Infection and Drug Resistance Dovepress

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Knowledge, Attitudes, and Educational Gaps About Vaccination in Chinese Medical Students and Residents: A Pilot Study from a Single Tertiary Referral Center

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Objective: Physicians play a key role in vaccination advocacy. To explore potential educational gaps, we surveyed the knowledge and opinions on vaccination, as well as their own vaccination status, among Chinese medical students and residents in a single medical institute.

Methods: We recruited sixth- and seventh-year medical students and internal medicine residents to carry out this investigation. All participants were given a questionnaire to fill out.

Results: In total, 118 responses from medical students (n=75) and residents (n=43) were analyzed. Thus, 58.5% of participants (69/118) declared that they had enough knowledge, and 68.6% (81/118) wanted to learn more. The average knowledge score was 15.3±2.4 (the full mark was 21 points), while the average accuracy rate was 72.9%. Most respondents agreed that vaccines are useful and that the national vaccination program is effective. Although nearly all participants supported the importance of revaccination, only 48.3% had actually received boosters. There were no significant differences in knowledge and general attitude between medical students and residents. Vaccine uptake in childhood was good. With regard to the 12 vaccines other than the national standard immunization program, the most frequently declared vaccine was against coronavirus disease 2019 (89.8%), while 55.1% had received the human papillomavirus vaccine. There were no significant differences in vaccination coverage between medical students and residents, except for varicella vaccine (40% in medical students vs 18.6% in residents, p=0.017).

Conclusion: A large proportion of medical students and residents in this tertiary referral center exhibited attitudes that favored vaccine acceptance. However, there are certain gaps in their knowledge of and attitudes toward vaccination, which could be addressed by implementing a formal standardized vaccine curriculum.

Keywords: vaccination, medical education, knowledge, attitudes

Introduction

Vaccination is one of the most effective preventive health measures, leading to an improvement in survival rates and the reduction of disease burden.[1] Vaccination not only directly benefits the immunized person, but also indirectly benefits unimmunized people through community immunity. However, there is growing evidence of vaccine delays or refusals.[2] Vaccine hesitancy was considered as one of the top ten threats to global health in 2019 by the WHO.[3] This topic has gained more attention since the global coronavirus disease 2019 (COVID-19) pandemic. The reasons are diverse: underestimation of the risks of natural infection, lack of trust in the effectiveness of vaccines, concerns about safety issues and side effects, and obstacles in access to healthcare or limited general knowledge about vaccines.[4–7]

Received: 24 September 2024
Accepted: 20 November 2024
Published: 29 November 2024

Physicians have an important influence on decisions about vaccination, even among vaccine-hesitant individuals.[8–10] A systemic review found that there is strong evidence for an association between vaccination uptake in young children and positive vaccine recommendations.[8] A review of qualitative studies also revealed that trust in healthcare providers was one of the common themes associated with parental vaccination decisions.[11] Healthcare providers play a vital role in promoting vaccine uptake among vaccine hesitators, through strategies such as building trusting relationships, soliciting questions about vaccines, and providing educational materials to patients.[12,13] It is important to understand the knowledge and attitudes of future healthcare providers. Existing educational gaps have already been identified in different countries.[14–16]

Several studies have explored opinions and knowledge about vaccination, as well engagement in vaccination schedules, among medical students and medical staff.[17–20] The results differed markedly between these studies depending on the nationality and diseases considered. In China, most of these studies included only one vaccine, eg, the vaccine against COVID-19, human papillomavirus (HPV), or seasonal influenza.[21–25]

Therefore, in order to explore potential educational gaps, we conducted a questionnaire survey to obtain an overview of the opinions toward and knowledge of vaccination, and their own vaccination status, among Chinese medical students and residents in a single medical institute.

Materials and Methods

Participants

In Peking Union Medical College, the standard undergraduate medical education program lasts for 8 years. From the first to the fourth year, students receive preclinical education. From the fifth to the eighth year, as in medical schools in the USA, students study clinical medicine, participate in clinical practice, and carry out some research work. After graduation, they receive the national standardized medical residency training, which lasts for 3 years in China. We conducted a survey among the sixth- and the seventh-year medical students and the internal medicine residents. This study received approval from the institutional ethics committee of Peking Union Medical College Hospital.

Questionnaire Description

First, to assess knowledge and attitudes about vaccination in Chinese medical students and residents, a questionnaire was drafted (Supplementary file). Then, a preliminary survey was conducted among eight participants, and homogeneity reliability analysis was performed (α=0.718), indicating acceptable reliability. Although the questionnaire had not undergone validity analysis, all questions were derived from previous literature or similar questionnaires.[17,19,26] In addition, the questionnaire had been evaluated by three infectious disease specialists and a methodologist, suggesting adequate content validity. Each questionnaire took approximately 10 minutes to complete, demonstrating good feasibility.

