and pandemic preparedness(23). Population-wide vaccination

is logistically complex; successfully administering vaccines requires sufficient supply, efficient delivery, proper storage, clear prioritization of target groups, and adequate infrastructure for distribution(24). Vaccinating the global population is seen as the most promising yet challenging strategy, as it demands the rapid, safe, and effective administration of millions of doses while ensuring equitable access to healthcare(25). Countries worldwide encounter challenges in planning and executing vaccination strategies, which are crucial for controlling COVID-19.(21,26). Vaccination efforts can be hindered by issues with supply, delivery, storage, prioritization, and logistics(27). Inadequate healthcare infrastructure and weak information management may also threaten rapid vaccination in low- and middle-income countries(28). Critical barriers to vaccine acceptance in Tehran included low trust in government policies, health authorities, and vaccine manufacturers, doubts about the vaccine's effectiveness, concerns over potential side effects, and a lack of perceived need for vaccination(29). Structural obstacles, such as time constraints, transportation issues, costs, and the location of clinics or vaccination sites, remain challenges for many vaccination programs. Research shows that overcoming these barriers can enhance vaccine coverage across various population groups(30).

Healthcare professionals significantly influence the public's decisions to receive the COVID-19 vaccine. Community health workers are also crucial in new vaccine rollouts, contributing to planning, target identification, community engagement, service delivery, and follow-up(31–33).

The government must develop a unified, coordinated action plan and implement strategic policies to address critical gaps, including empowering a more centralized, multi-dimensional delegation to public and private sectors to tackle shortages in frontline healthcare staff and facilities and the organized mobilization required for an effective multilateral vaccination rollout (33). Ongoing policy implementation and service delivery are essential in modern society. In early 2018, Cloete, Coning, Wissink, and Rabie introduced the 7Cs (Content, Context, Capacity, Commitment, Clients and Coalition, Communication, and Cooperation and Coordination) to enhance service delivery and policy implementation, making it vital to understand these protocols as tools for societal improvement. The research presents varying opinions on applying the 7C protocols. However, more studies are needed to demonstrate how organizations utilize these protocols to enhance policy implementation and service delivery(35).

There is currently insufficient evidence regarding the most effective interventions for increasing COVID-19 vaccinations. Further research is required to identify the most successful elements of outreach programs and inform the development of new strategies. Multifaceted, community-engaged, and evidence-based approaches are likely to enhance vaccination rates(30). In 2020, only 4% of research focused on COVID-19; however, as mass vaccination efforts began, there was a lack of research on effective vaccine delivery and the operation of vaccination centers, indicating a need for further investigation(26,36). Thus, conducting such studies is crucial to addressing vaccine hesitancy and enhancing vaccination rates(37).

As noted, the effective rollout of the COVID-19 vaccination remains uncertain and has yet to be thoroughly examined. Given that the immunization plan has been announced and implemented globally, it is essential to analyze the implementation of the Mass Vaccination Policy against SARS-CoV-2 through the lens of the 7-C Protocol. The findings of this study can help assess the current status of COVID-19 mass vaccination, enhance policymaking, and advance the implementation of programs for public health emergencies.

Methods

Study design and setting

This cross-sectional descriptive and analytic research was conducted in 2023. The article was written following the STROBE guidelines (specific version for cross-sectional studies). The study was carried out in Shoushtar County, Khuzestan Province, in the southwest of Iran. Regarding organizational structure, healthcare services in Shoushtar County fall under the Shoushtar Faculty of Medical Sciences (SFMS) jurisdiction. A unique feature of the health infrastructure in the Islamic Republic of Iran is the integration of medical universities with the government's health system administration. As a result, each medical university in Iran is tasked with conducting research and education and delivering healthcare services to the population in a designated region. The research was conducted in primary healthcare units, including urban and rural comprehensive health service centers, health posts, health houses, and mass vaccination sites.

Study population and subjects

The study participants were divided into primary care professionals (clinical) and public health professionals (community). The clinical group consisted of physicians, while the public health group included midwives, allied health workers, urban community health workers (health caregivers), and rural community health workers (Behvarz). It should be noted that the inclusion criteria for the study encompassed all healthcare workers employed at the primary level of service delivery who were involved in the mass COVID-19 inoculation program. Additionally, individuals unwilling to participate or had no direct involvement with the vaccination program were excluded from the study.

Measurements

Based on the findings of prior qualitative research conducted by the first author, an instrument was developed for this study. The questionnaire was developed deductively using the 7C policy analysis model framework (Content, Context, Capacity, Commitment, Clients and Coalition, Communication, and Cooperation and Coordination). Qualitative and quantitative face validity were assessed to ensure the questionnaire accurately measured the intended concepts. The questionnaire was presented to 30 participants from the study population and five subject experts. During interviews, the difficulty level (clarity and understanding of phrases and words), irrelevancy (irrelevance of the questions to the topic), and ambiguity (potential for misinterpretation or lack of clarity in wording) were evaluated. The Item Impact Method (IIM) was used for quantitative face validity. Content validity was also assessed both qualitatively and quantitatively. Using the Content Validity Ratio (CVR), the necessity of the questions was reviewed, and four questions with a CVR of less than 0.33 were removed. The Content Validity Index (CVI) was then employed to assess the clarity and relevance of the questions. Six questions with CVI scores between 0.70 and 0.79 were revised and improved .

Additionally, test-retest was used to evaluate the tool's reliability. The questionnaire was completed by 30 participants from the target group in two stages, two weeks apart. The Intraclass Correlation Coefficient (ICC) was used for the five-point Likert scale, and the Kappa index for binary questions. The ICC ranged from 0.51 to 0.84 across the dimensions, with a median of 0.76. The Kappa index for the dimensions ranged from 0.60 to 0.77, with a median Kappa of 0.65.

McDonald's Omega coefficient was calculated separately for each domain to determine internal consistency. The Omega values ranged from 0.62 to 0.86, with a median of 0.78. The results indicated that the questionnaire's internal consistency and reliability were satisfactory.

This questionnaire consisted of two sections and 45 items. The first section focused on demographic information such as age, gender, education level, work experience, workplace area, type of facility, and professions type. The second section addressed various domains of vaccination policy analysis (7C), including content (12 items), context (5 items), commitment (5 items), capacity (8 items), clients and coalition (2 items), communication (6 items), and coordination and collaboration (7 items).

The questionnaire employed a five-point Likert scale, ranging from "very high" to "very low," with corresponding numerical values from five to one. In cases where the median scores of the questionnaire and its dimensions were below 3, the policy analysis was considered inappropriate, whereas scores of 3 and above were deemed appropriate. It is also worth mentioning that the relationship between professional role, type of facility, workplace area, and work experience was pre-specified (priori) as secondary objectives of the study.

Data collection

The permit for implementation of the study was issued after approving the proposal and issuance the ethics code by the Research and Health Deputy of SFMS. Then, the researcher held briefing sessions for

the study participants. Based on the research information form, participants were given education and guidance on the study's objectives, the research benefits, and how to complete the questionnaire.

Additionally, informed consent forms were obtained from the participants, and questionnaires were distributed to the staff for completion if they agreed to participate. For those who did not attend the sessions, the researcher visited their workplace in person to provide explanations and distribute the questionnaires. Once the questionnaires were filled out, the researcher revisited the workplaces to collect them.

Sample size and sampling

Given that no similar previous study was found, a pilot study was conducted using the study tool among the study population in Shoushtar. Since the goal of completing the questionnaire was to make practical decisions regarding the analysis of vaccination policy implementation, and considering that the primary variable in this study was measured using a Likert scale, the issue with using a quantitative variable approach based on numerical scales is that it does not practically reflect the project's applicability. Additionally, due to the smaller sample size under conditions with continuous variables (compared to categorical variables), the lower relative power of the study cannot be justified. Therefore, numerical values or scores from the questionnaire cannot be used to determine the sample size. The proportion (frequency) of individuals in the pilot study whose overall average score across all questions was three or higher (more than 50% of the questionnaire scale) was calculated to address this issue. The sample size was then estimated using the formula for proportion estimation in descriptive studies (with a dichotomous primary variable or measuring P) as follows: $n = (Z_{1-\alpha/2})^2 P (1-P) / d^2$

The study's precision (d) was set at 0.05, with a prevalence rate of the outcome ($p = 0.93$). The z^2 value for a 95% confidence interval was 1.96. The calculated sample size was 125 individuals, and considering a 10% non-response or non-participation rate, the final sample size was 145 participants. The sample was selected using mixed methods (proportional stratified random sampling and simple random sampling). The required sample size was determined based on the proportion of staff working in health centers, posts, and houses and then proportionally selected by stratified random sampling according to the size of each occupational group.

Data analysis

The data were analyzed using tables, figures, and descriptive and analytical statistics in STATA_{14.2} software. Descriptive indicators such as frequency, mean, standard deviation, median, and interquartile range were applied for demographic variables. The status of vaccination policy implementation and its domains were examined using descriptive indicators like median, interquartile range, and proportions. Poisson regression was employed to assess the relationship between occupations category, facility type, workplace area, and work experience with the analysis of vaccination policy implementation. While controlling for potential confounders (professional role, workplace area,

and work experience), the association between health facilities and program implementation was examined using multivariable Poisson regression(38).

The chi-square test for trend and Poisson regression examined the dose-response relationship between work experience and program implementation. The confidence interval estimates were adjusted based on gender, occupations type, facility type, workplace area, and work experience using survey data analysis to prevent selection bias and enhance accuracy. The confidence intervals were calculated using a binomial approximation for prevalence rates below 10% and above 90% and a normal approximation for rates between 10% and 90%. It is important to note that since the prevalence rate exceeded 10%, the odds ratio (OR) for examining relationships at this prevalence level tends to overestimate the effect. Therefore, the prevalence ratio (PR) was the appropriate effect size measure. Sensitivity analysis was performed by adjusting various covariates to assess the effects of the exclusion and inclusion of different variables on the model, aiming to further test the robustness of the relationship between the independent and dependent variables. A significance level of 0.05 was established.

