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A study on the willingness and influencing factors of non-EPI vaccines recommendations among Chinese vaccination staff under major infectious disease outbreaks

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ABSTRACT

WHO had warned of the impending "X disease," emphasizing the need to quickly establish an immune barrier. The willingness of vaccination staff to recommend vaccines was crucial in such scenarios. This study aimed to investigate willingness and influencing factors of Non-EPI Vaccines recommendations among Chinese vaccination staff in Hangzhou, China. We selected vaccination staff in 191 vaccination clinics from Hangzhou for a questionnaire-based survey using a cross-sectional survey. Descriptive statistics were made on the characteristics of participants. Univariate and multivariable analyses were used to determine the influencing factors of Non-EPI Vaccines recommendations. The overall recommendation rate was 76.2%. Compared to Supplementary and Individual Non-EPI Vaccines, vaccination staff were more willing to recommend Alternative ($x^2 = 215.655$, $P < 0.05$) and Combined Non-EPI Vaccines ($x^2 = 214.998$, $P < 0.05$). Multivariate logistic regression analysis showed that vaccination staff who did not participate in COVID-19 vaccination work (OR = 2.942, 95%CI:1.121 ~ 9.302), believe they had an obligation to recommend Non-EPI Vaccines ($OR_{disagree} = 7.957$, 95%CI:1.238 ~ 87.69; $OR_{neutrality} = 4.187$, 95%CI:1.66 ~ 10.563), and think that the effects of non-routine immunization vaccines were very good ($OR_{disagree} = 3.133$, 95%CI:1.677 ~ 14.495; $OR_{neutrality} = 2.512$, 95%CI:1.164 ~ 5.418) were more willing to recommend Non-EPI Vaccines. On the contrary, vaccination staff who believe that recommending Non-EPI vaccines increased their workload ($OR_{disagree} = 0.307$, 95%CI:0.11 ~ 0.856; $OR_{neutrality} = 0.642$, 95%CI:0.258 ~ 0.986) would decrease willingness to recommend them. The most of vaccination staff were willing to recommend non-EPI vaccines under major infectious disease outbreaks. To further control the pandemic of major infectious diseases, the health management departments should enhance the knowledge of vaccines among vaccination staff and alleviate their workload.

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Introduction

Vaccination is the process of administering vaccines to the body to stimulate antibody production and confer specific immunity without causing the disease. To maximize the immune response of vaccines and ensure that recipients acquire and maintain a high level of immunity, it is imperative to follow a stringent and rational vaccination protocol.[1] This approach not only helps in building a robust immune barrier but also is crucial in effectively controlling the prevalence of corresponding infectious diseases. Vaccination is recognized as the most cost-effective method for the prevention, control, and eradication of infectious diseases.[2] According to estimates by the World Health Organization, vaccination prevents approximately 2 to 3 million deaths related to infectious diseases annually.[3]

In China, vaccines were classified into extended program on immunization (EPI) and non-extended program on immunization (non-EPI). Extended program on immunization vaccines referred to vaccines that were compulsory and free for residents according to government regulations, while non-extended program on immunization vaccines referred to residents that voluntarily receive at their own expense.[4] All vaccines played a crucial role in preventing a variety of diseases and meeting the diverse needs of different populations. As a component of national vaccination strategies, non-EPI vaccines also significantly contributed to the prevention of infectious diseases and the fulfillment of varied population demands.[5,6] In recent years, as public awareness of health had increased, and more and more people had the demand for non-EPI vaccines.[7] However, the current vaccination rate for non-EPI vaccines in China was generally low and exhibits regional disparities.[8,9]

Vaccination staff, as forefront workers in contact with vaccines and recipients, had a certain influence on the vaccination coverage rate of non-EPI vaccines through their willingness to recommend them.[10] The service consciousness of vaccination staff directly impacted the public's perception and vaccination behaviors regarding non-EPI vaccines, and their endorsements were proven to effectively increase the vaccination rates of such vaccines.[11,12] Domestic studies indicated that recommendations made by immunization personnel could significantly

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promote public vaccination, particularly for non-EPI vaccines that require out-of-pocket expenses.[13–15] The influence of vaccination staff's recommendations was especially pronounced in enhancing the vaccination rates for non-EPI vaccines.

Recently, the World Health Organization had declared that the "X disease" was not a question of whether it would occur, but when it would happen. Studies showed that among the 25 viral families surveyed, there were approximately 1.67 million unknown viruses yet to be discovered, with 631,000 to 827,500 potentially infectious to humans.[16,17] In response to the potential arrival of the "X disease," one of the important measures was to enhance the research and development technology and production capacity for new vaccines and to quickly establish an immune barrier after the outbreak of the "X disease." At this time, the willingness of vaccination staff to recommend vaccines was crucial.[18–20] For example, In the past 100 years, there had been four influenza pandemics: the Spanish flu in 1918, the Asian flu in 1957, the Hong Kong flu in 1968, and the influenza A (H1N1) in 2009. During the influenza pandemic, influenza vaccines had received great attention and application, and had a good protective effect.[21,22]

Research on the vaccination rates of non-EPI vaccines, both domestically and internationally, had predominantly focused on the willingness of recipients to be vaccinated and the factors influencing this willingness. However, there had been less emphasis on investigating the willingness of immunization personnel to recommend these vaccines and the factors that affected their recommendations.[23,24] More importantly, there was a lack of willingness to recommend non-EPI vaccines to vaccination staff at the time of an outbreak. Moreover, little was known about the willingness of these vaccination staffs to recommend non-EPI vaccines, especially in contexts of an epidemic or when their workload had significantly increased. The study of the willingness to recommend vaccination staff during the outbreak was highly novel and had important guiding significance for each country and government to carry out corresponding prevention and control measures in major infectious disease outbreaks.