A description of the project was presented at the beginning of the questionnaire. By filling out the questionnaire, participants agreed to contribute to the research project; thus, no individual consent forms were collected. Consent was assumed from people who took part in the study and recorded their responses in the survey system. The study was anonymous, and no incentives were offered in exchange for participation.

Dissemination Methods

The survey was performed in Peking Union Medical College Hospital (PUMCH) in June 2024. A self-report online questionnaire was distributed to the study participants. It was distributed on WeChat in various medical student groups. Additional measures were taken, such as reaching out to individuals owing to the low participation rate. If the individuals agreed, they could continue to answer the electronic questionnaire, whereas if the individuals disagreed, they could close the link. Before filling out the questionnaire, participants needed to log in, to avoid repeated responses. Thus, the response rate was non-calculable.

Statistical Analysis

Descriptive statistics were conducted on the questionnaire results. For single-choice questions, the proportion of each option in the answer was described. For multiple-choice questions, the selection rate of each option was counted. The

scores for questions 4–24 in the vaccination knowledge section were calculated, with 1 point awarded for each correct option chosen. Normally distributed continuous variables were represented as means with standard deviations (SD), while categorical variables were presented as percentages (%). For group comparisons between medical students and residents, the *t* test was used for normally distributed continuous data, while the chi-squared test was utilized for categorical data. Statistical significance was considered at $p<0.05$. All statistical results were obtained using SPSS 26 software (IBM Corp, Armonk, NY, USA).

Results

General Characteristics of Participants

In total, we collected 122 responses. We excluded four respondents who studied subjects other than medicine or were fourth-year medical students. Information provided by the remaining 118 participants (75 medical students and 43 residents) was further analyzed. The mean age was 26±3 years (range: 23–39 years). The sample was composed of 77 females (65.3%) and 41 males (34.7%), and there was no difference in sex distribution between the medical students and residents.

Knowledge Regarding Vaccination

Regarding self-evaluation of knowledge about vaccines, 58.5% of participants (69/118) (57.4% of medical students and 60.5% of residents, $p=0.740$) declared that they had enough knowledge about vaccines, while 52.5% of participants (62/118) (50.7% of medical students and 55.8% of residents, $p=0.590$) stated that the current medical course on vaccination did not meet their needs, and 68.6% (81/118) (62.7% of medical students and 79.1% of residents, $p=0.065$) wanted to obtain more knowledge about vaccination. There were also 21 single-choice questions in the knowledge section, giving a full mark of 21 points. The average knowledge score was 15.3±2.4 points, while the average accuracy rate was 72.9%. There was no significant difference in average knowledge score between medical students and residents (15.2±2.8 vs 15.4±2.0, $p=0.673$). Details of each question and scores regarding knowledge about vaccines are shown in Table 1.

Table 1 Description of Knowledge About Vaccines

Questions	Correct Answers, n (%)			*p*
	Total (n=118)	Medical Students (n=75)	Residents (n=43)	
Q4: What do you need to know about a certain vaccine?	107 (90.7)	66 (88.0)	41 (95.3)	0.321
Q5: What type of clinical research is used to evaluate the vaccine efficacy?	56 (47.5)	37 (49.3)	19 (44.2)	0.590
Q6: What are the indicators of vaccine efficacy?	101 (85.6)	65 (86.7)	36 (83.7)	0.661
Q7: The higher the efficacy of the vaccine is…	111 (94.1)	68 (90.7)	43 (100)	0.097
Q8: Which of the following aspects should be focused on in the evaluation of vaccine safety?	111 (94.1)	71 (94.7)	40 (93.0)	1.000
Q9: What method is commonly used to monitor and report adverse reactions in vaccine safety evaluation?	58 (49.2)	38 (50.7)	20 (46.5)	0.664
Q10: What is the most common adverse reaction of vaccination?	85 (72.0)	53 (70.7)	32 (74.4)	0.662
Q11: Advantages of live attenuated vaccines do not include…	100 (84.7)	62 (82.7)	38 (88.4)	0.407
Q12: Which characteristic of the immune response is the theoretical basis for vaccination?	103 (87.3)	68 (90.7)	35 (81.4)	0.146
Q13: Which immunoglobulin can pass through the placenta to the fetus?	79 (66.9)	47 (62.7)	32 (74.4)	0.192
Q14: Which disease is the *Haemophilus influenzae* vaccine mainly used to prevent?	16 (13.6)	11 (14.7)	5 (11.6)	0.643
Q15: Which of the following conditions is most suitable for hepatitis A vaccine?	82 (69.5)	71 (94.7)	42 (97.7)	0.760
Q16: Which vaccine can prevent liver damage and liver cancer?	114 (96.6)	71 (94.7)	43 (100)	0.311
Q17: How many doses is the hepatitis B vaccine usually administered in?	93 (78.8)	63 (84.0)	30 (69.8)	0.069

(*Continued*)

Table 1 (Continued).

