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# Safety of an inactivated SARS-CoV-2 vaccine among healthcare workers in China

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**ABSTRACT**

**Background**: Although the inactivated SARS-CoV-2 vaccine (CoronaVac) has undergone preclinical tests and clinical trials evaluating its efficacy and safety, few data have been reported in the post-licensure real-world setting. We aimed to assess the safety of the vaccine among healthcare workers.

**Methods**: A self-administered online survey on monitoring adverse reactions post vaccination was conducted among the staff who worked at and were vaccinated in a tertiary hospital in Taizhou, China, from February 24 to 7 March 2021. A total of 1526 subjects responded to the questionnaire when they received an e-mail or an e-poster on WeChat.

**Results**: The incidences of overall adverse reactions after the first and second injections were 15.6% (238/1526) and 14.6% (204/1397), respectively. The most common adverse reaction was localized pain at the injection site, with an incidence of 9.6% and 10.7% after each dose, accounting for 61.8% and 73.0% of adverse reactions, respectively. Fatigue, muscle pain, and headache were the most common systemic adverse reactions.

**Conclusions**: These findings implied that the inactivated CoronaVac vaccine has an acceptable safety profile among healthcare workers due to the low incidence of self-reported adverse reactions. This may boost public confidence in nationwide mass vaccination campaigns.

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Adverse reaction; China; COVID-19 vaccination; healthcare workers; safety

## 1. Introduction

Coronavirus disease 2019 (COVID-19) is caused by a novel coronavirus named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which is a highly contagious respiratory pathogen. Since the outbreak of COVID-19 at the end of 2019, it has spread over 200 countries and regions around the world at an alarming rate. As of 17 April 2021, the COVID-19 global pandemic had claimed more than three million lives, severely affecting our society and daily life.

Faced with a population-wide susceptibility to the virus, COVID-19 vaccination is the most effective way to control the epidemic. As of 18 March 2021, at least five different COVID-19 vaccines across three platforms have been conditionally approved for emergency use in China. Several cross-sectional surveys have shown that the demand for and willingness to receive the vaccine was high in the general population in China during the COVID-19 pandemic [1–3]. However, during the well-contained phase, the willingness to obtain COVID-19 vaccination immediately dropped from 58.3% to 23.0% [4], and healthcare workers were less willing to be vaccinated. More than half of the unwilling subjects in China were worried about side effects from the vaccine [5]. These findings suggested that concerns about the safety of the vaccine may prevent people from getting vaccinated immediately. More people would delay vaccination until vaccine safety was confirmed.

A previous study demonstrated that concerns about side effects and efficacy were barriers that negatively influenced on vaccination intention [6]. An inactivated SARS-CoV-2 vaccine (CoronaVac) has been evaluated for its safety, tolerability and immunogenicity in phase 1/2 [7,8] and efficacy and adverse reactions in phase 3 clinical trials carried out in Brazil [9,10]. However, little pragmatic evidence for its effectiveness and safety has been reported. The safety of vaccines against COVID-19 urgently needs to be assessed in a post-licensure real-world study. Therefore, we conducted a questionnaire survey on monitoring adverse reactions post vaccination among healthcare workers in China in a real-world setting.

## 2. Materials and methods

### 2.1. Study design and population

We conducted an anonymous cross-sectional survey online via the WeChat-incorporated Wen-Juan-Xing platform (Changsha Ranxing Information Technology Co., Ltd., Hunan, China), which is the largest online survey platform in China. Our target

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population was all staff who worked at and were vaccinated in a tertiary hospital in Taizhou, China. The sample included not only health professionals (doctors, nurses, medical technicians and pharmacists) but also administrative support staff such as janitors, dietary aides, and nursing aides. The interviewees received a notification on reporting adverse reactions after COVID-19 vaccination via WeChat or e-mail, and the respondents answered the self-administered questionnaire by visiting the Uniform Resource Location (URL) or scanning the Quick Response (QR) code on their mobile phones between February 24 and 7 March 2021. We first investigated their knowledge, attitudes and practices about the COVID-19 vaccine under emergency use authorization; then, all persons who were newly vaccinated were asked to recall their solicited and unsolicited local and systemic adverse reactions post vaccination. This study was exempted from informed consent and approved by the Ethics Committee of Taizhou Hospital of Zhejiang Province (Approval number: K20210217) in China. All procedures were performed in accordance with the guidelines of our institutional ethics committee and adhered to the tenets of the Declaration of Helsinki. All participants' information was anonymous.

### 2.2. Questionnaires

We designed a self-administered questionnaire based on the instruction manual for the adsorbed COVID-19 (inactivated) vaccine manufactured by Sinovac. After consultation with preventive experts about feedback on adverse reactions post vaccination, we revised the questionnaire. The content of the questionnaire was as follows: (1) basic demographic information, such as age, sex, education, occupation, professional technical title and health status; (2) knowledge of the inactivated vaccine being used in our hospital was measured by a question: 'What type of SARS-CoV-2 vaccine do you think is being used in the hospital?' Attitudes toward the COVID-19 vaccine were tested by the questions 'If conditions permit, will you take the SARS-CoV-2 vaccine for your family proactively?' and 'Are you concerned about the possible side effects of the SARS-CoV-2 vaccine?' (3) vaccination history, such as seasonal influenza vaccination in the past season; (4) potential associated factors about the respondents' vaccination decision-making and adverse reactions for vaccine recipients; (5) local and systemic adverse reactions after the first and second dose. Almost all of the questions were closed, with checkboxes provided for responses, except for the reporting of suspected side effects post vaccination.

