Willingness for COVID-19 Vaccination and Influencing factors in Nurses from Tangshan City, China: A Cross-sectional Study

Yunlong Wang

North China University of Science and Technology Affiliated Hospital

Lihuan Dong

North China University of Science and Technology Affiliated Hospital

Yajing Liang

North China University of Science and Technology Affiliated Hospital

Zonghai Guo

North China University of Science and Technology Affiliated Hospital

Jie Cheng (✉ chengjie9655@126.com)

North China University of Science and Technology Affiliated Hospital

Yujing Liu

North China University of Science and Technology Affiliated Hospital

Yanying Li

North China University of Science and Technology Affiliated Hospital

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Abstract

Background: To understand the willingness of nurses from Tangshan City to undergo Coronavirus disease 2019 (COVID-19) vaccination and identify its influencing factors.

Methods: In January 2021, 255 nurses from five medical institutions across Tangshan City were investigated through convenience sampling on a network platform of Sojump. Furthermore, SPSS Statistics v24.0 software was used for general descriptive analysis, rank-sum test and binary logistic regression analysis to analyse willingness rates for COVID-19 vaccination and corresponding influencing factors.

Results: A total of 255 valid questionnaires were collected (recovery rate, 85.71%). Among the 255 nurses surveyed, the willingness rate was 67.8%. The major reasons for willingness to undergo COVID-19 vaccination included a high-risk work environment necessitating COVID-19 vaccination (87.9%), expected benefits to themselves and others (72.8%) and worries regarding COVID-19 infection (66.5%). Meanwhile, reasons for unwillingness to undergo COVID-19 vaccination in 82 nurses included concerns regarding safety (89.0%), effectiveness (62.2%) and the possibility of fake vaccines (32.9%). Furthermore, among the 255 nurses, 43.9% were willing to recommend COVID-19 vaccination ($n = 112$), with the main reasons being prevention of COVID-19 infection (100.0%) and herd immunity via universal vaccination (90.2%). Moreover, the main reasons for unwillingness to recommend COVID-19 vaccination included poor popularity and wait-and-see attitude (85.3%) and hesitancy to recommend given the absence of COVID-19 vaccines (67.1%). With regard to attitude towards COVID-19 vaccine marketing, 149 (58.5%) nurses expressed favour, 101 (39.6%) nurses took a neutral position and 5 (1.9%) expressed displeasure. Univariate analysis revealed that male nurses, as well as those who actively inquired and sought information on COVID-19 vaccines, had significantly higher willingness for vaccination compared to female nurses and those not actively seeking information ($P < 0.05$). Meanwhile, binary logistic regression analysis indicated that gender, degree of education, working years and active inquiry or search for vaccine information were associated with willingness for COVID-19 vaccination ($P < 0.05$).

Conclusion: This study highlights the need for further improving the willingness of nurses from Tangshan City to undergo and recommend COVID-19 vaccination. Relevant departments should therefore publicise information regarding COVID-19 vaccines for medical staff to ensure the safe and effective promotion thereof.

Background

Since the outbreak of the Coronavirus Disease 2019 (COVID-19) in Wuhan, Hubei, China, starting from the end of 2019, the number of COVID-19 cases has rapidly increased [1]. According to the latest COVID-19 time-series data from Johns Hopkins University, over 100 million people worldwide had been infected as of 5 February 2021, of whom >2 million had died [2]. This pandemic has seriously affected various industries, leading to the most severe economic recession in various countries since World War II, along

with considerable lifestyle disruptions [3]. In China, effective prevention and control measures have been adopted to ensure maximum safety. However, small-scale outbreaks have still occurred in Hebei, Heilongjiang, Jilin and other parts of China in early 2021. This suggests that COVID-19 still exerts a considerable impact on human health and life and will likely persist for much longer, indicating the criticality of pandemic prevention and control in China and the world [4].

