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Vaccine literacy, vaccination intention, and their correlation among adults in Mainland China: a cross-sectional study

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Abstract

Background Vaccination is one of the most economic and effective strategies for preventing infectious diseases. However, public intention to be vaccinated is, to a certain degree, influenced by issues related to vaccine hesitancy, anti-vaccine movement, and public concerns about safety and adverse effects. Vaccine literacy is considered as a positive factor in improving vaccination intention, however, the correlation between vaccine literacy and vaccination intention has not been thoroughly investigated in mainland China. This study aims to (1) explore the correlation between vaccine literacy and vaccination intention among adults in mainland China; (2) investigate whether participants could seek out vaccine information on their own initiative and whether they knew basic information of common vaccines.

Methods An online cross-sectional survey was conducted on 614 adult participants from 27 May to 8 June 2023 by a convenience sampling. Data were collected by using the questionnaire of demographic characteristics, vaccine literacy, vaccination intention, initiative of seeking out vaccine information, and basic vaccine quiz about common vaccines. Data were analyzed by using IBM SPSS version 24.0 at a significance level of 0.05.

Results The mean scores of functional, and interactive-critical vaccine literacy were 2.97 ± 0.70 and 2.73 ± 0.66; the vaccination intentions of influenza, hepatitis B, COVID-19 and HPV were 58.5%, 80.0%, 71.3% and 62.9% respectively; interactive-critical vaccine literacy was significantly and positively associated with vaccination intention. The results also showed: 71.4% of the participants could seek out vaccine information on their own initiative, however, a certain proportion of the participants merely knew vaccine names and did not know basic information of common vaccines, especially influenza vaccine and hepatitis B vaccine.

Conclusions There is still room for improvement in vaccine literacy, vaccination intention of influenza and HPV vaccines, and basic vaccine information. Based on the significantly positive correlation between interactive-critical vaccine literacy and vaccination intention, it is advisable to harness vaccine literacy to boost vaccination intention by communicating and learning basic information of common vaccines.

Keywords Vaccine literacy, Vaccination intention, Influenza, Hepatitis B, COVID-19, HPV

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Introduction

Vaccination is one of the most cost-effective ways of preventing infectious diseases. It currently prevents 2–3 million deaths a year, and an additional 1.5 million could be averted through improved global vaccination coverage [1]. However, vaccine hesitancy, a delay in acceptance or refusal of vaccination despite availability of vaccination services [2], is getting more prominent these years and has been considered as one of the ten issues threatening global health in 2019 [1]. Meanwhile the anti-vaccine movement has grown tremendously in the past twenty years [3]; especially since COVID-19 vaccines were released, public mistrust and concerns about safety and adverse effects have been raised and these issues may negatively affect public vaccination intention [4].

Vaccine literacy entails knowledge, motivation, and competencies to find, understand and judge immunisation-related information to make proper immunisation decisions [5, 6]. These years, several scholars have advocated more attentions to vaccine literacy: Ratzan [7] appealed to develop vaccine literacy with the level of attention it deserved, and Biasio [8] emphasized that vaccine literacy was undervalued and the relevance of vaccine literacy in the domain of disease prevention was obvious. Since then, more studies have focused on the correlation between vaccine literacy and vaccination intention in order to improve vaccination intention or vaccination coverage in a perspective of vaccine literacy. Some previous studies showed that vaccine literacy was associated with vaccination intention [4, 9–13], while some studies did not find any association [14, 15]. Some factors associated with vaccine or health literacy, such as race, socio-economic status and GDP [16–19], and some factors associated with vaccination intention, such as vaccine confidence, continent, country, geographic region, and ethnicity [13, 20–23], may indirectly influence the result of the association between vaccine literacy and vaccination intention, resulting in a variety of study results. These results prove that the role of vaccine literacy is complex and deserves more researches.

The studies exploring the correlation between vaccine literacy and vaccination intention have been conducted more in foreign countries since 2020, however, there has been few studies in mainland China. Considering our country's several differences with other countries, for instance, a wide span of latitudes, a variety of climate, and different distribution characteristics of diseases making the disease prevention programs and vaccination policies-making more complex and diverse, the foreign research results might not be completely suitable for the actual condition of mainland China. One study [24] has been performed with this aim in mainland China, and it explored the correlation between parents' vaccine literacy and vaccination intention in the context of a special vaccine scandal, but the test dimensions of parents' vaccine literacy were short of interactive level, the test items of parents' vaccine literacy were only three, the vaccination intention was limited to vaccinate their children with domestic vaccines, and the whole study was limited to a certain vaccine scandal event background, so its result was not generalizable and absolutely suitable for normal situation. Based on the results showed by the existing similar studies, considering the context of mainland China, it was necessary to conduct the study to explore the correlation between vaccine literacy and vaccination intention among adults in mainland China. Therefore, we hypothesized that vaccine literacy was significantly and positively associated with vaccination intention. The purposes of this study were to: (1) explore the correlation between vaccine literacy and vaccination intention among adults in mainland China; (2) investigate whether participants could seek out vaccine information on their own initiative and whether they knew basic information of common vaccines, which is valuable for healthcare and other authorities to implement specified measures that harness vaccine literacy to enhance vaccination intention.

Methods

Study design

A cross-sectional survey using an anonymous online questionnaire was conducted on adults in mainland China from 27 May to 8 June 2023.

Study sample

A convenience sampling was applied in this study. The inclusion criteria were (1) aged ≥ 18 years, (2) able to use smart phone, tablet, laptop or computer, (3) willing to take part in this survey.

The sample size of the survey was calculated according to a mathematical formula: $n=4\{(u_{\alpha/2} + u_{\beta}) / \ln[(1+\rho)/(1-\rho)]\}^2+3$, which is applied to the study aiming to explore correlation [25]. Where, n is the minimum sample size, $u_{\alpha/2}$ is standardized normal distribution critical values at the test level of α (2-tailed), u_{β} is standardized normal distribution critical values under type II error β, and ρ is correlation coefficient. The sample size of 216 participants was determined using $\alpha=0.05$, $\beta=0.1$, and $\rho=0.219$ which was a correlation value observed in a previous similar study [9]. An additional 10% was added to account for potential invalid questionnaires. The final sample collected comprised 614 participants after excluding invalid responses that took less than 66 s.