Questions	Correct Answers, n (%)			*p*
	Total (n=118)	Medical Students (n=75)	Residents (n=43)	
Q18: When do newborns usually receive the first dose of hepatitis B vaccine after birth?	88 (74.6)	54 (72.0)	34 (79.1)	0.396
Q19: What is the target group for the rabies vaccine?	111 (94.1)	71 (94.7)	40 (93.0)	1.000
Q20: What is the relationship between smallpox and cowpox?	105 (89.0)	66 (88.0)	39 (90.7)	0.885
Q21: What is the main purpose of varicella vaccination?	115 (97.5)	72 (96.0)	43 (100)	0.471
Q22: How long is the duration of immunity after varicella vaccination?	27 (22.9)	16 (21.3)	11 (25.6)	0.597
Q23: What is the main target group of the herpes zoster vaccine?	82 (69.5)	52 (69.3)	30 (69.8)	0.961
Q24: What is the main preventive effect of herpes zoster vaccine?	30 (25.4)	20 (26.7)	10 (23.3)	0.682

Attitudes Toward Vaccination and Source of Information

Regarding the overall opinion of vaccination, 89.0% of individuals declared that "Vaccines are useful, and everyone (except those with contraindications) should be vaccinated". Considering the impact of the national vaccination program, 90.7% of individuals thought that it was effective. In term of advising relatives or friends to get vaccinated, 82.2% of individuals declared doing so, while residents more often stated this (p=0.041). With regard to factors influencing their opinions about vaccination, "medical literature and books" ranked first, followed by "senior doctors" and "internet and social media". Details of the questions and answers are shown in Table 2.

Table 2 Description of Attitudes Towards and Practice of Vaccination

Question Answer	Total, n (%)	Medical Students, n (%)	Residents, n (%)	*p*
Q25: Which option best fits your opinion on vaccination?				
A. Vaccination is effective and safe, and I think everyone (except those with contraindications) should be vaccinated.	105 (89.0)	65 (86.7)	40 (93.0)	0.450
B. There is too little evidence to confirm the effectiveness of vaccination.	13 (11.0)	10 (13.3)	3 (7.0)	
C. There is even too little evidence to confirm the safety of vaccination, and I do not think anyone should be vaccinated.	0 (0)	0 (0)	0 (0)	
Q26: Do you think that vaccination under the national standard immunization program is an effective measure for disease prevention?				
A. Yes, I think it works.	107 (90.7)	70 (93.3)	37 (86.0)	0.100
B. I do not think this is necessary, because I will get vaccinated with or without a national program.	5 (4.2)	1 (1.3)	4 (9.3)	
C. No, because there is insufficient evidence to prove that vaccination is effective or even that vaccination is safe.	2 (1.7)	2 (2.7)	0 (0)	
D. No, I do not think the vaccination should be mandatory.	4 (3.4)	2 (2.7)	2 (4.7)	
Q27: Do you know that some vaccines need to be boosted?				
A. I have been inoculated with these vaccines correctly.	57 (48.3)	34 (45.3)	23 (53.5)	0.465
B. Yes, I know. But I cannot be sure I have received all doses of these vaccines.	60 (50.8)	40 (53.3)	20 (46.5)	
C. I do not know. This is the first time I have ever heard about it.	1 (0.8)	1 (1.3)	0 (0)	
D. I do not know, but vaccination is lifelong protection and there is no need to repeat vaccination.	0 (0)	0 (0)	0 (0)	

(*Continued*)

Table 2 (Continued).