Vaccination is generally the most effective approach in controlling infectious diseases [5]. To effectively prevent and control the pandemic, countries worldwide have devoted themselves to the active development of vaccines against COVID-19. At present, a number of vaccines are in the stage of research and development or marketing. On 11 December 2020, the US Food and Drug Administration approved the emergency use authorisation of the COVID-19 vaccine jointly developed by Pfizer Inc. and BioNTech—the first vaccine against COVID-19 put into large-scale use throughout the United States [6]. On 30 January 2021, the Agenzia Italiana del Farmaco approved the utilisation of the AstraZeneca vaccine in all adults [7]. Simultaneously, the development of COVID-19 vaccines in China has also been essentially completed, with over 10 million vaccine doses having been developed since the implementation of vaccination programmes for key populations on 15 December 2020 [8]. Indeed, evidence has shown that COVID-19 vaccination can improve individual immunity to the virus [9], which can effectively control the spread of the COVID-19 pandemic.

The COVID-19 pandemic has certainly placed a considerable burden on the global health care system [10]. Medical workers, especially nurses who most frequently come in contact with patients, are at high risk for COVID-19 infection [11,12]. Health personnel immunisation can be an approach to reduce the spread of pathogens and reduce personnel and labour costs during the pandemic [13]. Therefore, enhancing nurses' immunity against COVID-19 is imperative given its ability to reduce not only the risk of COVID-19 infection but also the operational and labour costs of medical institutions. According to the Strategic Advisory Group of Experts on Immunization, the Tailoring Immunization Program combines health behaviour theory with social determinants and classifies factors influencing vaccination into four categories, including environment mechanism, social support, personal motivation and health worker factors [14–15]. Given that medical staff has been considered a source of important medical information for the public, medical staff knowledge has a critical impact on public vaccination behaviour. As such, medical staff consultations can be a key factor that influences whether or not the public decides to vaccinate [16].

To understand the willingness of nurses from Tangshan City of Hebei province to undergo COVID-19 vaccination and factors influencing the same, nurses from medical institutions across Tangshan City were investigated in January 2021 using convenience sampling on the network platform of Sojump. Our results can be expected to provide an objective reference for relevant departments in Tangshan City to formulate vaccination plans against COVID-19 and promote COVID-19 vaccination.

Methods

Study participants

Study participants identified using convenience sampling from two third-class hospitals, one second-class hospital and two first-class hospitals in Tangshan City, Hebei Province were screened by the researchers. After obtained consent from hospital managers, chief nurses of each hospital selected qualified nurses to complete the questionnaire using the 'Sojump' network platform. The inclusion criteria were as follows: (1) on-the-job nurses at medical institutions of all levels; (2) those with practice certificates; (3) those who can act independently and complete the questionnaire using mobile phones and other electronic devices independently; and (4) those who provided informed consent for this study. The exclusion criteria were as follows: (1) interns and nurse trainees and (2) those on leave (e.g. maternity and marriage leave).

Survey tools

General information questionnaire

The general information questionnaire is composed of ten items that determine information regarding gender, age, place of residence, degree of education, marital status, monthly income, working years, professional title, work department and hospital level.

Questionnaire on nurses' willingness to undergo COVID-19 vaccination

Questionnaire items were designed preliminarily by the researchers after literature review and group discussion. The consultation form was distributed to five experts holding a deputy senior position or greater to modify the questionnaire according to the experts' evaluation and opinions. Ultimately, the questionnaire included 27 items that determined willingness and reasons for vaccination, willingness and reasons for recommending vaccination to others, attitude towards vaccine marketing, psychological price of the vaccine and attitude towards the pandemic. Multiple-choice questions regard each option as 1 item, a total of 5 multiple-choice questions. A total of 20 nurses were pre-surveyed before the formal questionnaire was issued. The questionnaire was then adjusted appropriately based on the pre-survey results, while the final questionnaire was generated after deleting two items during the process.

Data collection

After obtaining the consent from the person in charge of each hospital, the questionnaire link and instructions were sent by the researchers to the Nursing Department and chief nurses of each hospital using the 'Sojump' network platform and Wechat from January 8 to 12, 2021. Thereafter, the Nursing Department and chief nurses sent the link and instructions for the questionnaire to the clinical nurses, who then completed the questionnaire through their mobile phones and other electronic devices. The same device can only be used once to prevent repeated filling, while questionnaires with incomplete data were prevented from being submitted to ensure data integrity. After data collection, questionnaires were verified, subsequently excluding those with obvious logical errors. Questionnaires completed by nurses outside of Tangshan City were excluded based on the nurses' IP address upon filling and the current

place of residence. Before answering, all respondents were informed regarding the purpose of the survey and had provided signed written informed consent online.