Ethical approval

The study was conducted at the Shoushtar Faculty of Medical Sciences. The faculty's institutional review board approved this research and registered it under the code 401000002. Additionally, the Research Ethics Committee of the Shoushtar Faculty of Medical Sciences approved the study's proposal (Code NO: IR.SHOUSHTAR.REC.1401.018, approved on January 25, 2023). The methods complied with the relevant guidelines and regulations. Written informed consent was obtained in each case.

Results

Demographic Characteristics

The study involved 134 individuals, with a response rate of 92.4% (Figure 1). The average age of participants was 37.2 ± 9.5 years. Among the respondents, 89.6% were female. The majority (48.5%) had less than ten years of work experience. Additionally, 65.7% of the staff worked in rural centers. Most participants (48.5%) held a bachelor's degree. Regarding professions type, 87.3% were allied and community health workers, while the remainder were physicians. Furthermore, 62.7% worked in health posts and health houses, while others were employed at comprehensive health centers (Table 1).

P-value	Total n (%) N=134	Appropriate n (%) N=128	Inappropriate n (%) N=6	Variables
0.97	37.3 (8.3)	37.3 (8.3)	37.2 (9.5)	Age, mean (SD)
0.92	10.0 [5.0-18.0]	10.0 [5.0-18.0]	12.5 [6.0-18.0]	Work experience, median [IQR]
				Work experience (in year)
1.00	65 (48.5)	62 (48.4)	3 (50.0)	< 10
	40 (29.9)	38 (29.7)	2 (33.3)	10-20
	29 (21.6)	28 (21.9)	1 (16.7)	> 20
				Gender
0.49	120 (89.6)	115 (89.8)	5 (83.3)	Female
	14 (10.4)	13 (10.2)	1 (16.7)	Male
				level of qualification
0.28	35 (26.1)	32 (25.0)	3 (50.0)	Diploma
	11 (8.6)	11 (8.6)	0 (0.0)	Associate
	65 (48.5)	63 (49.2)	2 (33.3)	Bachelor
	6 (4.5)	5 (3.9)	1 (16.7)	Master
	17 (12.7)	17 (13.3)	0 (0.0)	Doctor
				Type of healthcare professional
1.00	17 (12.7)	17 (13.3)	0 (0.0)	Physician
	117 (87.3)	111 (86.7)	6 (100.0)	Non-physician staff
				Type of healthcare facility
0.41	50 (37.3)	49 (38.3)	1 (16.7)	Health center
	84 (62.7)	79 (61.7)	5 (83.3)	Health post/house
				Workplace area
0.66	46 (34.3)	45 (35.2)	1 (16.7)	City
	88 (65.7)	83 (64.8)	5 (83.3)	Village

Table 1. **Distribution of Study Participant's Characteristics by Vaccination Implementation Analysis**

Confirmatory Results

Analysis of the COVID-19 Mass Vaccination Program Implementation

Approximately 95.0% (95%CI: 89.2 to 97.2) of the staff working in healthcare facilities reported that the implementation of the mass vaccination program was good and appropriate. The study's findings indicated that all physicians and 94.9% (95%CI: 89.2 to 98.1) of non-physician staff described the vaccination program's execution as satisfactory. Among those working in urban units, 97.8% (95%CI: 88.5 to 99.9) had a positive view of the vaccination implementation, while 93% (95%CI: 87.2 to 98.1) of those in rural units expressed similar sentiments. Furthermore, 98% (95%CI: 89.4 to 99.9) of employees at comprehensive health centers and 93% (95%CI: 86.7 to 98.0) at health posts and health houses stated that the program's implementation was favorable. Using survey data analysis, figure 2 compares the program's implementation status categorized by health occupations, workplace area, and type of facility, both in crude and standardized forms.

Analysis of the COVID-19 Mass Vaccination Program Implementation by domains:

Overall, employees working in healthcare facilities acknowledged that the broad-scale COVID-19 vaccination was appropriate, with a median score of 3.9 (3.4 to 4.4). The findings of this study indicate that delivering the immunization program was effective across all domains. The content, commitment, capacity, communication, and coordination and collaboration areas all had similar and favorable statuses, each with a median score of 4.0. However, the median scores for contextual factors (3.4 [3.0 to 4.0]) and clients and coalition (3.5 [3.0 to 4.0]) were lower than those of other dimensions (Figure 3). As shown in Table 2, nearly 24.0% of respondents believed that the status of clients and coalition could have been improved in the program's execution, and over 20.0% reported that the contextual factors needed to be improved. Notably, nearly 100% of study participants described the program's content factors as suitable.

Domains	Median [IQR] (From 5)	Proportion (95% CI)
Content	4.0 [3.6 to 4.5]	99.4 (97.9 to 99.8)
Context	3.4 [3.0 to 4.0]	79.3 (73.0 to 84.4)
Commitment	4.0 [3.4 to 4.4]	91.5 (86.3 to 95.0)
Capacity	4.0 [3.6 to 4.6]	97.6 (94.3 to 99.0)
Clients and Coalition	3.5 [3.0 to 4.0]	76.7 (70.4 to 82.0)
Communication	4.0 [3.7 to 4.7]	92.6 (87.4 to 95.8)
Coordination and Collaboration	3.9 [3.3 to 4.3]	86.4 (80.8 to 90.6)
Total	3.9 [3.4 to 4.4]	94.5 (89.2 to 97.2)

Table 2. Median and Inter Quartile Range (IQR) of vaccination implementation analysis by domains, with proportion of appropriate vaccination (scores of 3 and higher)

Content Domain Analysis

In most cases, the content domain received scores higher than 4.0, indicating a good and satisfactory status. Two items, specifically vaccination hours and vaccine card issuance, achieved a median score 5.0. However, the lowest median score within the content domain was assigned to item 10 (the vaccination program did not disrupt other essential health services), which scored 3.0 (2.0 to 4.0). About 30.0% of participants believed that the program disrupted the provision of other essential and routine health services. Additionally, 18.2% of staff indicated that identifying and following up with individuals who did not attend or were unwilling to get vaccinated was not readily achievable. Another noteworthy point in the content domain was the influence and benefit of recruiting and training health ambassadors, volunteers, and other collaborating personnel to participate in vaccination efforts, with 85.4% in agreement and 14.6% expressing disagreement.

Context Domain Analysis

The results showed that the median score for the context domain was consistently equal to 4.0 (satisfactory) in all cases except one. Motivational measures, such as financial incentives and career advancement opportunities for staff involved in the vaccination practices, must be adequately

considered. Among all questionnaire items, the lowest score (2.0 [1.0 to 3.0]) was assigned to this particular aspect.

Commitment Domain Analysis

The median score for the commitment domain was consistently satisfactory (equal to 4.0) across all items. However, 11.2% of responses indicated that the existing laws and regulations to encourage and promote vaccination must be revised and more effective. Additionally, nearly 10.0% of respondents expressed concerns about the need for more accountability among managers and senior officials (from the university/faculty) regarding the challenges and issues faced during the vaccination program deployment.

Capacity Domain Analysis

According to the present study's findings, the median score for the capacity domain was also satisfactory and equal to 4.0 across all items. However, in item number 26 (equipment (e.g., cold chain, emergency medical supplies, and computers) was adequate), approximately 13.0% of respondents deemed the necessary equipment (such as cold chain, resuscitation and emergency medical supplies, and computers) for the program to be inadequate and insufficient.

Coalition and Client Domain Analysis

The median score for mobilizing individuals and influential groups (religious leaders, celebrities and artists, teachers, community elders, and merchants) to persuade and encourage the public was 3.0 [2.0 to 4.0]. The interquartile range indicates that the lowest 25th percentile for this item was 2.0, which is the second lowest score after the motivation and encouragement topic.

Communication Domain Analysis

The status of the communication area in the massive rollout of vaccines against COVID-19 was reported as satisfactory, with a median score of 4.0 for all items within this area, which indicates a positive assessment of health staff communication efforts related to the vaccination measures.

Coordination and Collaboration Domain Analysis

The study findings indicated that the scores for all items in the coordination and collaboration domain of the vaccination program were equal and rated as 4.0, reflecting a good and satisfactory status. However, items 40 (cooperation from other agencies (e.g., governor's office, military) in implementing the vaccination program was satisfactory) and 41 (collaboration with NGOs, volunteers, and health ambassadors was effective) revealed that 16.0% of participants believed that the collaboration of other government offices and organizations (such as the governor, district offices, and army) needed to be improved. In comparison, 15.0% felt that collaborating with NGOs, volunteers, and health ambassadors in vaccination efforts and public awareness could have been more effective. Additionally, around 24.0%

of health staff described the participation of the private sector (clinics and medical offices) as unsatisfactory (Table 3).