This paper sought to address this gap by delving into the willingness of vaccine immunization staff to recommend non-EPI vaccines and the factors influencing this willingness under the background of epidemic prevention and control. The findings of this study analyze the factors that impacted the willingness of immunization workers to endorse non-EPI vaccines, providing a foundation for further refinement of non-EPI vaccines management and strategy formulation.

Materials and methods

Study design and survey subjects

We conducted a cross-sectional survey to assess the recommendation status of non-EPI vaccines by vaccination workers in Hangzhou, Zhejiang Province, China. Vaccination workers referred to professionals who undertook relevant duties and tasks in vaccination, and were responsible for the specific implementation of vaccination operations, as well as related management and guarantees. Hangzhou, the capital city of Zhejiang Province, is a developed city in eastern China. The administrative region of Hangzhou includes 10 districts, 1 county-level city, 2 counties, and a total of 191 towns (streets). By the end of 2023, the total permanent resident population of Hangzhou was approximately 12.522 million. The collection of information for this survey began in January 2022. To calculate the sample size for this survey, we referred to previous literature, assuming a willingness to recommend non-immunization program vaccines among 43% of vaccination workers, with a margin of error of ± 5%, a 95% confidence interval, and 80% power. Considering factors such as ineligible questionnaire responses due to conducting an online survey, the target sample size was determined to be 500. We edited the questionnaire on the "Questionnaire Star" online platform, created a questionnaire link, and sent it to each survey subject via We Chat (one of the most important and widely used social tools in Mainland China). Respondents filled out the questionnaires by accessing the Uniform Resource Locator (URL) on their mobile phones. All 201 vaccination clinics in Hangzhou participated in this survey, and at least two vaccination workers from each clinic were randomly selected to participate in the survey. All participants consented to participate and ensured identification and confidentiality in the handling of their data before answering the questionnaire.

Research involving human participants had been reviewed and approved by the Ethical Committee. Participants provided written informed consent to participate in the study.

Survey contents

In the research content, it was mainly divided into four parts, including sociodemographic characteristics, working condition, the attitude of vaccination staff toward non-EPI vaccines, and the willingness to recommend non-EPI vaccines.

Sociodemographic characteristics

We reviewed relevant literature, designed a questionnaire, and collected social demographic information. The questionnaire included basic information: gender (male/female), age, marital status (currently married/currently unmarried), education level (below bachelor's degree/bachelor's degree and above), family monthly income (<5000 RMB, 5000–9999 RMB 10,000–19999 RMB 20,000–29999 RMB, ≥30000 RMB), years of work experience, professional title (junior, middle, senior), and work location (city, suburb, rural area).

Working condition

During the COVID-19 period, vaccination staff, in addition to their routine vaccination duties, were also primarily engaged in two types of work: COVID-19 vaccination and epidemic prevention and control. The study addressed the survey of the workload of COVID-19 vaccination, including questions such as: were you involved in the COVID-19 vaccination work? During what time periods were these tasks carried out? How many doses of COVID-19 vaccine had been administered in your current street (township)? The content of epidemic prevention and control includes questions: Had you participated in epidemic prevention and control, and what specific tasks were you involved in, such as routine nucleic acid sampling in

the community, nucleic acid sampling for people under home quarantine, sampling for people in centralized isolation points, disinfection at centralized isolation points, disinfection in public places, and other epidemic prevention and control work; and how long had these tasks been ongoing?

The attitude of vaccination staff toward non-EPI vaccines

In response to the attitudes of vaccination staff toward non-EPI immunization vaccines, this study had designed a total of 11 items. They included (1) I think the effectiveness of non-immunization vaccines (compared to immunization vaccines) is better. Vaccination with non-EPI vaccines could prevent the occurrence of diseases, compared with vaccination with EPI vaccines; (2) I think non-immunization vaccines (compared to immunization vaccines) are safe; (3) I feel obligated to recommend non-immunization vaccines; (4) There is no loss for recipients who do not receive non-immunization vaccines; (5) The leaders attach great importance to non-immunization program vaccination work; (6) The colleagues around me actively recommend non-immunization vaccines; (7) If the media reports negative incidents about vaccines, I am unwilling to recommend non-immunization vaccines; (8) The non-immunization vaccine can increase my income; (9) If non-immunization vaccines will increase my workload, I am unwilling to recommend them, and vice versa; (10) Overall, recipients (parents) have a higher acceptance of non-immunization vaccines; (11) If the supply of non-immunization vaccines is not good, I am unwilling to recommend them. Each question has five answer categories: Strongly Disagree, Disagree, Neutral, Agree/Strongly Agree. In the multifactor analysis, Strongly Disagree/Disagree are grouped into one category, and Agree/Strongly Agree are grouped into another category.

Willingness to recommend non-EPI vaccines

Non-EPI vaccines were classified into two types, alternative and supplementary, based on whether they could replace the antigens contained in EPI vaccines. Alternative non-EPI vaccines referred to those that contain antigens that could replace the antigens in EPI vaccines, eliminating the need for additional doses of EPI vaccines. Supplementary non-EPI vaccines, on the other hand, did not contain antigens found in EPI vaccines and were used as a supplement to EPI vaccines. The survey covers 18 non-EPI vaccines, including 8 alternative non-EPI vaccines: hepatitis B vaccine, inactivated Japanese encephalitis vaccine, AC meningococcal conjugate vaccine, ACYW135 meningococcal vaccine, inactivated hepatitis A vaccine, pentavalent vaccine, quadrivalent vaccine, IPV inactivated vaccine; and 10 supplemental non-EPI vaccines: varicella vaccine, 13-valent pneumococcal conjugate vaccine (PCV13), Haemophilus influenzae type b vaccine (Hib), inactivated enterovirus 71 vaccine (EV71), oral rotavirus vaccine, influenza vaccine, HPV vaccine, 23-valent pneumococcal polysaccharide vaccine (PPV23), herpes zoster vaccine, hepatitis E vaccine. The study involved monovalent and combined vaccines. Monovalent vaccines were those that prevent a single disease, while combination vaccines were those that can prevent multiple diseases simultaneously. Except for Diphtheria, Tetanus, Acellular Pertussis and Haemophilus Influenzae Type b Combined Vaccine (quadrivalent vaccine) and Diphtheria, tetanus, pertussis (acellular, component), poliomyelitis (inactivated) vaccine, and Haemophilus type b conjugate vaccine (pentavalent vaccine), the rest were all monovalent vaccines.