Data collection

The online questionnaire and its link were created by "Wen Juan Xing" which is a professional and frequently-used platform to compose and distribute questionnaires in mainland China, then the link was forwarded by the

WeChat platform. WeChat is the main social media platform in China [26]. The vast major of the Chinese are WeChat users with an extensive age distribution from teenagers to the elderly [27, 28], which is appropriate to collect the targeted population. The questionnaire involved demographic characteristics, vaccine literacy, vaccination intention, initiative of seeking out vaccine information, and basic vaccine quiz about common vaccines. Prior to answering, participants were informed of the survey purposes, and voluntary and anonymous attendance.

Measurements of variables

Demographic characteristics

The collected demographic characteristics included age, sex, education degree, healthcare background, residence area, occupation and income.

Vaccine literacy

The vaccine literacy scale was developed by Biasio et al. [29], containing five items for functional vaccine literacy subscale representing language capabilities - the basic ability of reading comprehension, and nine items for interactive-critical vaccine literacy subscale representing cognitive efforts - interactive vaccine literacy more involving discussion with doctors or other people, and consulting and using vaccine information; critical vaccine literacy more focusing consideration of the credibility of vaccine information, the vaccine suitability for one's condition, and making the decision whether taking vaccine or not. Four possible options using a 4-point Likert scale were for each item (4-never, 3-rarely, 2-sometimes, 1-often for functional items; 1-never, 2-rarely, 3-sometimes, 4-often for interactive-critical items). There was a filter question before answering each subscale, and if the reply to the filter question was affirmative, the participant would be allowed to answer the following subscale. The score was obtained from the mean value of the responses to each item in each subscale. The score range was from 1 to 4, and higher score meant higher vaccine literacy level.

Before our survey, the vaccine literacy scale had been translated from English to Chinese and validated by Yang et al. [3], however, Yang et al. [3] modified the score calculation method from a 4-point Likert scale to a 5-point Likert scale. Therefore, considering a 4-point Likert scale would be applied in our study, which was different from Yang et al. [3], a pilot of 172 participants was conducted to validate the Chinese-translated vaccine literacy scale intended to be applied in our study. The expression in Chinese for the component of 14 items (questions) in the Chinese-translated vaccine literacy scale used in the pilot referred to the scale by Yang et al. [3] after receiving the author's agreement by email. As a result of the pilot, an item analysis showed good item discrimination, an exploratory factor analysis (EFA) showed adequate construct validity: functional and interactive-critical dimensions, and a reliability test showed that Cronbach's Alpha were 0.910 and 0.935 for functional and interactive-critical vaccine literacy subscales respectively. The validation results of the pilot are given in Supplementary material Table S1. The vaccine literacy scale used in the study is given in Supplementary material Table S2.

Vaccination intention

Vaccination intentions of four common adult vaccines - influenza, hepatitis B, COVID-19 and HPV vaccines - were measured. For influenza vaccination intention, the question "how likely you are willing to get influenza vaccine" was for the participants who had no influenza vaccination, and then the other question "the immunity produced by vaccine will weaken over time, and how likely you are willing to reuptake influenza vaccine" for the participants who had vaccinated against influenza. The responses of definitely "yes" or "probably" were coded as having intention, while the responses of "not sure", "not probably" or "definitely no" were coded as having no intention. In the same way, hepatitis B, COVID-19 and HPV vaccination intentions were collected.

Initiative of seeking out vaccine information

In order to know that participants received vaccine information passively or could seek out vaccine information actively, participants were asked to answer "you know vaccine information by 1=being forwarded, such as public platforms, leaflets, posters, blogs, recommendations, etc.; 2=searching on internet on your own initiative; 3=consulting doctors on your own initiative; 4=other sources on your own initiative; 5=neither being forwarded nor using your initiative", in which multiple choices were allowed. The response of "1=being forwarded, such as public platforms, leaflets, posters, blogs, recommendations, etc." was coded as passively receiving vaccine information, the responses of "2=searching on internet on your own initiative; 3=consulting doctors on your own initiative; 4=other sources on your own initiative" were coded as actively seeking vaccine information, and the response of "5=neither being forwarded nor using your initiative" was coded as neither passively receiving nor actively seeking vaccine information.

Basic vaccine quiz

Considering there was no particular and specified vaccine type in vaccine literacy scale, a simple vaccine quiz was applied to measure whether the participants knew basic information of popular influenza, hepatitis B, COVID-19, and HPV vaccines. For influenza vaccine, there were two questions: the first question was "have you ever heard about influenza vaccine?" (1=yes, 2=no)

and if the response was "yes", the participant would continue to answer the second question "do you know that it is necessary to be vaccinated against influenza each year?" (1=yes, 2=no). For hepatitis B vaccine, there were two questions: the first question was "have you ever heard about hepatitis B vaccine?" (1=yes, 2=no) and if the response was "yes", the participant would continue to answer the second question "do you know that it is necessary to test hepatitis B virus serum markers (HBV-M) before hepatitis B revaccination?" (1=yes, 2=no). For COVID-19 vaccine, there were two questions: the first question was "have you ever heard about COVID-19 vaccine?" (1=yes, 2=no) and if the response was "yes", the participant would continue to answer the second question "do you know that the adverse reactions caused by COVID-19 vaccine are basically similar to other vaccines?" (1=yes, 2=no). For HPV vaccine, there were three questions: the first question was "have you ever heard about HPV vaccine?" (1=yes, 2=no) and if the response was "yes", the participant would continue to answer the second question "do you know that it is still necessary to be screened for cervical cancer after HPV vaccination?" (1=yes, 2=no), and all participants answered the third question "men could be vaccinated against HPV" (1=right, 2=do not know/not sure, 3=wrong). The basic vaccine quiz used in the study is given in Supplementary material Table S3.