Domains / Items	Median [IQR] (From 5)	Proportion (95% CI)
Content		
1	4.0 [4.0 to 5.0]	95.2 (91.0 to 97.5)
2		98.6 (95.7 to 99.6)
3	4.0 [4.0 to 5.0]	99.0 (95.0 to 99.9)
4	4.0 [4.0 to 5.0]	98.8 (96.8 to 99.8)
5		99.4 (97.9 to 99.8)
6	4.0 [4.0 to 5.0]	99.0 (97.0 to 99.9)
7	5.0 [4.0 to 5.0]	99.2 (96.6 to 99.8)
8		81.8 (75.5 to 86.8)
9	4.0 [4.0 to 5.0]	85.4 (80.3 to 89.3)
10	5.0 [4.0 to 5.0]	70.7 (64.3 to 76.3)
11		96.5 (93.8 to 98.1)
12	4.0 [3.0 to 5.0]	95.4 (90.2 to 97.9)
	4.0 [3.0 to 5.0]	
Context		
13	3.0 [2.0 to 4.0]	94.2 (88.8 to 97.1)
14	4.0 [4.0 to 5.0]	91.6 (87.3 to 94.5)
15		92.3 (87.7 to 95.3)
16	4.0 [4.0 to 5.0]	81.9 (75.5 to 86.9)
17		38.1 (31.7 to 45.0)
Commitment		
	4.0 [3.0 to 5.0]	
18		
19	4.0 [3.0 to 5.0]	94.5 (89.7 to 97.2)
		88.8 (83.5 to 92.6)
20	4.0 [3.0 to 5.0]	92.1 (86.8 to 95.4)
21		99.5 (98.9 to 99.8)
22	4.0 [3.0 to 4.0]	90.2 (85.8 to 93.3)
	2.0 [1.0 to 3.0]	

Capacity

23		91.1 (85.7 to 94.6)
24	4.0 [3.0 to 4.0]	95.6 (92.4 to 97.5)
25	4.0 [3.0 to 4.0]	91.0 (86.0 to 94.4)
26	4.0 [3.0 to 4.0]	87.3 (81.8 to 91.3)
27	4.0 [4.0 to 5.0]	99.0 (97.0 to 99.9)
28	4.0 [4.0 to 5.0]	97.3 (94.6 to 98.7)
29	4.0 [4.0 to 5.0]	99.6 (99.6 to 99.7)
30	4.0 [3.0 to 4.0]	93.4 (88.1 to 96.4)

Clients and Coalition

		91.8 (87.7 to 94.6)
31	4.0 [3.0 to 5.0]	71.4 (64.5 to 77.4)
32	4.0 [3.0 to 5.0]	
	4.0 [3.0 to 5.0]	
	4.0 [3.0 to 5.0]	
	4.0 [4.0 to 5.0]	
	4.0 [4.0 to 5.0]	
	4.0 [4.0 to 5.0]	
	4.0 [4.0 to 5.0]	
	4.0 [3.0 to 4.0]	
	3.0 [2.0 to 4.0]	

Communication		
33	4.0 [3.0 to 5.0]	91.7 (86.2 to 95.1)
34		91.9 (86.7 to 95.2)
35	4.0 [3.0 to 5.0]	93.3 (89.7 to 95.7)
36	4.0 [3.0 to 5.0]	90.8 (85.2 to 94.4)
37		99.0 (97.9 to 99.6)
38	4.0 [3.0 to 5.0]	94.9 (90.0 to 97.4)
	4.0 [4.0 to 5.0]	
Coordination and Collaboration		
39	4.0 [4.0 to 5.0]	91.0 (86.5 to 94.1)
40		83.9 (78.2 to 88.4)
41		84.8 (79.6 to 88.8)
42	4.0 [3.0 to 5.0]	76.2 (69.8 to 81.7)
43		99.4 (97.9 to 99.8)
44	4.0 [3.0 to 4.0]	99.5 (98.0 to 99.8)
45	4.0 [3.0 to 5.0]	92.7 (87.5 to 95.8)
	4.0 [3.0 to 4.0]	
	4.0 [4.0 to 5.0]	
	4.0 [4.0 to 5.0]	
	4.0 [3.0 to 5.0]	

Table 3. Median and Inter Quartile Range (IQR) of **vaccination implementation analysis by items of domains, with proportion of appropriate vaccination (scores of 3 and higher)**

Exploratory Results

Factors Related to the Policy Analysis of COVID-19 Vaccination Program Implementation:

As seen in Table 4, the median score of physicians was slightly higher than that of others. While all physicians found the program's implementation favorable, 6% of non-physician staff disagreed. A univariable Poisson regression revealed that this difference was statistically significant (P-value < 0.05)

but with a weak association (PR = 0.94; 95% CI: 0.90 to 0.98). Workforces in comprehensive health service centers had a slightly higher median score than those in health posts and houses (4.0 vs. 3.9, respectively). Although personnel at these centers were 5.0% more satisfied than others, the difference was not statistically significant (P-value > 0.05) and showed no substantial relationship (PR = 0.95; 95% CI: 0.89 to 1.02). Notwithstanding, while the median score for rural areas was 4.0 and for urban areas 3.9, urban staff were 4.0% more satisfied. However, this difference was also not statistically significant (P-value > 0.05), and no considerable relationship was found (PR = 1.04; 95% CI: 0.96 to 1.12) (Figure 4).

Domains	Median [IQR] (From 5)	PR (95%CI)	P-value
Type of healthcare professional			
Physician	4.0 [3.6 to 4.6]	Ref	0.006*
Non-physician staff	3.9 [3.4 to 4.4]	0.94 (0.90-0.98)	
Type of healthcare facility			
Health center	4.0 [3.4 to 4.4]	Ref	0.136
Health post/house	3.9 [3.5 to 4.3]	0.95 (0.89-1.02)	
Workplace area			
Village	4.0 [3.4 to 4.4]	Ref	0.308
City	3.9 [3.5 to 4.4]	1.04 (0.96-1.12)	

Table 4. Median and Inter Quartile Range (IQR) of **vaccination implementation analysis by associated factors**

Dose-Response Relationship between Work Experience and Program Implementation

The Chi-square trend test did not show a statistically significant association between work experience and the rollout of the vaccination program ($\chi^2 = 0.04$, P-value = 0.839) (Table 6). According to Poisson regression results, dissatisfaction with the program slightly increased with more years of work experience, but the difference was minimal and not statistically significant (P-value = 0.719), indicating no meaningful relationship (PR = 0.98; 95% CI: 0.85 to 1.12), as seen in Figure 5.

P-value	95%CI	PR	n (%)	Variables
				Work experience (in year)
		Ref	65 (48.5%)	< 10
0.740	0.91-1.07	0.99	40 (29.9%)	10-20
0.719	0.85-1.12	0.98	29 (21.6%)	> 20

Table 6. Dose-response association between **work experiences with vaccination implementation analysis**

Sensitivity analysis

As shown in Table 7, the relationship between healthcare facility type and program implementation, analyzed using multivariable Poisson regression (step-by-step adjusting for covariates such as workplace area, healthcare professional type, and work experience), revealed similar and thus robust results. However, it is notable that adding these covariates— workplace area, type of healthcare professional, and work experience—reduced the strength of the association by 17%, indicating a downward bias.

P-value	aPR (95%CI)	Variables
		Model 1:
		Type of healthcare facility
	Ref	Health center
0.124	0.95 (0.88-1.02)	Health post/house
		Model 2:
		Type of healthcare facility
	Ref	Health center
0.170	0.95 (0.89-1.02)	Health post/house
		Model 3:
		Type of healthcare facility
	Ref	Health center
0.124	0.95 (0.89-1.01)	Health post/house

Table 7. **Sensitivity analysis for effect of healthcare facility types on vaccination implementation in different adjusted models**

Model 1: adjusted for workplace area, Model 2: adjusted for workplace area and type of healthcare professional, Model 3: adjusted for workplace area, type of healthcare professional and work experience

Discussion

Since one of the key and prominent policies during the epidemic of infectious diseases is the implementation of mass vaccination programs, it involves a complex decision-making process that varies based on the specific circumstances of each country. Therefore, analyzing how this policy is executed is crucial for decision-makers and planners in the health service system. This study aimed to assess the status of the vaccination policy and its domains during the COVID-19 epidemic.

Approximately 95% of healthcare workers reported that implementing the COVID-19 mass vaccination program was well-executed. The study revealed that the program's execution in content, commitment, capacity, communication, and coordination was satisfactory. However, it needed to be more robust regarding context, clients, and coalition than other dimensions. Most respondents highly praised the way and schedule of service delivery. However, about one-third noted that the vaccination program disrupted routine healthcare services. The majority emphasized using health ambassadors and volunteers for better program implementation. In terms of context, insufficient incentives and dissatisfaction with motivational efforts were reported by 62% of the staff. Nearly 29% believed that the mobilization of influential figures to encourage vaccination needed to be improved, while around 24% expressed dissatisfaction with the lack of private-sector involvement. No significant relationship was observed between professional type, workplace area, facility type, and work experience and implementing the vaccination program.

The analysis of the mass vaccination policy indicated that the program was implemented effectively and appropriately. The study by Majdzadeh et al. demonstrated that the quality of the mass vaccination performance against measles and rubella in the health centers affiliated with the Tehran University of Medical Sciences was satisfactory(39). Studies conducted on COVID-19 mass vaccination in China and the United States were also successful and showed a significant positive impact(19,20). Although the results of some studies generally align with this one, the performance and implementation of large-scale vaccination programs are influenced by the managerial and operational factors specific to each country, leading to differences in program execution(40). Research findings in Iran emphasized that utilizing health services encounters obstacles associated with context, content, and process(41). Therefore, this study aimed to analyze and interpret various domains of the vaccination program.

The study's findings revealed that mass immunization was well-managed in content-related processes, including staff training, prioritizing high-risk groups, identity verification, information recording, service hours, vaccine distribution and allocation, and infection control. Human resource management, as well as the training and education of personnel, play a crucial role in the COVID-19 vaccination program(14). Seyedain et al. found that the implementation of the cold chain and vaccination efforts requires significant effort, and it is essential that health staff are thoroughly briefed on vaccine storage, transportation, and potential side effects by guidelines(5). An Iranian study indicated that daily vaccination records and card issuance were satisfactory(39). Another key aspect of mass inoculation implementation, which can offer indirect immunity benefits for the elderly and vulnerable groups, is prioritizing high-risk groups. Equitable access and distribution of vaccines,

transparency, and trust are also critical factors in successfully implementing an immunization program(5). Thus, the success of large-scale vaccination is contingent on factors such as management, human resources, vaccine allocation, record-keeping, card issuance, infection control, and the disposal of infectious waste.