Statistical analysis

Data were loaded through the back-end database of Sojump and sorted by two investigators using Excel 2019. SPSS 24.0 statistical software was used for data analysis. Descriptive statistics were used for classification, the rank-sum test was used for univariate analysis and binary logistic regression analysis was used for multivariate analysis. Statistical significance was set at a two-tailed α value of 0.05.

Ethical Considerations

The Ethics Committee of North China University of Science and Technology approved this study. The researchers informed all the participants about the objective of the study. All participants signed informed consent forms, and they were informed about the anonymous and confidential nature of their data. The study was conducted following the ethical aspects put forth in the Declaration of Helsinki.

Results

General data

Among the 282 questionnaires collected, 255 were confirmed after excluding invalid questionnaires, resulting in a recovery rate of 90.4%. As shown in **Table1**, the respondents came from five hospitals, including two third-class hospitals, one second-class hospital and two first-class hospitals. Respondents had an average age of 32.11 ± 7.65 years (range, 21 to 59 years).

Table 1. General data of the study participants

Items	Cases (n)	Percentage (%)
Gender		
Male	20	7.8
Female	235	92.2
Age		
~20	98	38.4
~30	118	46.3
~40	31	12.2
~50	8	3.1
Place of residence		
City	237	92.9
Countryside	18	7.1
Degree of education		
Special secondary school	22	8.6
Junior college	175	68.6
Bachelor and above	58	22.8
Marital status		
Without	94	36.9
With spouse	161	63.1
Monthly income (yuan)		
<3000	35	13.7
~3000	82	32.2
~5000	98	38.4
~10,000	40	15.7
Working years (years)		
<5	69	27.1
~5	52	20.4
~10	106	41.5
~20	28	11.0

Professional title		
Nurse	44	17.3
Nurse practitioner	80	31.4
Supervisor nurse	112	43.9
Associate chief nurse	12	4.7
Chief nurse	7	2.7
Working department		
Department of medicine	102	40.0
Department of surgery	91	35.7
Intensive care unit/Emergency department	33	13.0
Department of infection	14	5.4
Others	15	5.9
Hospital level		
First-class	30	11.8
Second-class	71	27.8
Third-class	154	60.4

Analysis of nurses' willingness for COVID-19 vaccination and associated reasons

Nurses' willingness for COVID-19 vaccination

Among the study participants, 173 (67.8%) nurses expressed their willingness for COVID-19 vaccination, while the remaining 82 (32.2%) refused to receive vaccination.

Reasons for nurses' willingness for COVID-19 vaccination

Among the 173 nurses who expressed willingness for COVID-19 vaccination, the major reasons included engaging in high-risk work requiring vaccination against COVID-19 (87.9%), expected benefits to themselves and others (72.8%) and worries regarding COVID-19 infection (66.5%). Meanwhile, among the 82 nurses who were unwilling to undergo COVID-19 vaccination, the major reasons included concerns regarding safety (89.0%), effectiveness (62.2%) and the possibility of fake vaccines (32.9%). **Table 2** summarises the details regarding reasons for willingness/unwillingness.

Table 2. Reasons of nurses' willingness/unwillingness for COVID-19 vaccination

Reasons of nurses' willingness/unwillingness for vaccination against COVID-19 (Multiple choice)	Cases (%)
Reasons for the willingness of vaccination (n=173)	
Worries related to COVID-19 infection	115 (66.5)
Expected benefits to themselves and others	126 (72.8)
Engaging in high-risk work, necessitating COVID-19 vaccination	152 (87.9)
Conformity with several close individuals who want to get vaccinated	34 (19.7)
Free vaccination provided by the state	26 (15.0)
Others	3 (1.7)
Reasons for the unwillingness of vaccination (n=82)	
Worries regarding the safety of the vaccine	73 (89.0)
Worries regarding the effectiveness of the vaccine	51 (62.2)
Worries regarding the cost of the vaccine	5 (6.1)
Worries regarding the possibility of fake vaccines	27 (32.9)
Others	11 (13.4)

Analysis of nurses' willingness to recommend COVID-19 vaccination and associated reasons

Nurses' willingness to recommend COVID-19 vaccination

Willingness and unwillingness rates to recommend COVID-19 vaccination were 43.9% (n = 112) and 56.1% (n = 143) in the 255 nurses, respectively.