Statistical analysis

Data were analyzed by using IBM SPSS version 24.0. Frequencies and percentages were calculated to assess qualitative data of demographic characteristics, vaccination intention, initiative of seeking out vaccine information, and basic vaccine quiz; means and standard deviations (SD) were calculated for quantitative data of vaccine literacy. Independent sample *t*-tests and one-way ANOVA, which are considered robust to Likert data and non-normal distributions [30, 31], were used to examine significant level of vaccine literacy differences. Vaccination intention data met the conditions: sample size≥40 and the theoretical expected frequency of each cell≥5 for a 2×2 table, and the theoretical expected frequency of each cell>1 and the cells (%) with theoretical expected frequency less than 5≤20% for a R × C table [32], therefore, Chi-Square tests were used to examine significant level of vaccination intention differences. Point-biserial correlation test was used to examine the correlation between vaccine literacy which was a continuous variable and vaccination intention which was a binary varibale. The significance level was 0.05.

Results

Demographic characteristics

A total of 614 valid responses were collected. More than half of the participants were 18–24 years, female and students (n=377, 61.4%; n=376, 61.2%; and n=386, 62.9%, respectively). Most participants had Bachelor degree and lived in city or town (n=454, 73.9%; and n=419, 68.2%, respectively). The proportions of the participants with healthcare background and without were complements of each other (n=311, 50.7%; and n=303, 49.3%, respectively). In terms of per capita monthly household income, two participant groups had higher representation: those with less than 2,000 (n=119, 19.4%) and those with 2,000–3,499 (n=118, 19.2%). These were followed mainly by participants with 3,500-4,999 and more than 10,000 income brackets (n=95, 15.5%) (Table 1).

Vaccine literacy

A total of 614 valid responses were collected, and 450 participants responded to the functional vaccine literacy subscale and 480 participants responded to the interactive-critical vaccine literacy subscale because of a filter question for each vaccine literacy subscale. The mean scores of functional, and interactive-critical vaccine literacy were 2.97±0.70 and 2.73±0.66 respectively, showing medium vaccine literacy level (Table 2).

For functional vaccine literacy, no significant difference was found in sex, residence area, income and vaccination intention by groups. However, the participants with healthcare background scored significantly higher than those without healthcare background (p<0.05, 3.03±0.69, and 2.89±0.69, respectively) (Table 2 and Table S4).

For interactive-critical vaccine literacy, the female, the participants living in city or town and the participants with healthcare background scored significantly higher than the male, the participants living in countryside and the participants without healthcare background (p<0.01, 2.81±0.61, 2.58±0.72 in sex; p<0.05, 2.77±0.67, 2.63±0.63 in residence area; and p<0.001, 2.83±0.62, 2.61±0.68 in healthcare background, respectively). The participants with an income of 3,500-4,999 CNY scored significantly higher than those with less than 2,000 CNY (F=2.873, p<0.05), however, no significant difference was found between other income groups. The participants with vaccination intention scored significantly higher than those without vaccination intention (p<0.01, 2.80±0.62, 2.61±0.72 in influenza vaccination intention; p<0.05, 2.76±0.65, 2.55±0.70 in hepatitis B vaccination intention; p<0.05, 2.77±0.64, 2.60±0.70 in COVID-19 vaccination intention; and p<0.01, 2.79±0.62, 2.60±0.72 in HPV vaccination intention, respectively) (Table 2 and Table S4).

Table 1 Result of demographic characteristics

Variable	Category	Number (*n*)	Percentage (%)
Age	18–24	377	61.4
	25–34	66	10.7
	35–44	64	10.4
	45–54	81	13.2
	55–64	18	2.9
	≥ 65	8	1.3
Sex	Male	238	38.8
	Female	376	61.2
Education degree	Junior high school and below	13	2.1
	High school or technical secondary school	34	5.5
	Junior college	39	6.4
	College	454	73.9
	Master's diploma or above	74	12.1
Healthcare background	Yes	311	50.7
	No	303	49.3
Residence area	City or town	419	68.2
	Countryside	195	31.8
Occupation	Supervisor in government institutions, party-masses or enterprises	31	5.0
	Professional specializing in science and technology	67	10.9
	Worker settling affairs in government institutions, party-masses or enterprises	23	3.7
	Worker in commerce or service sector	24	3.9
	Worker in agriculture, forestry, animal husbandry, fishery, or water industry	4	0.7
	Worker in production industry, operator of transportation equipment, or other relevant workers	11	1.8
	Student	386	62.9
	None	9	1.5
	Others	59	9.6
Per capita monthly household income (CNY)	< 2,000	119	19.4
	2,000–3,499	118	19.2
	3,500-4,999	95	15.5
	5,000–6,499	88	14.3
	6,500-7,999	55	9.0
	8,000–9,999	44	7.2
	≥ 10,000	95	15.5

Vaccination intention

A total of 614 participants responded to the questions of vaccination intention. Figure 1, Fig. S1 – Fig. S10 and supplementary table Table S5 provide the result of vaccination intention.

For influenza vaccination intention, 359 participants (58.5%) had intention to be vaccinated. Vaccination intention for influenza vaccine did not show a significant difference between/across categories of sex, residence area, and income, but the participants with healthcare background were significantly more willing to be vaccinated than those without healthcare background ($p<0.05$, 63.0% and 53.8%, respectively).

For hepatitis B vaccination intention, 491 participants (80.0%) had intention to be vaccinated. Vaccination intention for hepatitis B vaccine did not show a significant difference between/across categories of residence area and income. However, the female and the participants with healthcare background were significantly more willing to be vaccinated than the male and the participants without healthcare background ($p<0.05$, 83.2% and 74.8% in sex; and $p<0.01$, 84.6% and 75.2% in healthcare background, respectively).