Preventive vaccination staff scored the non-routine immunization vaccines in the survey questionnaire on a scale of 1 to 10, with a score of 7 or higher indicating a willingness to recommend non-routine immunization vaccines, and a score lower than 7 indicating a reluctance to recommend non-routine immunization vaccines. By calculating the total score for each non-routine immunization vaccine item as rated by the preventive vaccination staff and comparing it to the standard scores of 126, 56, and 70, respectively, we could observe the willingness of the staff to recommend non-routine immunization vaccines, substitution non-routine immunization vaccines, and supplementary non-routine immunization vaccines. This study, when surveying the attitudes of vaccination staff toward non-routine immunization vaccines, categorized the results into five categories: strongly agree, agree, neutral, disagree, and strongly disagree. When conducting multivariate analysis, we merged them into three categories for analysis: agree, neutral, and disagree, respectively.

Quality control in research

This study implemented strict quality control measures by setting mandatory fields and logic checks in the survey questionnaire to enhance data completeness and accuracy. In the research design stage, the research question was clarified, the questionnaire was designed, and experts were invited to evaluate the questionnaire and make multiple rounds of revision. In the data collection stage, professional training was carried out for questionnaire collectors to reduce data errors caused by human factors. Meantime, participants were required to complete the questionnaire within 20 minutes. Surveys that exceed the answering time or are incomplete will not be included in the analysis. In the data analysis stage, the data were firstly cleaned and filtered, and the appropriate data analysis method was selected to ensure the accuracy of the data and results. The reliability and validity analysis of the questionnaire yielded a Cronbach's coefficient of 0.892, indicating high internal consistency. The validity was assessed using the Kaiser–Meyer–Olkin (KMO) test, which resulted in a KMO value of 0.846, indicating good validity for this study.

Statistical analysis

We utilized Microsoft Excel 2019 software to create a database and performed statistical analysis using SPSS25.0. For categorical variables, we summarized frequencies and percentages. Continuous numerical data were calculated for mean values and standard deviations (SD). Using the willingness to recommend non-EPI vaccines as the dependent variable (0=unwilling, 1=willing), a binary logistic regression model was constructed with the indicators that showed statistically significant differences in the univariate analysis as independent variables. The

willingness to recommend non-immunization program vaccines was first analyzed using a chi-square test for univariate analysis, and then variables that were significant in the univariate analysis were included in a multivariate logistic regression model using a stepwise regression method to include variables in the model, with inclusion and exclusion criteria set at $\alpha = 0.05$; the level of significance was set at $\alpha = 0.05$ (two-sided).

Results

Demographic characteristics of survey subjects

In total, 527 individuals were included in the analysis. Among all the participants, 84.3% were female, and 15.7% were male. Almost half of the participants were in the age range of 31–40 (266, 50.5%). Junior and medium professional titles account for 93.7%. The majority of participants were married (82.9%), undergraduate and above (72.5%), and had family monthly incomes between 5,000–9,999 CNY (41.0%) and 10,000–-19,999 CNY (31.9%). The average working years was 14.0 ± 8.1 years. 21.4% of the participants worked in urban areas, 42.5% in suburbs, and 36.1% in rural areas. Most participants held two or more jobs at the same time. Majority of participants were responsible for registration (69.1%), followed by inoculation 54.8%) and health pre-check (45.7%). Other jobs (7.4%) included report filling, administration, etc.

Regarding routine vaccination work, 52.4% of the participants worked in vaccination clinics with a daily number of vaccinations < 100 people. In terms of COVID-19 vaccination work, 26.0% of the participants worked in vaccination clinics that had administered 0–9,999 doses of COVID-19 vaccine, and the proportion administering 10,000–19,999 doses 20,000–-39,999 doses 40,000–59,999 doses, and ≧60,000 doses were 24.5, 17.3, 14.2, and 18.0%, respectively. For COVID-19 vaccination working time, more than half of the participants (59.2%) reported that few works took up time off work or rest days.

In terms of COVID-19 prevention and control work, more than half of participants (58.1%) indicated that few works took up time off work or rest days. 55.5% of participants had been involved in this work for over 2 months. The results of the aforementioned sociodemographic characteristics are shown in Table 1.

Willingness to recommend non-EPI vaccines

Regarding the willingness to recommend non-EPI vaccines among the surveyed subjects, the overall recommendation rate was 76.2% (402/527). Among the supplementary vaccines, the vaccine with the highest willingness to recommend was the varicella vaccine (84.1%), followed by the influenza vaccine, HPV vaccine, hand-foot-and-mouth disease vaccine, and 13-valent pneumococcal vaccine, at 81.8%, 80.6%, 75.7%, and 71.3%, respectively; the vaccine with the lowest willingness to recommend was the hepatitis A vaccine (47.8%). Among alternative vaccines, the vaccine with the highest willingness to recommend was the pentavalent vaccine (76.1%), followed by the AC meningococcal conjugate vaccine, ACYW135 meningococcal vaccine, inactivated hepatitis A vaccine, and IPV inactivated polio vaccine, at 72.5%, 69.6%, 65.3%, and 65.3%, respectively; the vaccine with the lowest willingness to recommend was the inactivated Japanese encephalitis vaccine (48.6%).The results are shown in Figure 1.