Question Answer	Total, n (%)	Medical Students, n (%)	Residents, n (%)	*p*
Q28: Have you ever advised your relatives or friends to be vaccinated?				
A. Yes B. No C. Have never thought about this	97 (82.2) 10 (8.5) 11 (9.3)	57 (76.0) 9 (12.0) 9 (12.0)	40 (93.0) 1 (2.3) 2 (4.7)	0.041
Q29: Vaccines are safe for healthy children.				
A. Yes B. No C. Do not know	95 (80.5) 6 (5.1) 17 (14.4)	59 (78.7) 4 (5.3) 12 (16.0)	36 (83.7) 2 (4.7) 5 (11.6)	0.784
Q30: There is no need to get vaccinated for diseases that are already rare right now.				
A. Yes B. No C. Do not know	30 (25.4) 69 (58.5) 19 (16.1)	22 (29.3) 39 (52.0) 14 (18.7)	8 (18.6) 30 (69.8) 5 (11.6)	0.169
Q31: People who refuse vaccination will put others at risk.				
A. Yes B. No C. Do not know	72 (61.0) 25 (21.2) 21 (17.8)	42 (56.0) 18 (24.0) 15 (20.0)	30 (69.8) 7 (16.3) 6 (14.0)	0.336
Q32: "Natural" immunization after disease is better than vaccine immunization.				
A. Yes B. No C. Do not know	7 (5.9) 94 (79.7) 17 (14.4)	3 (4.0) 60 (80.0) 12 (16.0)	4 (9.3) 34 (79.1) 5 (11.6)	0.447
Q33: What influences your opinion about vaccinations the most? (multiple choice)				
A. Medical literature and books B. Internet and social media C. Senior doctors D. Relatives and friends	101 (85.6) 62 (52.5) 75 (63.6) 28 (23.7)	64 (85.3) 38 (50.7) 45 (60.0) 14 (18.7)	37 (86.0) 24 (55.8) 30 (69.8) 14 (32.6)	0.915 0.590 0.289 0.088

Self-Reported Coverage for Vaccines

Roughly 75.4% of respondents declared that they had been all immunized according to the national standard immunization schedule for children. With regard to the 12 vaccines other than the national standard program, the most frequently declared vaccine was against COVID-19 (89.8%) and least declared was rotavirus (2.5%). Individuals who had been vaccinated against HPV were all females. Medical students more often declared having been vaccinated against varicella (p=0.017) compared with residents. Data are shown in Table 3.

Discussion

The cost-effectiveness of immunization depends greatly on the attitude and knowledge of physicians. We found that the majority of medical students and residents from a single tertiary referral center declared their support for vaccines, which is consistent with the findings of other research.[17–19] Most participants considered vaccines as a useful tool to prevent diseases and have advised others to receive vaccines. Meanwhile, only 58.5% of respondents stated that it is still necessary to get vaccinated for diseases that are already rare right now. However, some vaccine-preventable disease outbreaks continue to play a key role in promoting vaccination. Concerning attitudes toward the immunization obligation,

Table 3 Self-Reported Coverage of Vaccines

Question Answer	Total, n (%)	Medical Students, n (%)	Residents, n (%)	*p*
Vaccines according to the national standard immunization schedule for children				
A. All immunized	89 (75.4)	55 (73.3)	34 (79.1)	0.457
B. Partly immunized	12 (10.2)	7 (9.3)	5 (11.6)	
C. Not immunized	0 (0)	0 (0)	0 (0)	
D. Do not know	17 (14.4)	13 (17.3)	4 (9.3)	
The following 12 vaccines other than the national standard immunization				
1. Human papillomavirus (HPV) vaccine*	65 (55.1)	42 (56.0)	23 (53.5)	0.792
2. Influenza vaccine	54 (45.8)	33 (44.0)	21 (48.8)	0.573
3. Rubella vaccine	21 (17.8)	14 (18.7)	7 (16.3)	0.744
4. *Haemophilus influenzae* vaccine	14 (11.9)	11 (14.7)	3 (7.0)	0.214
5. Varicella vaccine	38 (32.2)	30 (40.0)	8 (18.6)	0.017
6. Pneumococcal vaccine	13 (11.0)	10 (13.3)	3 (7.0)	0.450
7. Rabies vaccine	22 (18.6)	13 (17.3)	9 (20.9)	0.629
8. Meningococcal vaccine	14 (11.9)	12 (16.0)	2 (4.7)	0.067
9. Measles vaccine	23 (19.5)	18 (24.0)	5 (11.6)	0.103
10. Rotavirus vaccine	3 (2.5)	2 (2.7)	1 (2.3)	1.000
11. Enterovirus type 71 vaccine	7 (5.9)	6 (8.0)	1 (2.3)	0.395
12. COVID-19 vaccine	106 (89.8)	67 (89.3)	39 (90.7)	1.000
Any other vaccine				
Other vaccines†	34 (28.8)	24 (32.0)	10 (23.3)	0.313

Notes: *No males received the HPV vaccine. In females, 84.4% of participants (65/77) received the HPV vaccine. †Other vaccines included hepatitis B vaccine (n=5), diphtheria and tetanus and pertussis vaccine (n=2), and cannot remember clearly (n=27).

only 61% respondents agreed that people who refuse vaccination will put others at risk. There are still some gaps in vaccine knowledge and acceptance attitudes in these participants.