For COVID-19 vaccination intention, 438 participants (71.3%) had intention to be vaccinated. Vaccination intention for COVID-19 vaccine did not show a significant difference between categories of residence area, but the female and the participants with healthcare background were significantly more willing to be vaccinated than the male and the participants without healthcare background ($p<0.05$, 75.0% and 65.5% in sex; $p<0.05$, 75.6%, and 67.0% in healthcare background, respectively). Noteworthily, the participants with an income of less than 2,000 CNY were more willing to be vaccinated than those with over 10,000 CNY ($p<0.01$, 78.2% and 56.8%, respectively) and the same result was observed between groups of 6,500-9,999 and over 10,000 CNY ($p<0.01$, 77.8% and 56.8%, respectively). No significant difference was found between other income groups.

For HPV vaccination intention, 386 participants (62.9%) had intention to be vaccinated. The female, the participants living in countryside, and the participants with healthcare background were significantly more willing to be vaccinated than the male, the participants living in city or town, and the participants without healthcare background ($p<0.001$, 78.7% and 37.8% in sex; $p<0.05$, 69.7% and 59.7% in residence area; and $p<0.01$, 68.5% and 57.1% in healthcare background, respectively). Noteworthily, the participants with an income of less than 2,000 CNY were more willing to be vaccinated than those with over 10,000 CNY ($p<0.01$, 68.9% and 47.4%, respectively), and the same result was observed between groups of 2,000–3,499 and over 10,000 CNY ($p<0.01$, 69.5% and 47.4%, respectively). No significant difference was found between other income groups.

Correlation between vaccine literacy and vaccination intention

Point–biserial correlation test exploring the correlation between vaccine literacy and vaccination intention showed that functional vaccine literacy was not significantly associated with vaccination intention, which was not consistent with the above hypothesis; however, interactive-critical vaccine literacy, as hypothesized, was

Table 2 Vaccine literacy scores and significant level in demographic characteristics and vaccination intention by groups

Variable	Category	Functional vaccine literacy scale ($n=450$, mean = 2.97, SD = 0.70)				Interactive-critical vaccine literacy scale ($n=480$, mean = 2.73, SD = 0.66)			
		Number	Mean	SD	Test/*p*	Number	Mean	SD	Test/*p*
Sex	Male	149	2.93	0.77	$t=-0.741$	167	2.58	0.72	$t=-3.436$
	Female	301	2.99	0.65	$p=0.460$	313	2.81	0.61	$p=\mathbf{0.001}$
Healthcare background	Yes	239	3.03	0.69	$t=2.163$	258	2.83	0.62	$t=3.558$
	No	211	2.89	0.69	$p=\mathbf{0.031}$	222	2.61	0.68	$p<\mathbf{0.001}$
Residence area	City or town	317	3.01	0.72	$t=1.935$	329	2.77	0.67	$t=2.156$
	Countryside	133	2.88	0.63	$p=0.054$	151	2.63	0.63	$p=\mathbf{0.032}$
Per capita monthly household income (CNY)	< 2,000	77	2.90	0.66	$F=1.840$	96	2.53	0.70	$F=2.873$
	2,000–3,499	85	2.90	0.67	$p=0.104$	86	2.71	0.56	$p=\mathbf{0.014}$
	3,500-4,999	75	3.05	0.65		70	2.88	0.57	
	5,000–6,499	66	2.82	0.76		69	2.76	0.71	
	6,500-9,999	75	3.12	0.70		82	2.77	0.66	
	≥ 10,000	72	3.01	0.72		77	2.79	0.70	
Influenza vaccination intention	Yes	277	2.93	0.72	$t=1.331$	300	2.80	0.62	$t=-2.861$
	No	173	3.02	0.65	$p=0.184$	180	2.61	0.72	$p=\mathbf{0.004}$
Hepatitis B vaccination intention	Yes	374	2.99	0.71	$t=-1.335$	409	2.76	0.65	$t=-2.479$
	No	76	2.87	0.59	$p=0.183$	71	2.55	0.70	$p=\mathbf{0.014}$
COVID-19 vaccination intention	Yes	329	2.96	0.72	$t=0.670$	360	2.77	0.64	$t=-2.422$
	No	121	3.00	0.62	$p=0.503$	120	2.60	0.70	$p=\mathbf{0.016}$
HPV vaccination intention	Yes	300	2.98	0.69	$t=-0.460$	324	2.79	0.62	$t=-2.843$
	No	150	2.95	0.71	$p=0.646$	156	2.60	0.72	$p=\mathbf{0.005}$

Both income groups of 6,500-7,999 and 8,000–9,999 were combined together and analyzed in order to maintain approximately equal amount of the participants in each income group