Analysis of the willingness to recommend alternative and supplementary non-EPI vaccines

The willingness of vaccination staff to recommend each type was compared, and it was found that there was a higher willingness to recommend alternative non-EPI vaccines (77.6%) compared to supplementary non-EPI vaccines, with a statistically significant difference between the two, $\chi^2 = 215.655$, $p = .001$. The results are shown in Table 2.

Analysis of the willingness to recommend individual and combined non-EPI vaccines

The willingness of vaccination staff to recommend individual and combined non-EPI vaccines was compared, and it was found that there was a higher willingness to recommend combined non-EPI vaccines (75.9%) compared to individual non-EPI vaccines, with a statistically significant difference between the two, $\chi^2 = 214.998$, $p = .001$. The results are shown in Table 3.

Factors influencing immunization staff's willingness to recommend non-EPI vaccines

Factors influencing classification

Among immunization staff, 56.4% of the staff believe they have an obligation to recommend non-EPI vaccines, while 54.5% and 54.3% of the staff agree that non-EPI vaccines are safer and better than EPI vaccines, respectively. Additionally, 50.3% of the staff think that recipients' parents have a high acceptance level for non-EPI vaccines. The results are shown in Figure 2.

Univariate analysis of immunization staff's willingness to recommend non-EPI vaccines

The univariate analysis results indicated that factors including whether taking part in COVID-19 vaccination efforts, whether involved in the prevention and control of infectious diseases, immunization staff's belief in the efficacy and safety of non-EPI (non-immunization program) vaccines being higher than that of EPI vaccines, immunization staff feeling obligated to recommend non-EPI vaccines, leadership within their institutions prioritizing non-EPI vaccination efforts, colleagues actively recommending non-EPI vaccines, unwillingness to recommend non-EPI vaccines whether the media reported negative incidents about vaccines, unwillingness to recommend if non-EPI vaccines increase their workload, and overall, a higher acceptance rate for non-EPI vaccines among recipients (parents), were related to the willingness to recommend non-EPI vaccines ($p < .05$). The detailed results are presented in Table 4.

Multivariate analysis of immunization staff's willingness to recommend non-EPI vaccines

The Omnibus Tests of Model Coefficients results for the non-EPI vaccine recommendation willingness model showed $\chi^2 = 144.236$, $p < .001$, indicating that the model was statistically significant; the Hosmer and Lemeshow

Table 1. Sociodemographic characteristics.

Variables		N	Rate (%)
Age	18–30	121	23.0
	31–40	266	50.5
	41–50	110	20.9
	>50	30	5.7
Gender	Men	83	15.7
	Women	444	84.3
Marriage status	Currently married	437	82.9
	Currently not married	90	17.1
Education level	<Undergraduate	145	27.5
	≥Undergraduate	382	72.5
Family income	<5,000 CYN	54	10.2
	5,000–9999 CYN	216	41.0
	1,0000–19999 CYN	168	31.9
	2,0000–2,9999 CYN	60	11.3
	≥3,0000 CYN	29	5.5
Working years	(Mean±SD)	14.0 (8.1)	
Professional title	Junior	269	51.0
	Medium	225	42.7
	Senior	33	6.3
Working place	Urban	113	21.4
	Suburb	224	42.5
	Rural	190	36.1
Occpational classification	Health precheck	241	45.7
	Registration	364	69.1
	Inoculation	289	54.8
	Health observation after inoculation	95	18.0
	Logistics management	186	35.3
	Others	39	7.4
Daily vaccination work			
Daily number of vaccinations	<100 persons	276	52.4
	100–199 persons	172	32.6
	200–299 persons	68	12.9
	≥300 persons	11	2.1
COVID-19 vaccination work			
COVID-19 vaccination doses	0–9,9999 doses	137	26.0
	10,000–19,999 doses	129	24.5
	20,000–39,999 doses	91	17.3
	40,000–49,999 doses	75	14.2
	≥60,000 doses	95	18.0
Working time	Not particpating	32	6.1
	During working hours	77	14.6
	A few of works take up time off work or rest days	312	59.2
	Most of work takes up time off work or rest days	87	16.5
	All the work takes up time off work or rest days	19	3.6
COVID-19 prevention and control work			
Working time	Not particpating	40	7.6
	During working hours	77	14.8
	A few of works take up time off work or rest days	307	58.1
	Most of work takes up time off work or rest days	84	15.9
	All the work takes up time off work or rest days	19	3.6
Participation time	Not participating	27	5.3
	<1 week	20	3.8
	1 week-1 month	72	13.6
	1–2 months	115	21.8
	≥2 months	293	55.5

Test results showed $\chi^2 = 4.612$, $p = .798$, indicating that the model fitted well. The results indicated that whether vaccination staff were involved in COVID-19 vaccination efforts, whether they felt obligated to recommend non-EPI vaccines, whether they believed non-EPI vaccines were effective, whether their colleagues actively recommended non-EPI vaccines, and whether non-immunization program vaccines increased the workload of vaccination staff leading to a reluctance to recommend, were factors affecting vaccination staff's willingness to recommend non-EPI vaccines. Multivariate results are shown in Table 5.