Not surprisingly, the knowledge of vaccination in medical students and residents was not very good in our study, with an average accuracy rate of 72.9%. This result is consistent with the respondents' self-evaluation of their knowledge about vaccines. Furthermore, knowledge on immunization was similar between medical students and residents. It is a pity that no significant improvement was seen from undergraduate to postgraduate medical education. Some experts have developed vaccination training courses for medical students, and these courses have been confirmed to be effective.[27–29] However, many medical schools do not offer a formal standardized vaccine curriculum. Educational interventions for students and residents should include vaccine safety and efficacy, evidence-based vaccine research, vaccine misinformation, factors influencing vaccine confidence, and how to guide patients through conversations about vaccine hesitancy.

The majority of vaccines developed to date have targeted children. However, as time passes after the initial vaccination, immune responses to vaccines can be less robust. Thus, it is important to provide the appropriate vaccination programs for the aging adult population.[30] In our survey, nearly all participants stated that vaccination boosters are important, only 48.3% had actually received boosters. It remains a challenge to improve the rate of coverage of vaccination boosters.

The information source is an important factor influencing attitudes toward vaccination.[31–33] In our study, the most significant source of information on vaccination was scientific evidence, which may come from the medical literature or from senior doctors. Moreover, we must not ignore the influence of the internet and social media. Improving the quality of vaccine information in the media may be helpful to build vaccine confidence.

Concerning vaccination coverage, vaccine uptake in childhood was found to be good, with most medical students and residents having been vaccinated following the immunization schedule for children. With regard to the subsequent 12

vaccines, except for COVID-19 vaccination (89.8%) and HPV vaccination in females (84.0%), the uptake of most vaccines uptake was relatively low (<50%).

The Chinese Center for Disease Control and Prevention recommends seasonal influenza vaccination for healthcare workers.[34] A meta-analysis showed that the overall effectiveness of influenza vaccine against laboratory-confirmed influenza was 36% (95% CI: 25–46%) in mainland China.[35] However, the coverage of seasonal influenza vaccine was quite low. Of the 2261 Chinese university students surveyed, 44.7% had influenza vaccine hesitancy. Another study also revealed that a very low proportion of participants had received an influenza vaccine in the past 3 years (4.1%, 9.2%, and 6.1%, respectively).[24] In our survey, nearly half of the participants had never been immunized against influenza. Efforts should be made to increase the acceptance of the influenza vaccine.

In 2013, a survey targeting Chinese medical students was conducted in Hong Kong, which found that only 232 students (22.9%), comprising 220 females (46.5%) and 12 males (2.2%), had received the HPV vaccine.[25] In 2020, a multicenter online survey of HPV vaccine hesitancy reported that the rate of vaccine hesitancy was as high as 62.36% among Chinese medical students.[21] It is encouraging that 55.1% of participants (84.0% of females) in our survey have received the HPV vaccine. Few countries have recommended male vaccination, on the basis that this is not cost-effective.[36] A study revealed a prevalence of HPV infection of 42.15% among outpatient men in Guangzhou, South China.[37] Further research is needed to determine whether male vaccination is cost-effective.

To the best of our knowledge, this is the first study conducted in Chinese medical students and residents to measure their vaccine knowledge and acceptance of vaccination. There are some limitations to our study. First, this being a single-center study, as well as the inability to calculate a response rate, may raise questions about selection bias. Second, attitudes and knowledge may vary significantly between different vaccines, and lumping them together may obscure important differences. Third, while we focused on knowledge and attitudes regarding vaccination, the skills needed to offer vaccination and considerations for special groups, such as pregnant women, were not evaluated in our survey. This highlights the need for further research in the future.

Conclusion

The majority of Chinese medical students and internal medicine residents in this tertiary referral center have positive attitudes toward the safety and efficacy of vaccines. Residents more frequently advise their friends and relatives to receive vaccines compared to medical students. Despite overall support for vaccination boosters, only about half of the participants had actually received boosters. Unfortunately, knowledge about vaccines is lacking, and no improvement was observed from undergraduate to postgraduate medical education. Implementing a formal standardized vaccine curriculum could be helpful to address this knowledge gap.

Ethical Approval

This study involving human participants was reviewed and approved by the Ethics Committee of Peking Union Medical College Hospital (No. I-24YJ0764). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Funding

This study was supported by the teaching reform project of Peking Union Medical College (No. 2023zlgl039).

Disclosure

Xinchao Liu and Yan Chen contributed equally to this work and share first authorship. The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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