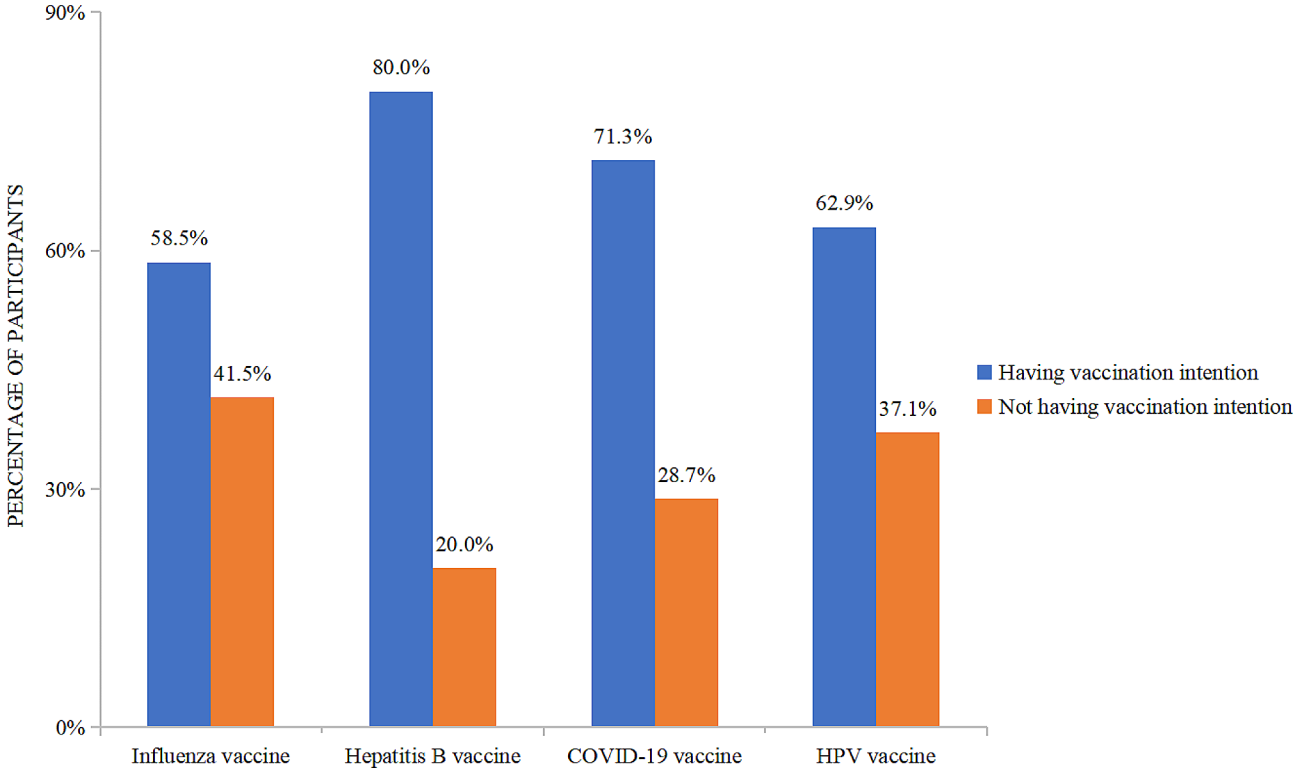

Fig. 1 Vaccination intention proportion of each vaccine

Table 3 Correlation between vaccine literacy and vaccination intention

Variable	Functional vaccine literacy	Interactive-critical vaccine literacy
	r_{pb}	r_{pb}
Influenza vaccination intention	-0.063	0.135**
Hepatitis B vaccination intention	0.063	0.113*
COVID-19 vaccination intention	-0.029	0.110*
HPV vaccination intention	0.022	0.135**

*Correlation is significant at the 0.05 level (2-tailed)

** Correlation is significant at the 0.01 level (2-tailed)

significantly and positively associated with influenza, hepatitis B, COVID-19, and HPV vaccination intentions ($p<0.01$, $r_{pb} = 0.135$; $p<0.05$, $r_{pb} = 0.113$; $p<0.05$, $r_{pb} = 0.110$; and $p<0.01$, $r_{pb} = 0.135$, respectively) (Table 3).

Initiative of seeking out vaccine information

Figure 2 provides the survey results regarding the initiative of seeking out vaccine information. 65.5% ($n=402$) of the participants received vaccine information by being forwarded, such as public platforms, leaflets, posters, blogs and recommendations, etc., which was a passive way. 71.4% ($n=438$) of the participants could seek out vaccine information actively: 32.9% ($n=202$), 29.5% ($n=181$) and 9.0% ($n=55$) got vaccine information by searching on internet, consulting doctors, and other ways on their own initiative. 13.5% ($n=83$) were neither by being forwarded nor by using their initiative. The finding indicates that most participants were able to seek out vaccine information actively.