However, there are challenges regarding disruptions to routine services and the identification and follow-up of eligible individuals who have not yet received the vaccine. In this regard, several studies have shown that combating the COVID-19 pandemic, including vaccination efforts, has caused disruptions in ongoing health programs, posing challenges for service providers and the public(42–44). Sagastume et al. highlighted that low- and middle-income countries' main barriers to delivering essential health services were reduced demand and supply(45). Odone et al. argued that health emergencies, such as the recent pandemic, negatively impact the prevention and control of communicable diseases, increasing the likelihood of vaccine-preventable diseases(46). Arsenault et al. acknowledged that factors such as receiving more healthcare visits, regular consultations with a specific provider, access to other preventive services, and high-quality care were positively associated with COVID-19 vaccination(47). One study identified strengthening community-based programs and engaging volunteers as a solution in Australia(48). The increased demand for visits due to COVID-19 infections and vaccinations, staff shortages, and absenteeism have created challenges. Therefore, managers and planners must focus on these issues to prevent harm to other essential health services.

The analysis of contextual factors indicated that the administrative and logistical processes of the vaccination program were well-executed. If campaign planners manage the support systems in advance, they can reduce the waiting time for vaccine recipients and improve the public's and staff's satisfaction. Shakory et al. and Hosangadi et al. emphasized the importance and role of logistical factors(32,49). Meyer et al. identified the primary challenge for vaccination centers as a shortage of clinical staff(50). This study and other research indicate that the most critical factor in successfully implementing a vaccination program is having a sufficient and effective workforce.

The assignment of duties, division of work, and devolution were also among the contextual factors of the program, which were reported to be in good condition. Swift et al. suggested that staff should have clear job descriptions, including the execution steps, roles, and responsibilities of each staff member(51). However, the Philadelphia study highlighted the importance of monitoring staff duties and ensuring they fully understand their roles(52). Some obstacles to the rollout of rapid mass vaccination practices include a shortage of qualified personnel to manage vaccinations, increased patient load compared to pill distribution methods, and logistical difficulties in maintaining the cold chain(53). As Kumar et al. (54) pointed out, in events involving the participation of various individuals and organizations, paying attention to the roles and responsibilities of participants, along with clear devolution, leads to better performance.

A notable finding in the contextual aspect of vaccination was the poor performance regarding motivation, financial compensation, and the reward system. A study conducted in the Czech Republic

revealed that the prevalence of burnout among physicians working in mass vaccination centers was 32% (55). Low-quality services and poor health outcomes often result from lacking motivation and staff dissatisfaction(56). Therefore, to meet public health needs during epidemics, one of the key priorities is to focus on supporting healthcare workers, enhancing their resilience, and ensuring their well-being. Performance-based financial incentives are one strategy to address this issue(57). Mahdavi et al. believe that financial rewards effectively boost motivation and resilience among healthcare workers during epidemics(58). Implementing holistic strategies for managing health forces over the COVID-19 pandemic can help mitigate its effects, enhance the resilience of medical staff, and improve the performance of healthcare facilities.

The level of commitment and accountability regarding the COVID-19 vaccination in Shoushtar was reported as satisfactory. Items such as the authority and diligence of the health network in implementing the program were commendable. Medical ethics considerations were well observed during vaccination, including respect for personal privacy, confidentiality, and discretion. Ensuring the application of fundamental ethical principles in public health strategies is crucial for effective policymaking and program execution, and it is essential for public health workers to be competent in this area(59). Vaccination activities should be carried out in an environment of respect and autonomy for the target group(60). Transparency regarding the known and unknown aspects of vaccination strengthens public trust(61). A survey conducted in 14 countries showed that people's confidence in the healthcare system and government significantly increased the odds of receiving at least two or three doses of the COVID-19 vaccine(47). While upholding medical ethics, including respect for privacy and confidentiality, health authorities should strengthen leadership and diligence in managing programs to foster commitment and trust in COVID-19 vaccination efforts.

In terms of public commitment to vaccination, timely attendance was relatively satisfactory. Hossein et al. found that the vaccine acceptance rate in low- and middle-income countries is higher relative to developed countries, with people being more eager to receive the vaccine, which aligns with the findings of our study(14). However, based on the findings of this study, developing necessary laws and regulations to encourage and motivate people to get vaccinated is essential. Given the profound impact of immunization on global health security, passing legislation to support this policy is urgent (59). Bîrsanu et al. suggested that governments establish a legal framework for this issue(63). Public awareness campaigns, combined with transparency, can enhance trust and increase the willingness of individuals to get vaccinated. Moreover, since the external effects of communicable diseases become prominent during epidemics, laws and regulations are crucial for better management of preventive efforts.

The findings regarding program capacity revealed that the necessary resources for vaccination (physical, human, and informational) were adequately provided to vaccination centers. Similarly, Majdzadeh et al.'s study reported no challenges regarding the resources needed for vaccination(39). Proper planning and providing infrastructure, equipment, and supplies play a vital role in the success of mass vaccination, a point emphasized in various studies(5,24,64). The results also highlighted the need for increased

attention to providing equipment such as cold chain tools, resuscitation and emergency medical supplies, and computers. Since vaccine safety and efficacy are critical, the cold chain management, storage, and transportation of vaccines must be handled with high precision and sensitivity(28,65). Another issue reported in mass vaccination, consistent with this study's findings, is the challenge of resuscitation and medical emergencies at vaccination sites(51). Vaccination sites also urgently need computers for identity verification, record-keeping, and vaccine card issuance, as noted in a Canadian study(66). Vaccination centers should ensure the timely procurement and maintenance of essential equipment, such as cold chain tools, resuscitation supplies, and computers for administrative tasks. Regular training and monitoring ensure staff can efficiently manage vaccine administration's technical and medical aspects.

Clients and coalitions scored lower compared to other domains. Persuading and encouraging people through influential individuals and groups was a component that needed strengthening. Seyedin et al. also showed that the success of vaccination programs depends on the involvement of religious leaders and influential figures(5). Another study found that political, social, and cultural leaders play a critical role in informing and educating the public during public health campaigns in emergencies(14). During epidemics, it is essential to leverage all community resources, as success in a large-scale program requires the participation of all sectors of society. Health system managers must effectively communicate the importance and urgency of the issue to other government sectors to enhance public cooperation.

One of the findings of this study showed that public communication regarding the program's implementation, the benefits of vaccination, and the vaccine's effectiveness through various media such as radio, television, and social media was well-executed. Media play a significant role in shaping both accurate and inaccurate beliefs, making it essential for them to be aware of their critical responsibility(5). Social media, in particular, can spread misinformation while addressing public concerns(67). Overall, successful immunization services require clear and continuous communication with the public and healthcare workers (25), a priority that health policymakers and managers must consider.

In this study, the coordination and collaboration among various levels of the healthcare service network (health houses, health posts, comprehensive health centers, emergency services, and hospitals) during epidemic vaccination efforts were found to be effective. However, cooperation with other governmental, non-governmental, and community-based organizations, particularly the private health sector, must be strengthened. The primary challenge facing Iran's health information management system during the infectious disease epidemic is adequate collaboration and involvement from public and private centers in data registration and reporting(68). Italy's local and state health authorities utilized private entities to establish mass vaccination centers(69). Fan et al. discovered that success in vaccination efforts depends on coordination between health sectors and other areas, especially volunteer and community-based organizations(20). Smith et al. also emphasized the participation of various sectors, including private businesses and non-profit organizations, in vaccination programs(19). The successful

implementation of such programs requires the collaboration of all stakeholders(32,49). Bolstering another program area, such as context, commitment, coalition, and communication, is necessary.

Analyzing factors related to implementing the COVID-19 vaccination policy did not reveal any significant or notable relationships. In other words, the findings of this study suggest that during pandemics and crises, all health sector resources—regardless of profession, type of service delivery facility, location, and work experience —exhibited the necessary commitment, cooperation, and coordination in performing assigned roles and tasks. In contrast to these results, a study conducted in Ethiopia found a significant relationship between the type of center, profession, and attitudes toward COVID-19 vaccination(33). The discrepancy in findings is attributed to the effect size measurement. The Ethiopian study used the OR (Odds Ratio) index, which tends to overestimate, whereas the present study employed the PR (Prevalence Ratio) index to determine the strength of the association. There was no significant difference between the type of facility and the mass COVID-19 vaccination program implementation. However, it is worth noting that including variables such as workplace area, professional role, and work experience weakened the strength of the association by 17% (downward bias). Given that the difference between crude and adjusted effect sizes exceeds 10%, these variables act as confounders in this relationship (low risk of bias).

Strengths and limitations

Given that this analysis is based on the perspectives of the personnel themselves, there is a possibility of bias in their responses. They may describe aspects of their performance positively, while those concerning others may not be as favorably portrayed. Therefore, it is essential to consider other stakeholders' viewpoints to gain a more comprehensive and balanced understanding of the program's implementation. The research lacked qualitative insights into health professionals' performance regarding the COVID-19 vaccine and related factors, which could have supported the quantitative results. Additionally, as a cross-sectional study, it did not explore the causal relationship between the factors and the outcome variables.