Reason for nurses' willingness to recommend COVID-19 vaccination

As shown in **Table 3**, the main reasons for willingness to recommend COVID-19 vaccination in the 112 nurses included effectiveness in preventing COVID-19 infection (100.0%) and herd immunity through universal vaccination (90.2%). Meanwhile, the main reasons for unwillingness to recommend COVID-19 vaccination in the 143 nurses included poor popularity and the wait-and-see attitude (85.3%) and hesitancy to recommend given the absence of vaccines against COVID-19 (67.1%).

Table 3. Reasons for nurses' willingness/unwillingness to recommend COVID-19 vaccination.

Reasons for nurses' willingness/unwillingness to recommend COVID-19 vaccination (multiple choice)	Cases (%)
Reasons for willingness to vaccination recommend (n = 112)	
Effectiveness in preventing COVID-19 infection	112 (100.0)
Herd immunity through universal vaccination	101 (90.2)
Free vaccination	62 (55.4)
Others	5 (4.5)
Reasons for unwillingness to recommend vaccination (n = 143)	
Poor popularity and wait-and-see attitude	122 (85.3)
Hesitancy to recommend given the absence of a vaccine against COVID-19	96 (67.1)
Worries regarding the safety and effectiveness of the vaccine	78 (54.5)
Others	7 (4.9)

Attitude of nurses towards COVID-19 vaccine marketing

With regard to nurses' attitude towards COVID-19 vaccine marketing, 149 (58.5%) nurses expressed favour, 101 (39.6%) took a neutral position and 5 (1.9%) expressed displeasure, as shown in **Table 4**.

Table 4. Attitude towards COVID-19 vaccine marketing

Attitudes	Cases (%)
In favour: Effectiveness in preventing COVID-19 infection	105 (41.2)
In favour: With simultaneous government subsidies	44 (17.3)
Neutral position: With further evaluation of the long-term effects and side effects of the vaccine	101 (39.6)
Against: Lack of vaccine effectiveness due to novel coronavirus mutation	5 (1.9)

Analysis of factors influencing nurses' willingness for COVID-19 vaccination

Univariate analysis of nurses' willingness for COVID-19 vaccination

As described in **Table 5**, univariate analysis revealed that male nurses and those who actively inquired and sought information regarding COVID-19 vaccines had significantly higher willingness for vaccination

compared to female nurses and those who did not inquire and seek information ($P < 0.05$).

Table 5. Univariate analysis of willingness to receive COVID-19 vaccination

Items	Willing to be vaccinated	Unwilling to be vaccinated	Z	P
	n (%)	n (%)		
Gender				
Male	18 (10.4)	2 (2.4)	-2.206	0.027
Female	155 (89.6)	80 (97.6)		
Age (year old)				
~20	64 (37.0)	34 (41.5)	-0.781	0.435
~30	81 (46.8)	37 (45.1)		
~40	22 (12.7)	9 (11.0)		
~50	6 (3.5)	2 (3.5)		
Place of residence				
City	161 (93.1)	76 (92.7)	-0.111	0.912
Countryside	12 (6.9)	6 (7.3)		
Degree of education				
Special secondary school	14 (8.1)	8 (9.8)	-1.186	0.235
Junior college	125 (72.3)	50 (61.0)		
Bachelor and above	34 (19.7)	24 (29.3)		
Marital status				
Without spouse	62 (35.8)	32 (39.0)	-0.492	0.623
With spouse	111 (64.2)	50 (61.0)		
Working years (years)				
<5	50 (28.9)	19 (23.2)	-0.122	0.903
~5	28 (16.2)	24 (29.3)		
~10	77 (44.5)	29 (35.4)		
~20	18 (10.4)	10 (12.2)		
Professional title				
Nurse	30 (17.3)	14 (17.1)	-0.942	0.346
Nurse practitioner	51 (29.5)	29 (35.4)		
Supervisor nurse	76 (43.9)	36 (43.9)		