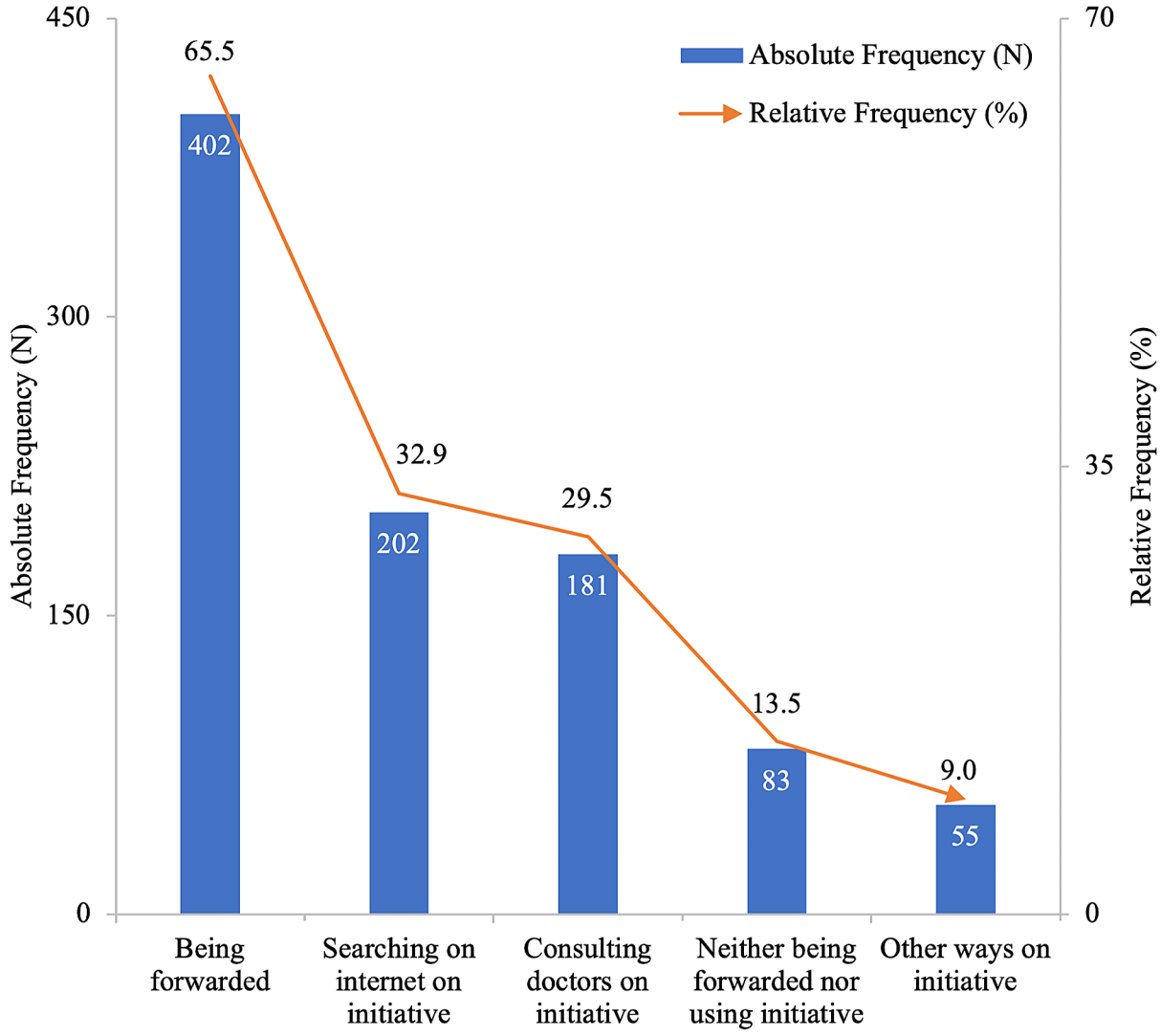

Fig. 2 Result of initiative of seeking out vaccine information

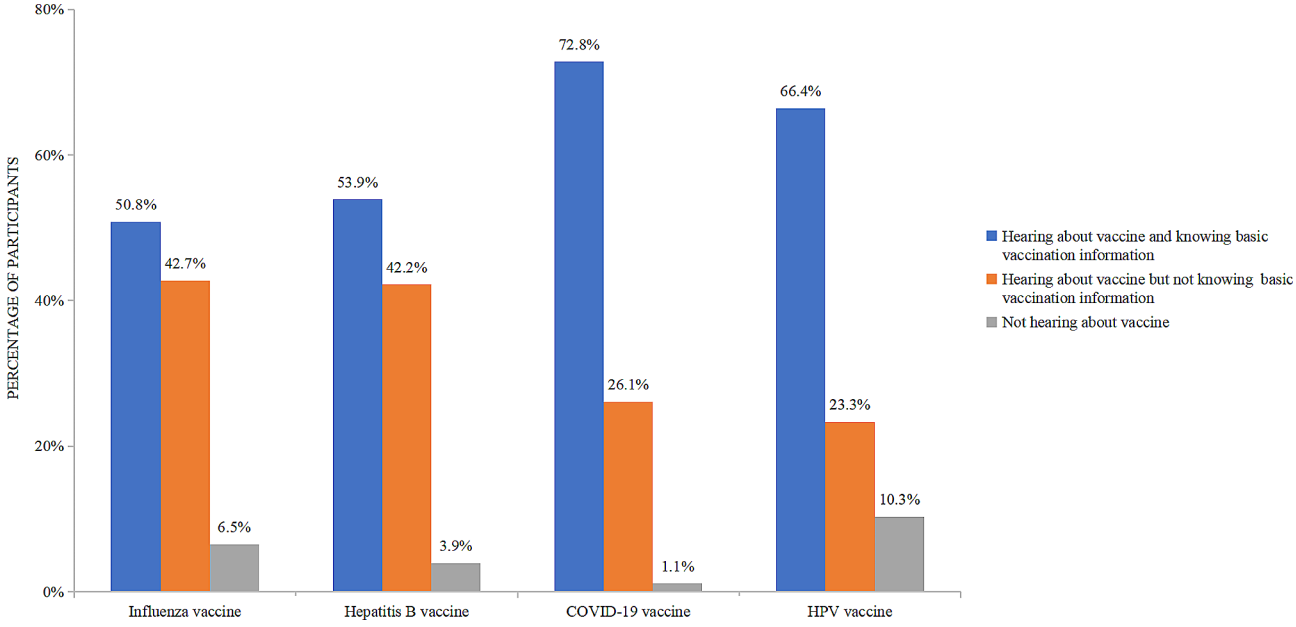

Fig. 3 Result of knowing vaccine and its relative vaccination information

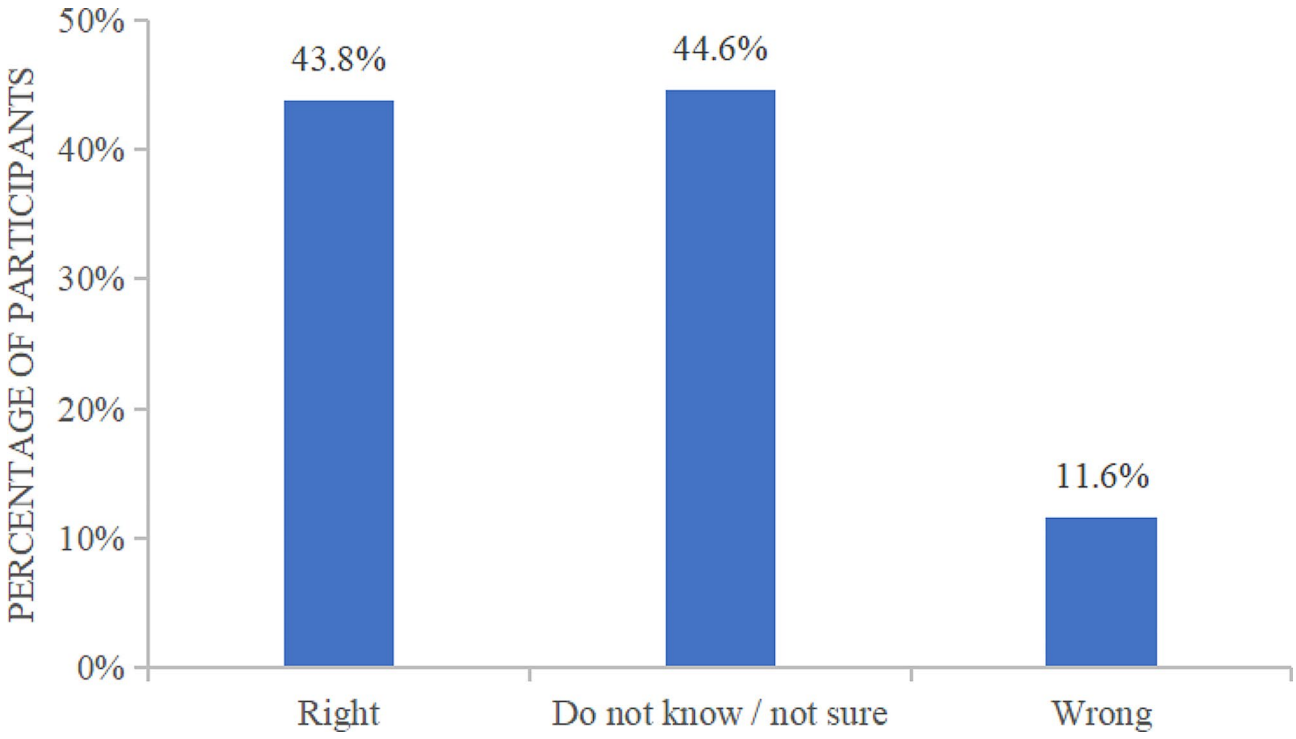

Fig. 4 Result of the responses to the question - men could be vaccinated against HPV

Basic vaccine quiz

Figures 3 and 4 provide the survey results regarding the basic vaccine quiz. For influenza vaccine, 93.5% (n=574) of the participants heard about it, however, 42.7% (n=262) of the participants heard about it but did not know that influenza vaccination is necessary to uptake each year. For hepatitis B vaccine, 96.1% (n=590) of the participants heard about it, however, 42.2% (n=259) of the participants heard about it but did not know that it is necessary to test hepatitis B virus serum markers (HBV-M) before hepatitis B revaccination. For COVID-19 vaccine, 98.9% (n=607) of the participants heard about it, and 26.1% (n=160) of the participants heard about it but did not know that the adverse reactions caused by

COVID-19 vaccine are basically similar to other vaccines. For HPV vaccine, 89.7% ($n=551$) of the participants heard about it, and 23.3% ($n=143$) of the participants heard about it but did not know that it is still necessary to be screened for cervical cancer after HPV vaccination. For the question that men could be able to be vaccinated against HPV, 43.8% ($n=269$) of the participants answered "right", while 44.6% ($n=274$) and 11.6% ($n=71$) respectively answered "do not know/ not sure" and "wrong". The finding indicates that a certain proportion of the participants did not know basic information of common vaccines, especially influenza vaccine and hepatitis B vaccine.

Discussion

In terms of vaccine literacy skill, this study showed medium vaccine literacy level - which was defined based on the vaccine literacy score range from 1 to 4 [29], a 'limited' vaccine literacy (score value ≤ 2.50) [12, 16, 33], and the previous similar studies with the result of medium vaccine literacy [4, 17, 34]. Specifically, comparing to two studies [12, 35] conducted on Italian adults, the interactive-critical vaccine literacy score reported in this study was lower (3.27, 3.38 and 2.73, respectively). After considering the participants' sociodemographic characteristics, we found the majority of the participants was the 18–24 years group (61.4%) and students (62.9%) in this study, and that might cause a lower interactive-critical vaccine literacy score. The reason seems to be proved by a similar result in another study [4] conducted on students aged 18–37 with a mean age of 21.31 years (2.73 and 2.70 for interactive-critical vaccine literacy, respectively). Young adults, especially university students, who have recently entered or