Conclusion

The analysis of the mass vaccination policy revealed that the program was implemented effectively. However, a deeper examination of various aspects of the program's execution highlighted challenges in some areas. The findings suggest that while the health sector's capacities and resources were well-mobilized during the epidemic, external forces and facilities need better organization and guidance. Strong partnerships of local influencers and leaders in inter-sector collaborations and encouraging public participation could facilitate smoother operations. Given that routine healthcare services tend to be disrupted during epidemics and crises, it is essential for the private health sector, volunteers, and health ambassadors to play a more active role in service delivery. Epidemics place the most significant burden on healthcare personnel, who often face financial and non-financial constraints, making it crucial for managers and authorities to provide financial incentives and support to motivate staff. Additionally,

the study indicates that during pandemics and crises, all health sector resources, regardless of occupations, facility, or work experience, demonstrate the necessary commitment, cooperation, and coordination to fulfill their assigned roles and responsibilities.

Declarations

Data availability

All data and materials in this research can be obtained by contacting the corresponding author: Nayeb Fadaei Dehcheshmeh (fadaei-n@shoushtarums.ac.ir).

Acknowledgments

We now express our appreciation and gratitude for the cooperation and participation of SFMS.

Author Contributions

Conceptualization, NFD and HJ; methodology, NFD and HJ; formal analysis, NFD; data curation, AHG, BD, and ZB; writing—original draft preparation, NFD; All authors have read and agreed to the published version of the manuscript.

Competing interests

The authors declare no conflicts of interest.

Funding

The authors received no funding for this work.

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Figures

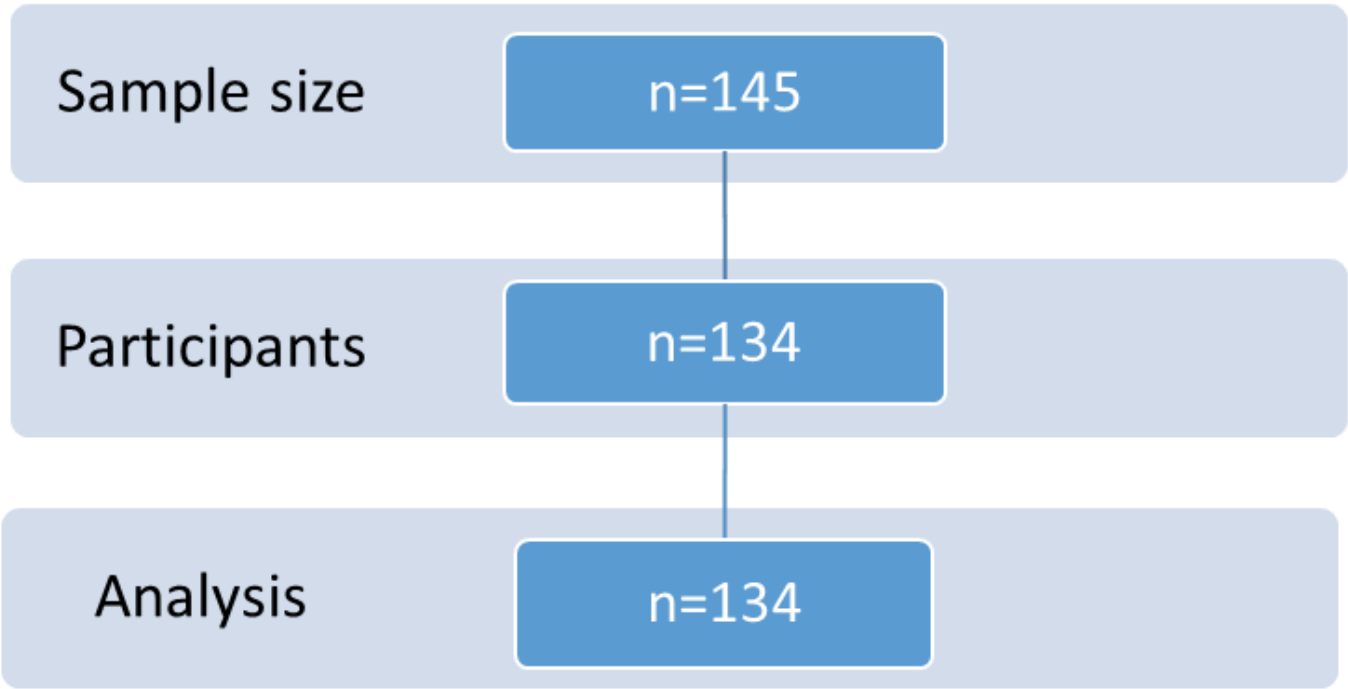


Figure 1

Flow diagram for study participants and analysis

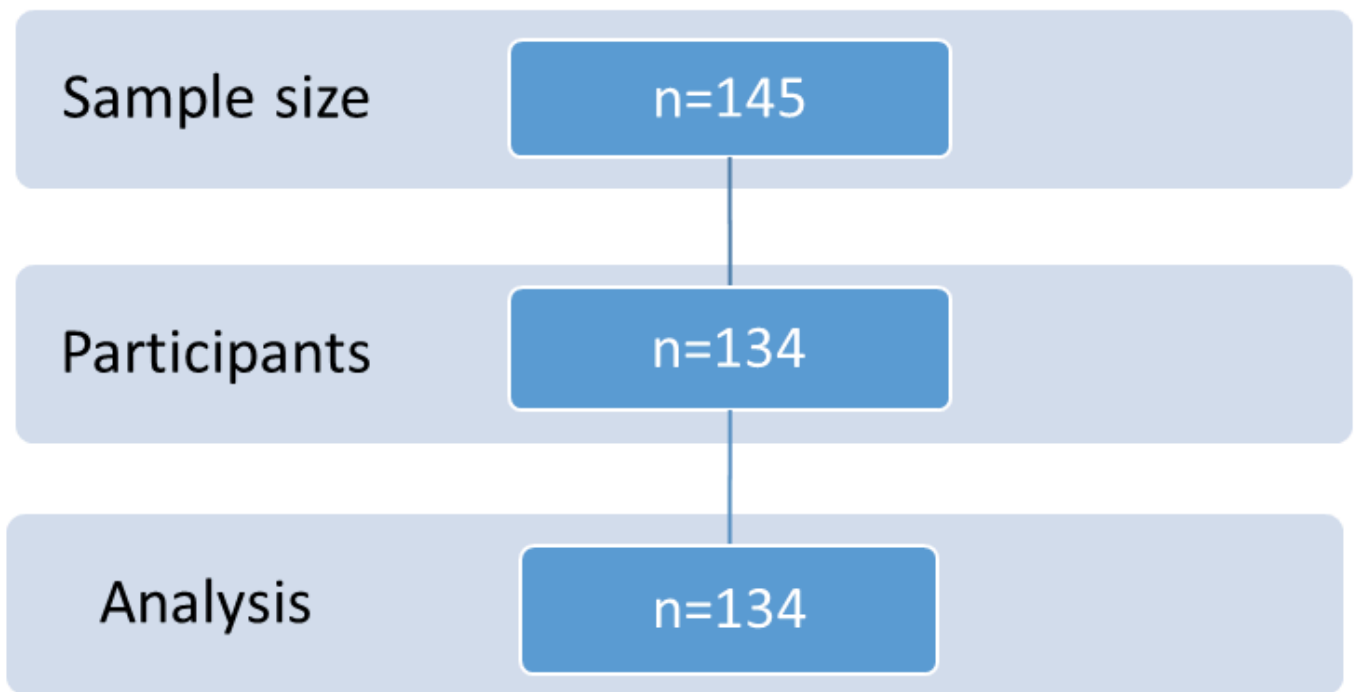


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Flow diagram for study participants and analysis