Associate chief nurse	11 (6.4)	1 (1.2)		
Chief nurse	5 (2.9)	2 (2.4)		
Working department				
Department of medicine	67 (35.8)	35 (35.4)	-0.231	0.818
Department of surgery	62 (38.7)	29 (42.7)		
Intensive care unit/Emergency department	23 (13.3)	10 (12.2)		
Department of infection	12 (6.9)	2 (2.4)		
Others	9 (5.2)	6 (7.3)		
Hospital level				
First-class	18 (10.4)	12 (14.6)	-0.569	0.569
Second-class	54 (31.2)	17 (20.7)		
Third-class	101 (58.4)	53 (64.6)		
Monthly income (yuan)				
<3000	21 (12.1)	14 (17.1)	-0.010	0.992
~3000	60 (34.7)	22 (26.8)		
~5000	65 (37.6)	33 (40.2)		
~10,000	27 (15.6)	13 (15.9)		
Impact of COVID-19 on life				
No impact	6 (4.19)	2 (4.81)	-0.556	0.578
Little impact	70 (51.46)	35 (52.40)		
Some impact	65 (30.96)	35 (32.21)		
Great impact	32 (13.39)	10 (10.58)		
Taking the initiative to inquire or search for information in COVID-19 vaccines				
No	110 (63.6)	36 (43.9)	-2.962	0.003
Yes	63 (36.4)	46 (56.1)		
Psychological price of the vaccine (yuan/dose)				
<50	27 (15.6)	14 (17.1)	-1.070	0.285
~50	100 (57.8)	52 (63.4)		

~100	35 (20.2)	13 (15.9)
~200	11 (6.4)	3 (3.7)

Multivariate analysis of nurses' willingness for COVID-19 vaccination

Binary logistic regression analysis was conducted with nurses' willingness for COVID-19 vaccine as the dependent variable (0 = Willing, 1 = Unwilling) and nurses' gender, age, place of residence, degree of education, marital status, working years, professional title, working department, hospital level, monthly income, impact of COVID-19 on life, initiative to inquire or search for COVID-19 vaccine information and the psychological price of the vaccine as the independent variables. **Table 6** details the assignment of independent variables.

Accordingly, our results showed that gender, degree of education, working years, initiative to inquire or search for vaccine information were related to the willingness for COVID-19 vaccination ($P < 0.05$), as presented in **Table 7**.

Table 6. Assignment for the independent variables

Independent variables	Assignment
Gender	Male = 1; Female = 2
Age (year old)	~20 = 1; ~30 = 2; ~40 = 3; ~50 = 4
Place of residence	City = 1; Countryside = 2
Degree of education	Special secondary school = 1; Junior college = 2; Bachelor's degree and above = 3
Marital status	Without spouse = 1; With spouse = 2
Working years	<5 = 1; ~5 = 2; ~10 = 3; ~20 = 4
Professional title	Nurse = 1; Nurse practitioner = 2; Supervisor nurse = 3; Associate chief nurse = 4; Chief nurse = 5
Working department	Department of medicine = 1; Department of surgery = 2; Intensive care unit/Emergency department = 3; Department of infection = 4; Others = 5
Hospital level	First-class = 1; Second-class = 2; Third-class = 3
Monthly income	<3000 = 1; ~3000 = 2; ~5000 = 3; ~10,000 = 4
Impact of COVID-19 on life	No impact = 1; Little impact = 2; Some impact = 3; Great impact = 4
Initiative to inquire or search for the information regarding COVID-19 vaccines	Yes = 1; No = 2
Psychological price of the vaccine (yuan/dose)	<50 = 1; ~50 = 2; ~100 = 3; 200 = 4

Table 7 Multivariate logistic regression analysis for willingness to undergo COVID-19 vaccination