are on the verge of entering society, often have limited social and life experiences, which may result in lower interactive-critical vaccine literacy skill. This highlights education system and health ministry should turn more attentions to young groups and provide education on vaccination and immunization. Combining with gradually more experiences, as one ages, a deep-seated understanding of vaccine literacy and its application to overall health can lead to the continued enhancement of knowledge and practice [7]. This, in turn, contributes to the improvement of interactive-critical skills such as decision-making and problem-solving.

In terms of vaccination intention, we found that influenza vaccination intention was the lowest among four vaccines, and a same result was also shown by a previous study [12], which seems to be a general issue. This result might be explained by the public's not taking the common influenza serious. The public lacked a comprehensive cognition of influenza harm and the value of influenza vaccination [12, 36]. Following influenza vaccination intention was HPV vaccination intention, and noteworthily, we found that the female was significantly more willing to be vaccinated against HPV than the male, possibly potentially partly due to Chinese HPV vaccination policy only targeting the female. Lee et al. [37] pointed out that HPV vaccination initially was introduced only for girls, resulting in public health awareness of campaigns targeting women and girls. Interestingly, our results showed that although it is free for the Chinese citizen to take COVID-19 vaccine and it is chargeable for the Chinese adults to take hepatitis B vaccine in mainland China, the COVID-19 vaccination intention was lower than hepatitis B vaccination intention. This implies that the factors influencing COVID-19 vaccination intention might be more complicated. Our results showed that the demographic factors influencing COVID-19 vaccination intention were sex, income and healthcare background. Similarly, several studies [38–40] among adults showed significant differences of COVID-19 vaccination intention in sex and income. The highest COVID-19 vaccine acceptance was in the participants with higher income [41]. These results are inconsistent with those of previous studies. For instance, sex was not significantly associated with COVID-19 vaccination intention among adults [12, 14, 42]. There was no significant difference of COVID-19 vaccination intention in income among urban, well-educated adults [43]. The discrepancies might be caused by religion, race, and various national policies. Except for the demographic variables, several other factors must be vital for COVID-19 vaccination intention, such as vaccine confidence [13], vaccine perception and hesitancy [15], and eHealth literacy [14].