Discussion

Vaccination staff were the primary broadcasters of vaccination information and play an irreplaceable role in the promotion of vaccination knowledge.[25] The willingness and behavior of the staff to recommend non-EPI vaccines were prerequisites for the implementation of non-EPI vaccine vaccinations.[26] The main findings of this study were: (1) the recommendation rate for non-EPI vaccines among vaccination staff in Hangzhou, China, was 76.2%; (2) compared to Supplementary non-EPI vaccines, vaccination staff were more willing to recommend alternative non-EPI vaccines; (3) compared to individual non-EPI vaccines, vaccination staff

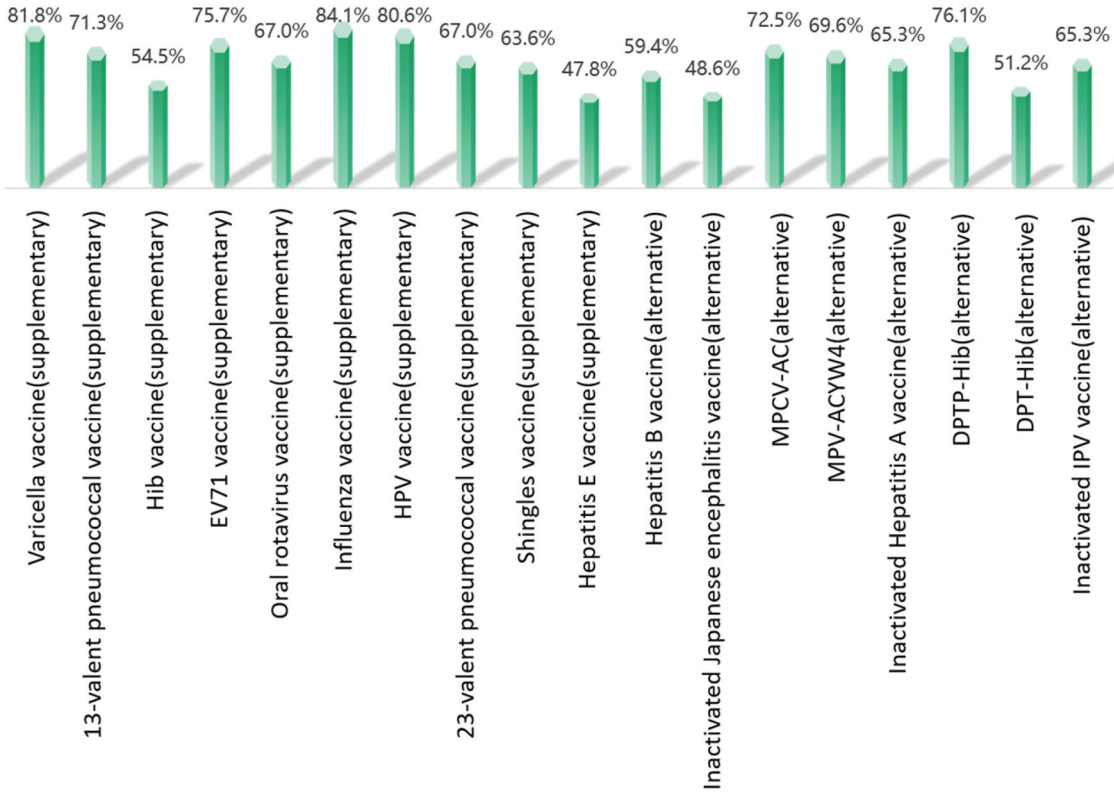

Figure 1. Willingness to recommend non-EPI vaccines.

Table 2. Comparison of alternative and supplementary non-EPI vaccines.

Variables	Recommended	Rate (%)	Not recommended	Rate (%)	χ2	*P*
Alternative Non-EPI Vaccines	409	77.61	118	22.39	215.655	0.001
Supplementary Non-EPI Vaccines	377	71.54	150	28.46		

Table 3. Comparison of individual and combined non-EPI vaccines.

Variables	Recommended	Rate (%)	Not recommended	Rate (%)	χ2	*P*
Individual Non-EPI Vaccines	400	75.90	127	24.10	214.998	0.001
Combined Non-EPI Vaccines	343	65.09	184	34.91		

were more willing to recommend combined non-EPI vaccines; (4) whether participating in COVID-19 vaccination efforts, attitudes toward non-EPI vaccines, and external environmental factors influence vaccination staff's likelihood to recommend non-EPI vaccines.

Research[27–29] indicated that in some countries and regions, public awareness of non-immunization program vaccines was relatively low, which affected their acceptance and willingness to be vaccinated. However, with the strengthening of vaccine education and advocacy, people's awareness and acceptance of these vaccines had increased, and vaccination staff played a key role in improving the vaccination rates of non-immunization program vaccines.[30] Public health policies in different countries also varied greatly in the promotion of non-immunization program vaccines, with some countries increasing vaccination rates by providing financial subsidies.[31] For example, China offered free COVID-19 vaccinations to the public, while countries such as the United States and Norway provide free influenza vaccinations for the elderly and young children.[32,33] The study[34] had found that regional economies would affect vaccine vaccination, and the higher the economic level, the higher the willingness to recommend vaccines, conversely, and the lower the willingness to recommend. Regional economies might also be influencing the willingness of vaccination staff to recommend non-EPI vaccines. These factors could influence the vaccination rates of non-immunization program vaccines.

Our study showed that nearly 80% of vaccination staff were willing to recommend non-EPI vaccines. The willingness to recommend non-EPI vaccines among vaccination staff varies in different regions of China. A study from Xuzhou in Jiangsu Province showed a willingness rate of 35%[6] among vaccination staff, while in Dezhou in Shandong Province, the rate was 55%,[35] in Ningbo in Zhejiang Province, it was 80%,[23] and in Yantai in Shandong Province, it was 89%.[36] The variation in the willingness of vaccination staff in different regions to recommend non-EPI vaccines might be due to differences in economic levels; regions with higher economic levels tend to have staff more willing to recommend non-EPI vaccines. At the same time, as the public's awareness of disease prevention and demand for health services increased, more and more