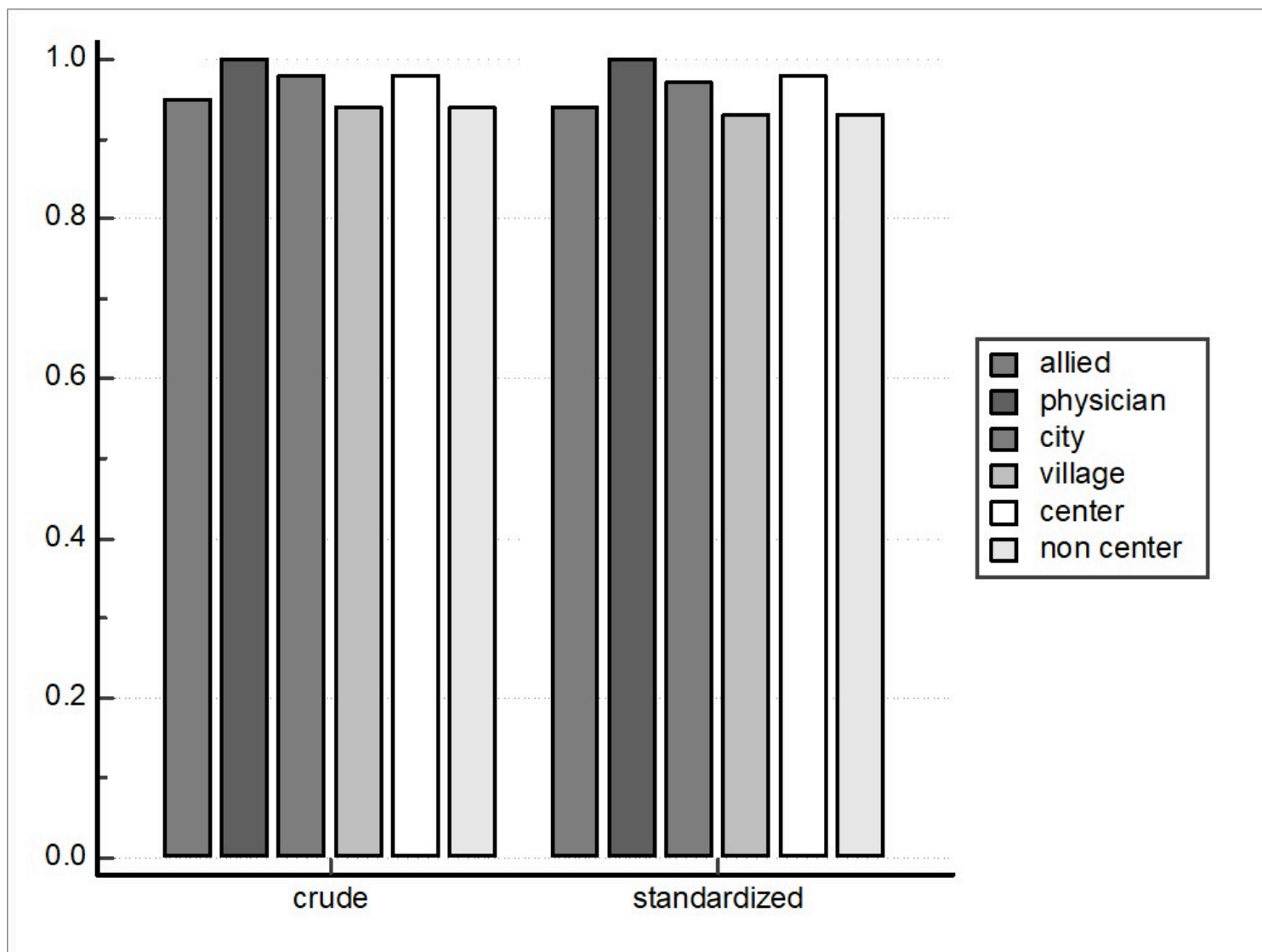


Figure 2

The prevalence of appropriate vaccination for professional role, workplace area, and facility type by crude and standardized

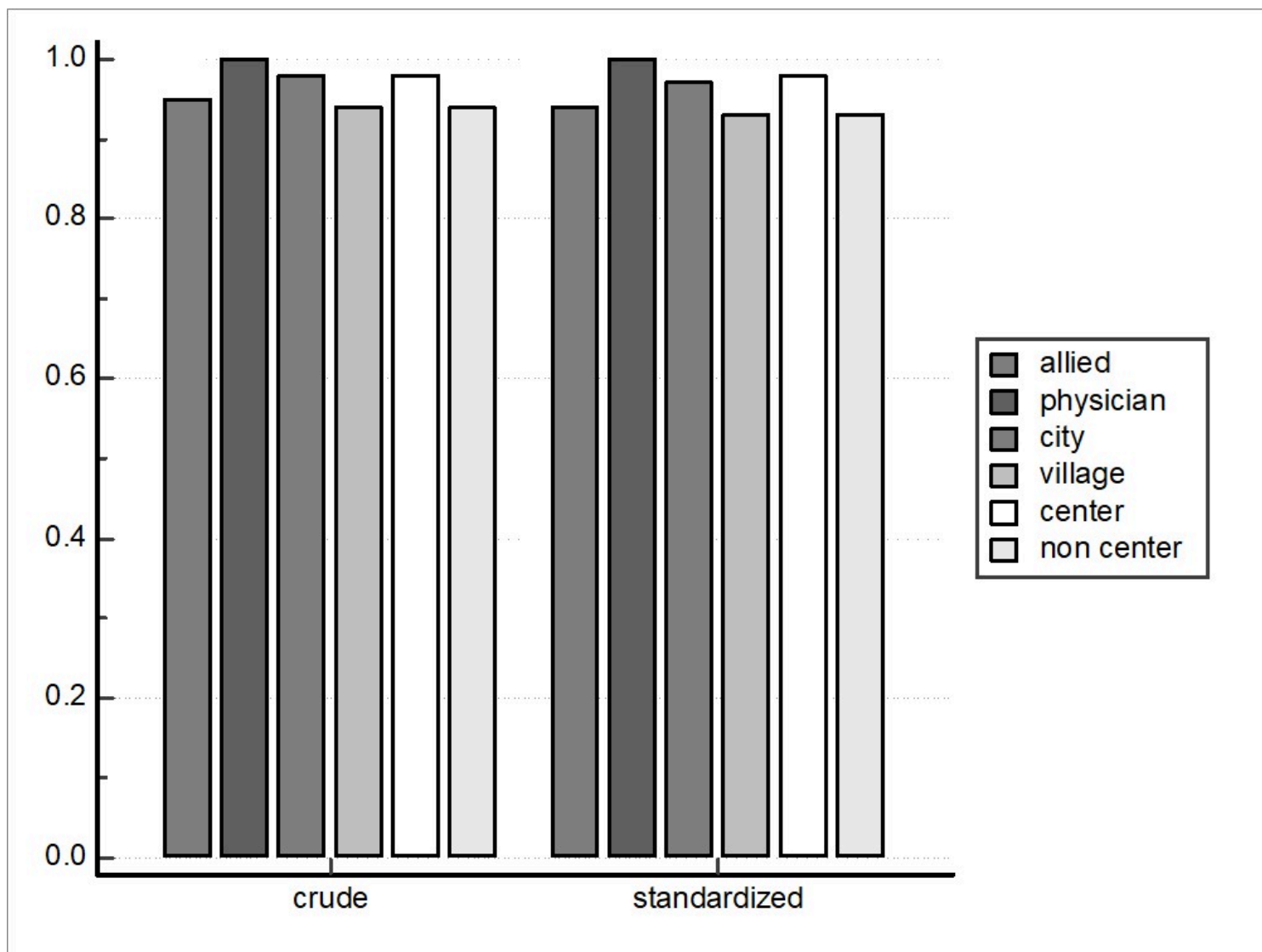


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The prevalence of appropriate vaccination for professional role, workplace area, and facility type by crude and standardized

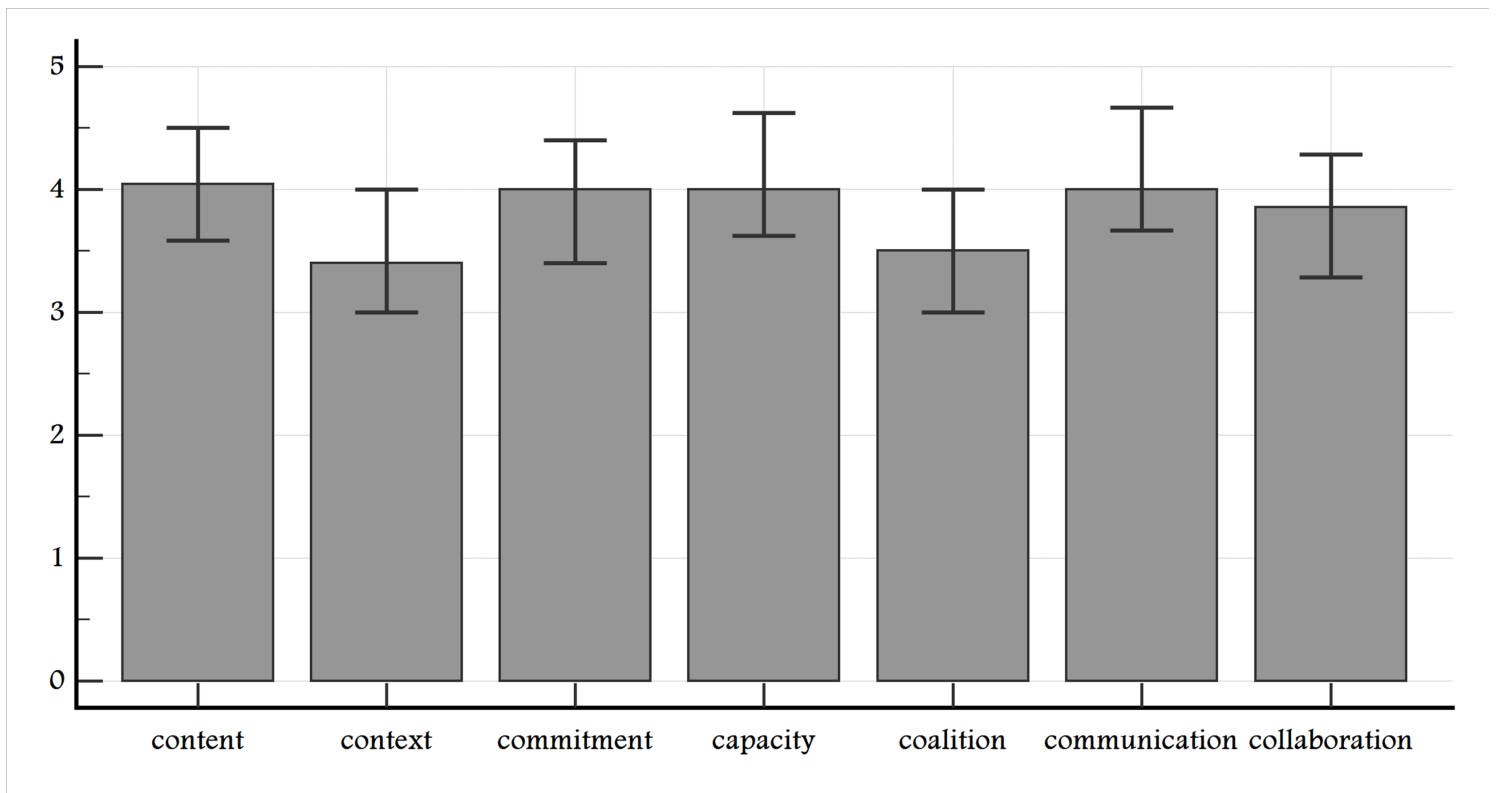


Figure 3

The median of the vaccination domains, with the error bar indicated by IQR confidence interval