Our results showed that functional vaccine literacy was not significant associated with vaccination intention. Similar results were showed by a study among Italian adults [12], a study among nursing students in Saudi Arabia [4] and a study among parents in Malaysia [44]. The result could be explained from the psychometric perspective. Functional vaccine literacy is relevant to semantic system and focuses on language abilities, while interactive-critical vaccine literacy involves cognitive capabilities and focuses on the problem solving and decision making [29]. During vaccination-decision making, which is a process from information finding, reading and understanding, applying, critical communication, vaccination intention to decision making [45–49], functional vaccine literacy seems more distal from vaccination intention than interactive-critical vaccine literacy. Therefore, the role of functional dimension in the process of forming vaccination intention and decision might be less prominent than interactive-critical dimension. Our results showed interactive-critical vaccine literacy was significantly and positively associated with vaccination intention. Similarly, a study [12] from Italy conducted on adults showed that the association was significant

between interactive-critical score and vaccination intention of COVID-19, flu and other infectious diseases. And another study [9] conducted on older adults from Thailand also found that COVID-19 vaccine literacy was significantly and positively associated with their vaccination intention. In addition, interactive-critical COVID-19 vaccine literacy was a significant predictor of nursing students' intention to be vaccinated against COVID-19 [4]. These suggest that vaccine literacy, especially interactive-critical dimension, should be considered as a beneficial approach to drive vaccination intention of the public. Interestingly, we found that the correlation coefficients between vaccine literacy and vaccination intention in this study and in a previous study [9] were not exceptionally strong, despite observing significant and positive correlations. Moreover, in some studies [14, 15], no significant correlation was found. Vaccine literacy is one of the factors influencing vaccination intention [4, 9–13], furthermore, this influence might be associated with several other potential factors, such as vaccine confidence [13], demographic characteristics [16, 17, 19–23, 50, 51], and ecological antecedents and consequences [18]. These factors operate at multiple levels, encompass various dimensions, and exhibit complexity, which renders the role of vaccine literacy a subject of ongoing discussion. Noteworthily, a recent metalysis [52] has shown that vaccine literacy significantly predicted vaccination intention while its correlation with vaccine uptake was comparatively weaker. Furthermore, a theoretical framework has been proposed by Biasio et al. [53], where vaccine literacy was positioned at the intersection of antecedents (such as demographics) and intermediate variables (such as beliefs and attitudes), explaining why vaccine literacy had a greater impact on vaccination intention than actual vaccination behaviors.

Our results showed that most of the participants were able to seek out vaccine information on their own initiative. However, the effectiveness of seeking out vaccine information seemed not ideal, for a certain proportion of the participants merely knew vaccine names and did not know basic information of common vaccines that they should have known, especially influenza vaccine and hepatitis B vaccine. By contrast, although not entirely ideal, the results of the basic vaccine quiz for common COVID-19 and HPV vaccines showed significant improvement. One reason may be the great efforts made by the Chinese government and the pertinent professionals these years to extensively advocate COVID-19 and HPV vaccination and relative knowledge [3, 54, 55]. This suggests it is worth focusing on publicizing basic information of common vaccines, which may be a valuable way to improve vaccine literacy to drive vaccination intention. In this sense, vaccine literacy also involves knowledge, in addition to motivation and competencies [6]. Accordingly, public health pratitioners could provide tailored knowledge associated with common preventable diseases' risks, vaccines and vaccination by regular public health campaigns.

[1] The disproportion between occupation groups was the major limitation in the study. A large proportion of the participants were students. A convenience sampling method, which was also a limitation, easily produces the participants who have the similar identity with the researchers. Therefore, the vaccine literacy level showed by the study might be underestimated, proved by a similar score in a study [4] conducted on students, and by the relatively higher scores in two studies conducted on adults [12, 35]. Another limitation in this study was the disparity in the amount of the participants across educational degree categories, leading to not an analysis on the differences across educational degree categories in this study, mainly concerning a bias in the result produced by statistical parametric test. However, the participants with healthcare background and without healthcare background in the study were almost half and half. Thus, the results of the study could provide several helpful information to future researches and vaccination professionals. For future researches, it will be valuable to explore the factors influencing vaccine literacy, which could be used to improve vaccine literacy and vaccination intention.

Conclusion

This study showed medium vaccine literacy level, lower influenza and HPV vaccination intentions, more positive hepatitis B and COVID-19 vaccination intentions, and significantly positive correlation between interactive-critical vaccine literacy and vaccination intention. This gives an insight into the importance of interactive-critical vaccine literacy to vaccination intention. It is advisable for disease prevention policy makers to take into account people's vaccine literacy levels when customizing their communication strategies to increase intention to be vaccinated. This study also showed that most of participants could seek out vaccine information actively, however a certain proportion of the participants did not possess common sense about popular vaccines, especially both vaccines of influenza and hepatitis B. This is an important implication that it is necessary to publicize basic vaccine knowledge in mainland China. It is advisable for the pertinent health authorities and education system to focus on introducing and communicating basic information of popular vaccines to improve the cognition of common infectious diseases' risks and vaccine benefits.

Abbreviations

COVID-19	Corona Virus Disease of 2019
HPV	Human Papilloma Virus

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

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Author contributions

SG, YL, XW, SL, MC, and BY contributed to the design of the study and data collection. SG contributed to the analysis and interpretation of the data, and writing the original draft of the manuscript. YL revised the manuscript for intellectual content before submission. All authors reviewed the manuscript.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Ethics approval consent to participate

The study was approved to be exempt from ethical review by Ethics Committee in College of Basic Medical Sciences Jilin University. Prior to participating, the participants were informed of the survey purposes, and voluntary and anonymous attendance. All the participants could receive a gift of discount coupon.

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