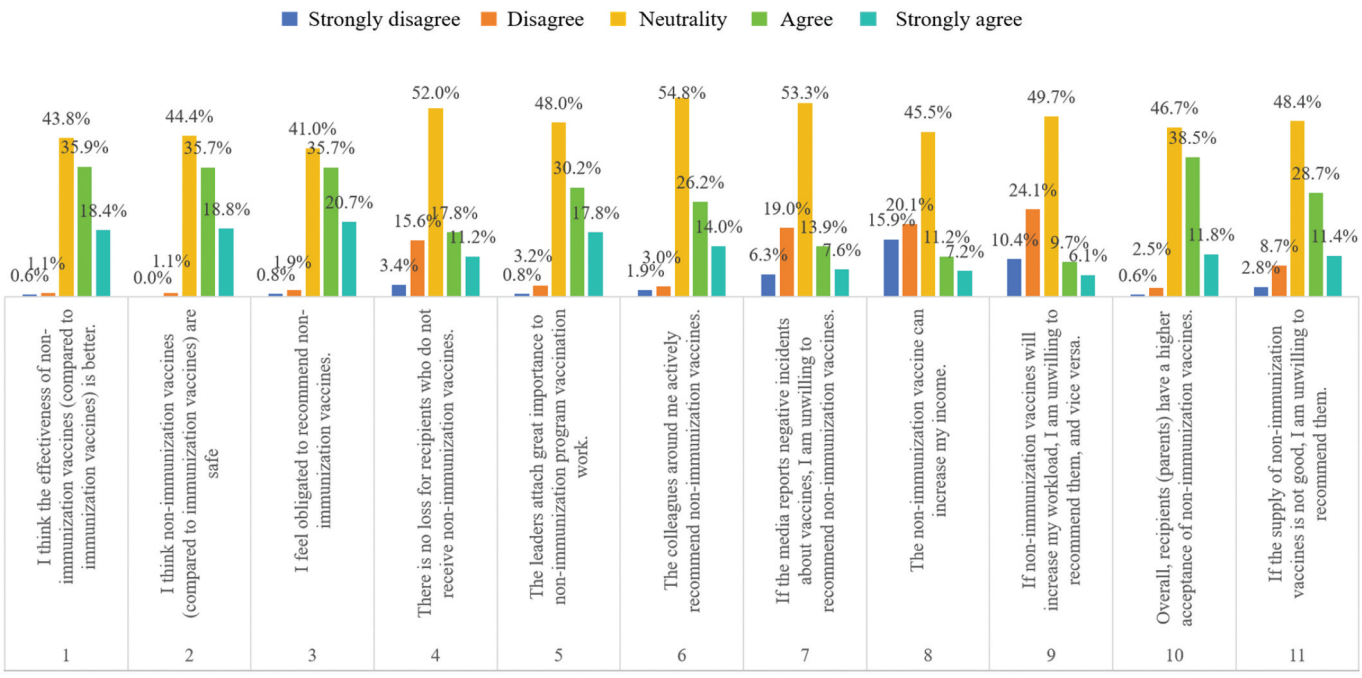

Figure 2. Factors influencing recommendation behavior.

parents were willing to vaccinate their children with non-EPI vaccines, leading to an increased willingness among vaccination staff to recommend these vaccines.[37,38]

The level of importance that leaders in community health service centers place on non-EPI (Expanded Program on Immunization) vaccinations was a driving factor for the willingness of vaccination staff in outpatient clinics to recommend them. The incentive policies for preventive vaccination staff actually might vary among different vaccination clinics, and this could also directly impact their willingness to recommend non-routine immunization vaccines. The role of community vaccination clinics was to provide non-EPI vaccination services, and the procurement of non-EPI vaccines was based on actual needs, without quantitative vaccination targets. Additionally, since March 5th, 2016, a "zero price difference" supply model had been implemented for non-EPI vaccines. As a result, community vaccination clinics lacked the pressure and external incentives to promote the work. The attitude of vaccination units toward non-EPI vaccines played a crucial role in the willingness of outpatient vaccination personnel to recommend them at this stage. It was recommended to develop relevant assessment or incentive policies for key non-EPI vaccines, in order to enhance the importance placed on non-EPI vaccines by leaders in community health service centers and improve vaccination rates.

In addition to statistical analysis of the overall willingness to recommend non-EPI vaccines, this study also analyzed the willingness of vaccination staff to recommend different types of non-EPI vaccines. The results showed that vaccination staff had different levels of willingness to recommend various non-EPI vaccines, with the highest being for the influenza vaccine (84.1%) and the lowest for the hepatitis E vaccine (47.8%). This might be because the survey was conducted during the peak of the epidemic, and vaccinating against influenza could protect public health. Therefore, vaccination workers were more willing to recommend such vaccines.

Research[39,40] indicated that the greater the prevalence and burden of infectious diseases, and the ability of vaccines to prevent their spread, the higher the public interest in the non-EPI vaccines, prompting vaccination staff to be more willing to recommend it. This might be one of the reasons for the inconsistency in the willingness of vaccination staff to recommend different non-EPI vaccines. Additionally, policies[41] enacted in Zhejiang Province to continuously promote influenza vaccination among key populations, such as the elderly and children, reflect the high willingness of vaccination staff to recommend vaccines for pneumonia and influenza as part of influenza epidemic prevention and control efforts.Apart from the influenza vaccine, The vaccination staff's willingness to recommend the varicella vaccine and the HPV vaccine were 81.8% and 80.6%, respectively, which was relatively high compared to their willingness to recommend other vaccines. A survey[42] on the awareness and recommendation willingness of HPV vaccine among staff from Chinese disease prevention and control institutions also found that most vaccination staff had received HPV vaccine consultations from others and were willing to recommend the HPV vaccine to others. Our survey revealed that the willingness of vaccination staff to recommend the hepatitis E vaccine was 47.8%, and the willingness to recommend the Inactivated Japanese encephalitis vaccine was 48.6%, which was lower than the willingness to recommend other vaccines. This may be due to the general lack of awareness of the hepatitis E vaccine among the public, coupled with a lack of effective and scientific promotion of the hepatitis E vaccine, resulting in a lower recommendation willingness. There were two types of Japanese encephalitis vaccines: attenuated live vaccines and inactivated vaccines. The attenuated live Japanese encephalitis vaccine was a national immunization

Table 4. Univariate analysis of subjects' willingness to recommend non-EPI vaccines.