Factors	B	SE	Wald	P	OR	95% (CI)
Gender	1.850	0.806	5.270	0.022	6.357	1.311~30.834
Age (year)	-0.874	0.420	4.316	0.038	0.417	0.183~0.952
Place of residence	0.174	0.619	0.079	0.779	1.190	0.354~3.999
Degree of education	0.592	0.286	4.284	0.038	1.807	1.032~3.166
Marital status	-0.612	0.453	1.830	0.176	0.542	0.223~1.316
Working years	0.901	0.386	5.442	0.020	2.461	1.155~5.245
Professional title	-0.271	0.263	1.068	0.301	0.762	0.456~1.276
Working department	0.042	0.134	0.097	0.755	1.043	0.801~1.357
Hospital level	-0.024	0.231	0.010	0.919	0.977	0.621~1.536
Monthly income	0.067	0.189	0.126	0.722	1.069	0.739~1.548
Impact of COVID-19 on life	-0.041	0.186	0.047	0.828	0.960	0.666~1.384
Initiative to inquire or search for information on COVID-19 vaccines	0.962	0.296	10.575	0.001	2.618	1.466~4.677
Psychological price of the vaccine (yuan/dose)	-0.292	0.201	2.118	0.146	0.747	0.504~1.107
Constant	-7.967	2.714	8.617	0.003	<0.001	

Discussion

The highly contagious COVID-19 has currently remained prevalent globally, with droplet and contact transmission being its primary mode of transmission [17]. All countries worldwide have devoted themselves to actively developing vaccines against COVID-19 to curb the pandemic. According to relevant research, vaccination rates against COVID-19 needs to reach at least 47% to achieve herd immunity, with a higher COVID-19 basic reproduction number (R_0) possibly requiring higher vaccination rates to achieve herd immunity [18].

By the end of 2019, a total of 212 hospitals of all levels and 23,000 registered nurses were recorded in Tangshan City [19], with the current study selecting a total of 255 nurses from five hospitals across Tangshan City through convenience sampling. Accusingly, our findings showed that 67.8% of the nurses surveyed were willing to undergo COVID-19 vaccination. A previous study by Kabamba et al., however, showed that only 27.7% of the medical staff expressed willingness to undergo COVID-19 vaccination [16]. Moreover, another study by Verger et al. reported that 48.6% of the medical staff would definitely be willing to undergo COVID-19 vaccination [20], while Unroe et al. showed that 45% of the medical staff expressed willingness for COVID-19 vaccination [12]. Compared to the aforementioned studies focusing

on foreign medical staff, the current found relatively higher willingness for vaccination among medical staff in China. However, nurses included herein still had lower willingness compared to Chinese residents (88.6%), as reported by Lazarus et al. [21]. This could be explained by the considerably greater medical knowledge among medical workers relative to residents. However, most of the vaccines against COVID-19 are still in clinical trials and have gained relatively poor reliability reputation given the public's scepticism regarding the safety and effectiveness of the vaccine. Meanwhile, the effective control of the pandemic situation in China has also reduced the willingness of medical staff to undergo COVID-19 vaccination to a certain extent. However, based on the survey results on vaccination willingness rates obtained herein, a universal vaccination plan against COVID-19 in China would certainly be able to achieve herd immunity. Nevertheless, providing more information related to COVID-19 vaccines to medical staff is still necessary.

Among the 173 nurses who showed the willingness for COVID-19 vaccination, 87.9% believed that the high-risk nature of work of their work warranted vaccination. This suggests that a high-risk work environment had been the major reason for high willingness to undergo COVID-19 vaccination, thereby indicating the need for vaccination from a professional point of view. Furthermore, 72.8% of the nurses thought that they and others could benefit from the vaccination, suggesting that most nurses have more knowledge regarding the vaccine and that social benefits and public welfare constitute a reason for vaccination against COVID-19. Moreover, 66.5% of the nurses were concerned regarding COVID-19 infection, indicating the need for vaccination from the perspective of individual benefits. Meanwhile, 82 nurses expressed unwillingness to undergo COVID-19 vaccination due to worries regarding safety (89.0%) and effectiveness (62.2%), which was essentially consistent with the research results presented by Mohaithef and Kreps [22–23]. This can be explained by the following two reasons. Firstly, the COVID-19 pandemic spreads rapidly, accompanied by a high risk for mutations in the novel coronavirus. At present, over 100 subtypes of the novel coronavirus have been recorded, causing public concern over the effectiveness of the vaccine and fear for the absence of preventive effects after vaccination. Secondly, some limitations in medical research are still presented given the relatively recent (i.e. over 1 year) discovery of the novel coronavirus. Therefore, the safety of vaccines against COVID-19 in various countries has been questioned, leading to low vaccination willingness rates among nurses. Moreover, 32.9% of nurses were worried about fake vaccines mainly due to the endless vaccine problems in China over the recent years, which has affected the Chinese public's confidence in the role of vaccines in disease prevention.