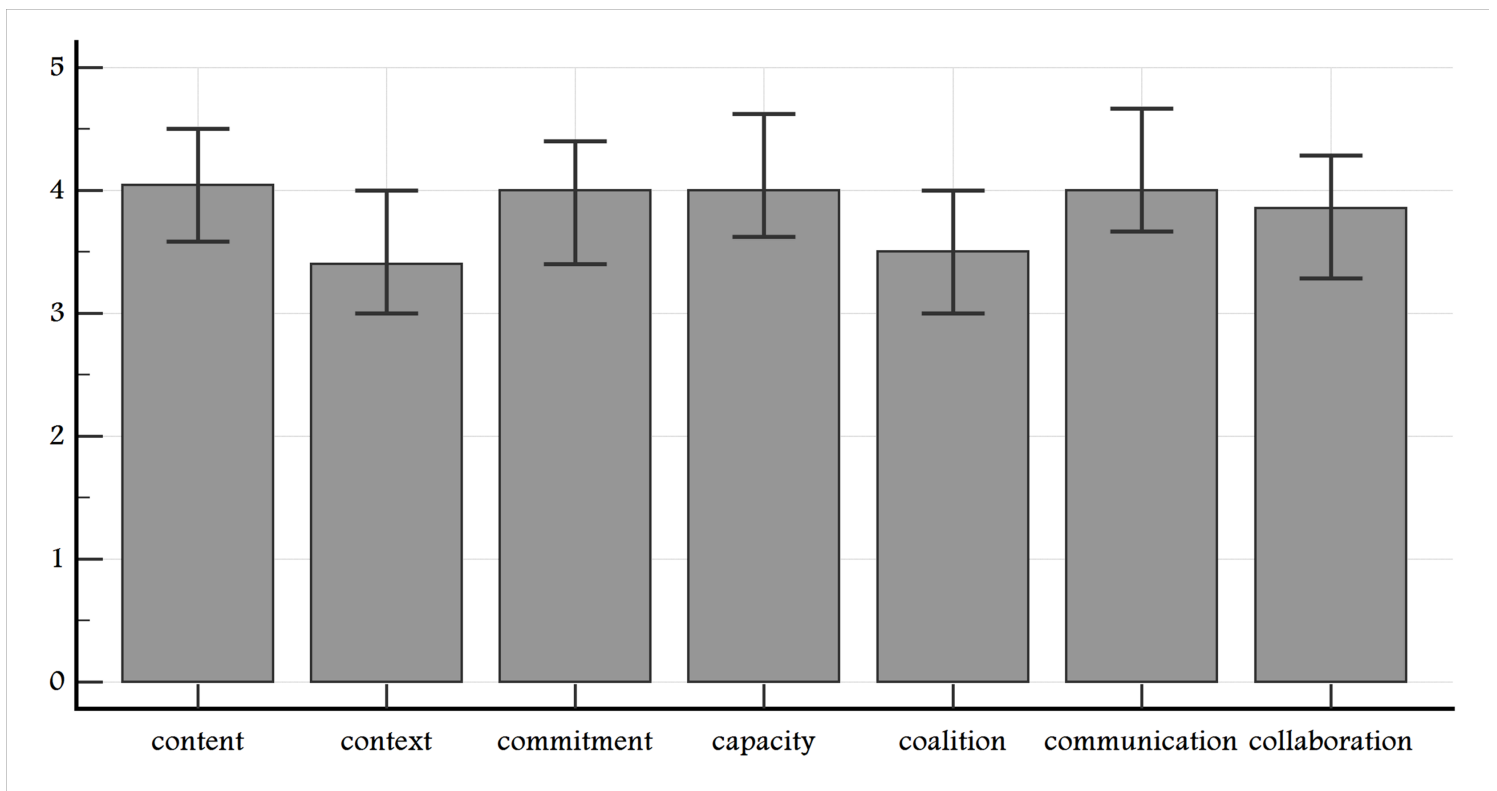


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The median of the vaccination domains, with the error bar indicated by IQR confidence interval

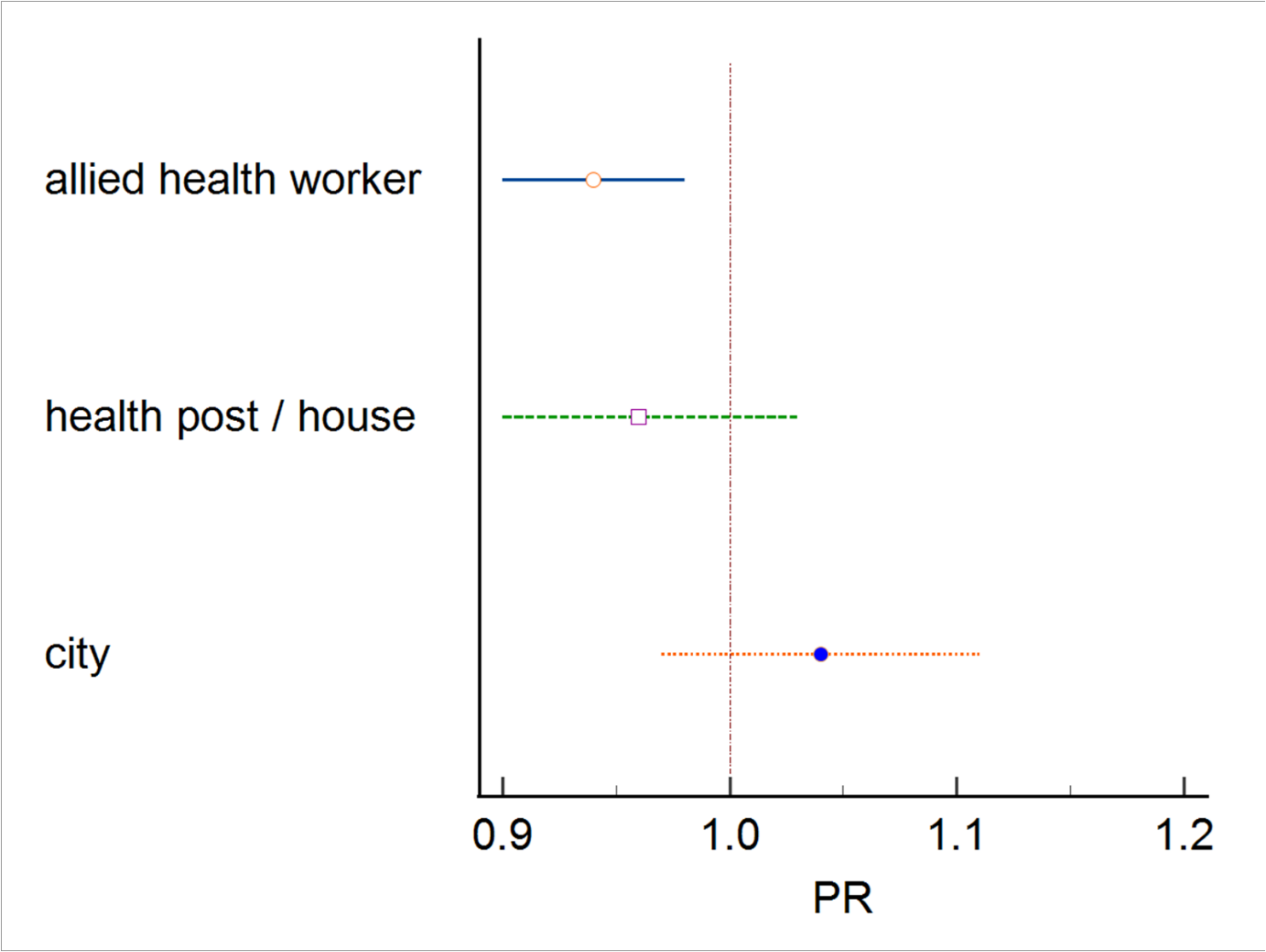


Figure 4

The prevalence ratio of appropriate vaccination and confidence interval for professional role, workplace area, and facility type