	Variables	Number of respondents	Recommended	Recommendation rate (%)	χ2	*P*
Age	18–30	19	16	84.21	1.715	0.634
	31–40	102	81	79.41		
	41–50	266	198	74.44		
	>50	140	107	76.43		
Gender	Men	83	66	79.52	0.571	0.450
	Women	444	336	75.68		
Marriage status	Currently married	437	337	77.12	0.988	0.32
	Currently not married	90	65	72.22		
Education level	<Undergraduate	145	110	75.86	0.019	0.889
	≥Undergraduate	382	292	76.44		
Family income	<5,000 CYN	54	41	75.93	4.026	0.402
	5,000–9999 CYN	216	166	76.85		
	1,0000–19999 CYN	168	126	75.00		
	2,0000–2,9999 CYN	60	31	51.67		
	≥3,0000 CYN	29	18	62.07		
Professional title	Junior	269	207	76.95	0.307	0.858
	Medium	225	171	76.00		
	Senior	33	24	72.73		
Working place	Urban	113	80	70.80		
	Suburb	224	177	79.02		
	Rural	190	156	82.11		
Daily number of vaccinations	<100 persons	276	215	77.90	1.457	0.692
	100–199 persons	172	126	73.26		
	200–299 persons	68	52	76.47		
	≥300 persons	11	9	81.82		
Whether to participate in COVID-19 vaccination work	yes	488	367	75.20	4.219	0.04
	no	39	35	89.74		
Whether responsibilities were undertaken for epidemic prevention and control work beyond vaccination duties	yes	499	379	75.95	8.562	0.0154
	no	28	23	82.14		
I think the effectiveness of non-immunization vaccines (compared to immunization vaccines) is better.	Disagree(Strongly disagree)	9	6	66.7	90.241	0.001
	Neutrality	231	131	56.7		
	Agree(Strongly agree)	287	265	92.3		
I think non-immunization vaccines (compared to immunization vaccines) are safe	Disagree(Strongly disagree)	6	5	83.3	73.327	0.001
	Neutrality	234	137	58.5		
	Agree(Strongly agree)	287	260	90.6		
I feel obligated to recommend non-immunization vaccines.	Disagree(Strongly disagree)	14	7	50.0	77.326	0.001
	Neutrality	216	126	58.3		
	Agree(Strongly agree)	297	269	90.6		
There is no loss for recipients who do not receive non-immunization vaccines.	Disagree(Strongly disagree)	100	84	84.0	2.285	0.389
	Neutrality	274	178	65.0		
	Agree(Strongly agree)	153	140	91.5		
The leaders attach great importance to non-immunization program vaccination work.	Disagree(Strongly disagree)	21	10	47.6	54.67	0.003
	Neutrality	253	164	64.8		
	Agree(Strongly agree)	253	228	90.1		
The colleagues around me actively recommend non-immunization vaccines.	Disagree(Strongly disagree)	26	9	34.6	63.469	0.002
	Neutrality	289	198	68.5		
	Agree(Strongly agree)	212	195	92.0		
If the media reports negative incidents about vaccines, I am unwilling to recommend non-immunization vaccines.	Disagree(Strongly disagree)	133	116	87.2	41.932	0.007
	Neutrality	281	183	65.1		
	Agree(Strongly agree)	113	103	91.2		
The non-immunization vaccine can increase my income.	Disagree(Strongly disagree)	190	147	77.4	3.881	0.283
	Neutrality	240	163	67.9		
	Agree(Strongly agree)	97	92	94.8		
If non-immunization vaccines will increase my workload, I am unwilling to recommend them, and vice versa.	Disagree(Strongly disagree)	182	159	87.4	32.657	0.01
	Neutrality	262	172	65.6		
	Agree(Strongly agree)	83	71	85.5		
Overall, recipients (parents) have a higher acceptance of non-immunization vaccines.	Disagree(Strongly disagree)	16	12	75.0	35.823	0.01
	Neutrality	246	159	64.6		
	Agree(Strongly agree)	265	231	87.2		
If the supply of non-immunization vaccines is not good, I am unwilling to recommend them.	Disagree(Strongly disagree)	61	51	83.6	1.456	0.538
	Neutrality	255	173	67.8		
	Agree(Strongly agree)	211	178	84.4		

program vaccine, which was free of charge, and might affect the willingness of vaccination staff to recommend the inactivated Japanese encephalitis vaccine.

This study found that compared with supplementary non-EPI vaccines and individual non-EPI vaccines, vaccination staff were more willing to recommend alternative non-EPI vaccines and combined vaccines. This was also the first time in China that a research team had specifically analyzed the willingness of vaccination staff to recommend alternative, supplementary, individual, and combined non-EPI vaccines. We analyzed that in some cases, children might not be able to receive immune program vaccines due to health

Table 5. Multivariate analysis of subjects' willingness to recommend non-EPI vaccines.

Variables	B	Standard error	Wald value	*P*	OR	95%*CI* Lower limit	95%*CI* Upper limit
Whether to participate in COVID-19 vaccination work	1.079	0.587	3.376	0.044	2.942	1.121	9.302
I think the effectiveness of non-immunization vaccines (compared to immunization vaccines) is better.			9.611	0.008			
Disagree(Strongly disagree)	2.074	1.224	2.869	0.048	7.957	1.238	87.69
Neutrality	1.432	0.472	9.197	0.002	4.187	1.66	10.563
I feel obligated to recommend non-immunization vaccines.			5.810	0.035			
Disagree(Strongly disagree)	1.142	0.782	2.135	0.028	3.133	1.677	14.495
Neutrality	0.921	0.392	5.514	0.036	2.512	1.164	5.418
The colleagues around me actively recommend non-immunization vaccines.			15.940	0.001			
Disagree(Strongly disagree)	2.688	0.734	13.416	0.001	14.696	3.488	61.913
Neutrality	0.071	0.466	4.589	0.027	3.052	1.374	4.323
If non-immunization vaccines will increase my workload, I am unwilling to recommend them, and vice versa.			6.100	0.029			
Disagree(Strongly disagree)	−1.179	0.522	5.101	0.024	0.307	0.11	0.856
Neutrality	−0.446	0.463	4.929	0.038	0.642	0.258	0.986
Constant	−4.702	0.922	25.944	0.001	0.009		