Health workers may play an important role in promoting public willingness to undergo vaccination [15], highlighting the importance of nurses' willingness to recommend vaccination. In the current study, 112 nurses (43.9%) expressed their willingness to recommend COVID-19 vaccination to the public, which was consistent with the rate (46.77%) reported by Verger et al. [20]. The main reasons for their willingness to recommend vaccination included effectiveness in preventing COVID-19 infection (100.0%) and herd immunity through universal vaccination (90.2%). Meanwhile, 143 (56.1%) nurses were unwilling to recommend vaccination to the public owing to the poor popularity and wait-and-see attitude (85.3%), as well as hesitancy given the current absence of vaccines against COVID-19 (67.1%). The aforementioned reasons suggest the need to emphasise vaccination among medical staff after the approval of vaccines

against COVID-19 in China. Moreover, strengthening the scientific research, development and supervision of vaccines, as well as standardising its storage, transportation and vaccination process, are certainly necessary to reduce side effects as much as possible and improve safety and effectiveness. Consequently, the aforementioned measure are expected to effectively promote vaccination against COVID-19.

Given the abnormal distribution of data obtained herein, a nonparametric rank-sum test was used for univariate analysis. Notably, a previous study by Kabamba et al. showed that gender was not a factor that influenced whether medical staff was willing to be vaccinated against COVID-19 ($P > 0.05$). However, both univariate and multivariate analyses conducted herein showed that male nurses had 6.357 times higher willingness for vaccination than female nurses (OR = 6.357, 95% CI: 1.311–30.834, $P < 0.05$). This could be primarily related to the small sample size of male nurses in the current study. In actual clinical settings, however, male nurses account for approximately 2% of the total number of nurses in China. Furthermore, nurses who actively inquired regarding or searched for information on COVID-19 vaccines showed 2.618 times higher willingness to undergo COVID-19 vaccination compared to those who did not (OR = 2.618, 95% CI: 1.466–4.677). Accordingly, news media outlets, as well as medical and health institutions, should seek to strengthen the availability of relevant information regarding COVID-19 vaccines and promote nurses' awareness so as to improve their willingness to undergo vaccination.

Conclusion

The current study revealed that nurses in Tangshan City had a high degree of acceptance towards COVID-19 vaccination. Nonetheless, there is certainly room to further improve nurses' willingness to undergo and recommend vaccination against COVID-19, with most nurses hoping to avoid COVID-19 infection through vaccination. Moreover, relevant departments are encouraged to implement positive and adequate measures to strengthen nurses' knowledge regarding COVID-19 vaccines to better prepare COVID-19 vaccination programmes. Similarly, strengthening public opinion, emphasising problems relevant to nurses and enhancing nurses' confidence in vaccination are imperative against COVID-19.

Declarations

Ethics approval and consent to participate

This study was approved by the Ethics Committee of North China University of Science and Technology. The purpose of the research was explained to all participants and the confidentiality of the researchers was guaranteed. The survey also included an informed consent form. Fill out this form and then complete the survey, indicating that the participant agrees to the research. The statement in the introductory part of the questionnaire clearly indicates the voluntary nature of participation, and states that anonymity, confidentiality and the fact that the research results are only used for research purposes.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that there is no conflict of interest.

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Authors' contributions

YL W led the design of the survey of the study and interpretation of the data; LH D drafted the manuscript; YJ Liang and YL W data analysis; ZH G and YJ Liu were investigated; J C rigorous review and improve the manuscript; YL W and YY L revised the manuscript. All authors made substantial contributions to the study and approved the study.

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Author information

The first authorship is Yunlong Wang.

Affiliations

Department of Neurosurgery , North China University of Science and Technology Affiliated Hospital No. 73 Jianshe South Rd, Tangshan, 063000, Hebi, China

Yunlong Wang, Lihuan Dong, Yajing Liang, Zonghai Guo, Jie Cheng, Yujing Liu, Yanying Li

Corresponding author

Correspondence to J C.

Abbreviations

COVID-19 Coronavirus Disease 2019

R_0 basic reproduction number

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