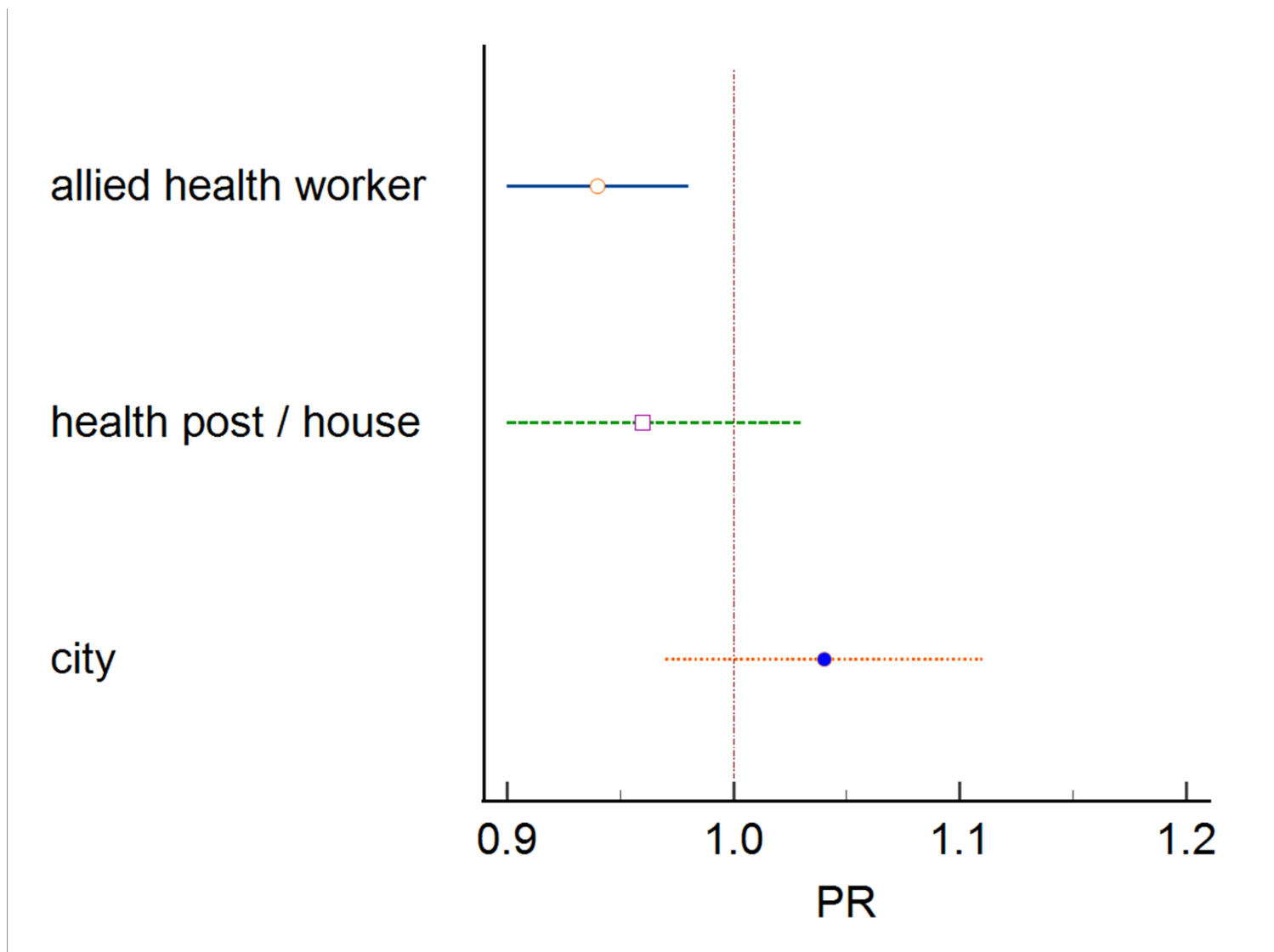


Figure 4

The prevalence ratio of appropriate vaccination and confidence interval for professional role, workplace area, and facility type

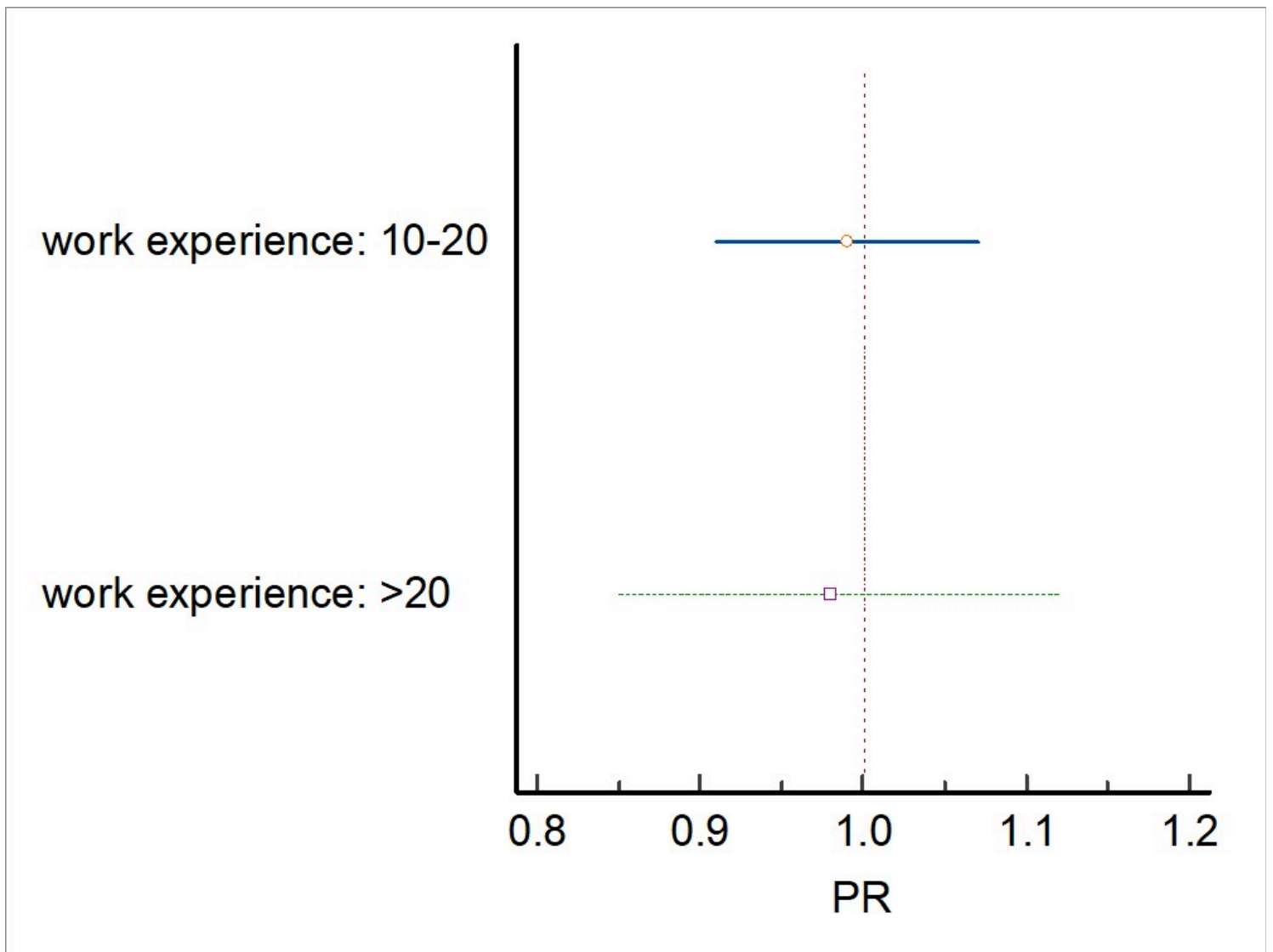


Figure 5

The prevalence ratio of appropriate vaccination and confidence interval for work experience subgroups

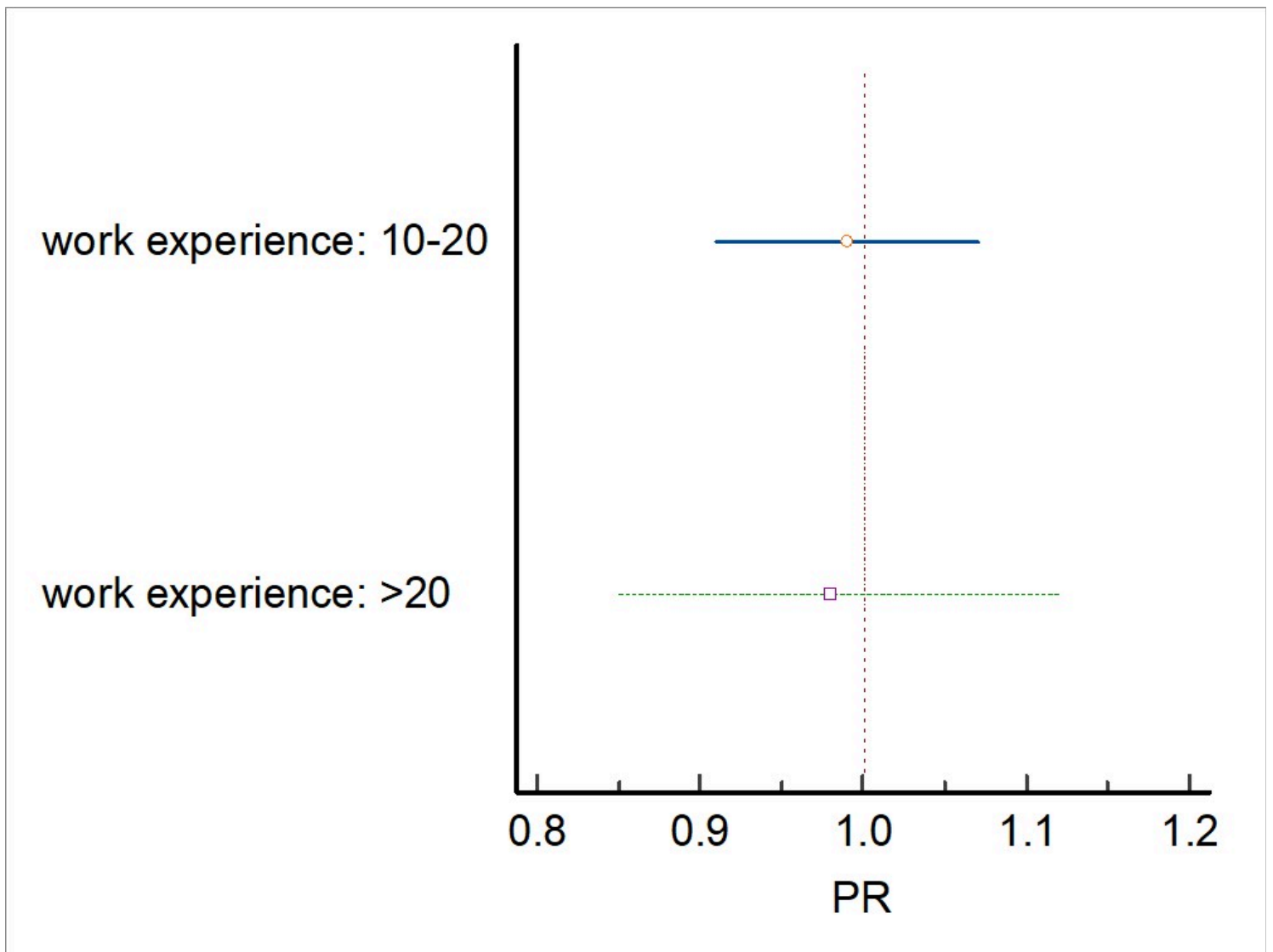


Figure 5

The prevalence ratio of appropriate vaccination and confidence interval for work experience subgroups