reasons, such as immune function defects or when they were undergoing immune suppressive treatment, they could not be vaccinated with attenuated live vaccines. At this time, staff might recommend the use of alternative non-EPI vaccines with the same preventive effect to ensure that children could obtain vaccine protection when their physical conditions permit. In addition, the vaccination of combined vaccines could reduce the number of vaccinations, reducing the overall risk and probability of adverse reactions to the vaccine, and combined vaccines could provide protection against a variety of diseases at one time, which was convenient for the recipients and their guardians.

Results from multivariate analyses indicated that whether vaccination staff participate in COVID-19 vaccination efforts and whether they took on additional tasks during the pandemic might affect their willingness to recommend non-EPI vaccines. During the COVID-19 pandemic, vaccination staff experienced a sudden increase in work pressure and working hours. Preliminary research conducted by our team also found that during the COVID-19 pandemic in Hangzhou, China, the overall prevalence of professional burnout syndrome among vaccination staff was 20.8%, with significant psychological stress and poor mental health observed.[43] In a high-pressure environment, vaccination staff might be reluctant to take on additional work tasks, which could also influence their willingness to recommend non-EPI vaccines.[44,45] Of course, there was another factor that could not be ignored. When disease X occurred in the future, the infectiousness of virus or bacteria, spread of disease, and the severity of symptoms might also affect the willingness to recommend non-EPI vaccines.

The results of the multivariate regression analysis indicated that the immunization staff's cognitive attitudes toward non-EPI vaccines included the belief that non-EPI vaccines were more effective and safer than EPI vaccines, as well as a sense of obligation to recommend non-EPI vaccines. External environmental factors included the degree of attention leaders of their institutions pay to the immunization work of non-EPI vaccines, whether colleagues around them recommend the immunization of non-EPI vaccines, and the influence of external media propaganda. Additionally, whether the immunization of non-EPI vaccines increased the workload of vaccination staff and the acceptance of non-EPI vaccines by recipients were also factors that affect the willingness of immunization staff to recommend non-EPI vaccines. The proportion of immunization staff who believed in the effectiveness and safety of non-EPI vaccines was significantly high, possibly due to their professional understanding of the effects and safety of various types of vaccines, which might become a factor influencing whether they were willing to recommend non-EPI vaccines. Previous studies had also shown that staff satisfaction with their work, personal achievement, and an increasing sense of responsibility are associated with higher service awareness and a greater willingness to recommend.[46,47] Therefore, immunization units or centers for disease control at all levels need to conduct good training for newly recruited immunization staff, introduce knowledge about non-EPI vaccines, increase professional knowledge reserves, and enhance service awareness and responsibility. With the rapid development of the era of self-media, the speed of various information dissemination was incredibly fast, and more and more staff were facing increasing online pressure, so media reports on negative events about vaccines affect whether immunization staff were willing to recommend non-EPI vaccines.[48,49] This also suggested that we should manage the public opinion on vaccine immunization work to prevent adverse events from fermenting online, causing vaccination public personnel to no longer be willing to recommend non-EPI vaccines, or even leading to public distrust in the protective function of vaccines. Based on the results of the study, we could propose targeted strategies to train vaccination staff and at the same time allocate tasks to minimize the deviation of vaccination staff willingness to recommend non-EPI vaccines in the context of the outbreak.

This study had certain advantages and limitations. Through our research, for the first time in the context of the epidemic, we analyzed vaccination workers' willingness to recommend non-EPI vaccines and its influencing factors. At the same time, we compared the willingness to

recommend alternative non-EPI vaccines and complementary non-EPI vaccines, finding that compared to complementary non-EPI vaccines, vaccination staff are more willing to recommend alternative non-EPI vaccines. Of course, this study also has certain drawbacks. On the one hand, the content of the questionnaire was filled out by the respondents themselves, which might lead to misunderstandings on certain issues, inconsistencies between expressions and actual behaviors, affecting the results of the study. On the other hand, the study still had some influencing factors that have not been included, such as the implementation of reward and penalty mechanisms among vaccination staff. The prevalence of each disease in the region was not considered, which might also be a factor influencing the willingness to recommend non-EPI vaccines. The safety profile of different vaccine nature was inconsistent, which might also affect the willingness to recommend vaccines. Another important influencing factor was that differences in economic levels in different regions might lead to different willingness of vaccinators to recommend vaccines. Further research will continue to be carried out to refine the conclusions of the subject.

In general, as an important supplement to EPI vaccines, non-EPI vaccines were recommended that various forms and channels be used to provide vaccination staff with training on non-EPI vaccine knowledge. This study had broader implications for public health policy formulation and regional differences. For one thing, the results of this study provided a clear direction for the formulation of public health policies, such as publicity and awareness of non-EPI vaccines. For another, from the perspective of resource allocation, results of the study were helpful for the rational allocation of public health resources. By prioritizing the vaccine needs of different regions and populations, governments could invest more precisely in funding, manpower, and material resources. Meanwhile, government departments[50] should introduce management and support measures for non-EPI vaccination, enhance the attention of community health service center leaders, promote the enthusiasm, and reduce the work pressure of vaccination staff, providing strong support for improving the vaccination rate of non-EPI vaccines. Finally, as an extended policy, it was recommended that government integrate non-EPI vaccine education into routine immunization practices when major infectious disease broke out. This, in turn, would enhance the willingness to recommend non-EPI vaccines and played an important role in preventing diseases and promoting health through non-EPI vaccines.

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