### 2.3. Statistical analysis

The primary outcome of the survey was adverse reactions after COVID-19 vaccination. The safety analyses included all vaccine recipients and whether they received one or two doses of the vaccine. Safety analyses were expressed as counts and percentages for solicited and unsolicited local reactions and systemic events during the period of one week after vaccination. Categorical variables of basic characteristics, including socio-demographic characteristics, knowledge and attitudes about the vaccine, were also displayed as counts and percentages. The potential factors associated with adverse reactions, such as sex, age, position, knowledge and attitudes about the COVID-19 vaccine, were initially assessed using the chi-square test.

Multinomial logistic regression is the extension of (binary) logistic regression when the categorical dependent outcome has more than two levels. This model was then developed to identify the factors associated with adverse effects, with the odds ratio (OR) and a 95% confidence interval (CI) being calculated. Variables that were significant at the $P< 0.05$ level in the univariate analyses were included in the model. All data were analyzed by IBM SPSS statistics 22.0 software (SPSS Inc., Chicago, IL, USA). A $P$-value of $<0.05$ was considered to represent a statistically significant difference among the test populations.

## 3. Results

### 3.1. Characteristics of the study population

A total of 1673 (39.9%, 1673/4191) staff in the hospital completed the questionnaire. Among them, 1526 received at least one dose of COVID-19 vaccine, and 1397 (91.5%) completed their vaccination with two doses. The response rate was 46.4% among those who received one or two doses of the vaccine.

The sample consisted of 316 men (20.7%) and 1,210 women (79.3%), and their mean age was 35.4 ± 8.9 years. The proportions of total service years, education levels, position, and professional titles are reported in Table 1. A total of 79.0% of participants were aware the SARS-CoV-2 vaccine was based on virus inactivation techniques. More than half of the participants worried about adverse reactions to the vaccine, but only 2.6% of participants would not take vaccines for family proactively. In addition, 5.6% of subjects ever had adverse reactions to other vaccines, and 6.3% had a positive allergic history.

In this survey, 129 participants received only one injection of vaccine. Among them, one- third had a less than 14-day interval since the first injection, 19.4% had a cold at the time scheduled for the second vaccine, 16.3% had an adverse reaction after the first dose, and the others refused the second dose for unknown reasons.

### 3.2. Adverse reactions

In our survey, 646 adverse events were reported by 238 (15.6%) recipients of the first dose, and 457 adverse events were reported by 204 (14.6%) recipients of the second dose. Among them, 105 (7.5%) participants reported at least one adverse reaction after both inoculations. The distribution of multiple types of adverse reactions after vaccination is shown in Table 2. The most common adverse reaction was localized pain at the injection site, which accounted for 61.8% of the first adverse reactions and 73.0% of the second adverse reactions post vaccination. The most commonly observed systemic adverse reactions were fatigue, muscle soreness and headache. Fatigue was reported in 127 (8.3%) recipients after the first dose and in 91 (6.5%) recipients after the second dose. Muscle pain was reported in 123 (8.1%) after the first dose and

Table 1. Baseline characteristics of the vaccinated participants ($n$= 1,526).

| Variables | Category | $n$ (%) |
|---|---|---|
| Sex | | |
| | Male | 316(20.7) |
| | Female | 1210(79.3) |
| Age(years) | | |
| | 18–30 | 456(29.9) |
| | 30–40 | 622(40.8) |
| | 40–50 | 349(22.9) |
| | 50–60 | 99(6.5) |
| Total service time (years) | | |
| | 0–4 | 516(33.8) |
| | 5–9 | 295(19.3) |
| | 10–14 | 281(18.4) |
| | 15–19 | 240(15.7) |
| | ≥20 | 194(12.7) |
| Body mass index (kg/m$^2$) | | |
| | <18.5 | 127(8.3) |
| | 18.5–23.9 | 975(63.9) |
| | 24–27.9 | 346(22.7) |
| | ≥28 | 78(5.1) |
| Education level | | |
| | Junior Secondary and below | 125(8.2) |
| | Senior Secondary | 112(7.3) |
| | Junior College | 239(15.7) |
| | Undergraduate | 896(58.7) |
| | Graduate | 154(10.1) |
| Position | | |
| | Doctor | 289(18.9) |
| | Nurse | 794(52.0) |
| | Medical Technician | 87(5.7) |
| | Pharmacist | 25(1.6) |
| | Administration | 331(21.7) |
| Professional titles | | |
| | Internship | 97(6.4) |
| | Primary grade | 525(34.4) |
| | Medium grade | 411(26.9) |
| | Associate professor | 158(10.4) |
| | Professor | 69(4.5) |
| | Others | 266(17.4) |
| Knowledge of inactivated vaccine being used in the hospital | | |
| | Yes | 1205(79.0) |
| | No | 321(21.0) |
| Worry about adverse reactions | | |
| | No | 697(45.7) |
| | Yes | 829(54.3) |
| Take vaccine for the family proactively | | |
| | Yes | 1096(71.8) |
| | No | 40(2.6) |
| | Not sure | 390(25.6) |
| Adverse reactions to other vaccines | | |
| | No | 1441(94.4) |
| | Yes | 85(5.6) |
| Allergic history | | |
| | No | 1430(93.7) |
| | Yes | 96(6.3) |

109 (7.8%) after the second dose, followed by headache and/or dizziness, with incidences of 6.0% and 3.4%, respectively. In addition, other adverse events with an incidence of more than 1% were fever, diarrhea, nausea, cough and rash. All adverse effects were mild and transient (Table 2).

Of the 238 participants who had adverse reactions after the first dose, 201 (84.5%) participants opted to continue with the second dose, among whom 105 (52.2%) had at least one adverse reaction. As shown in Figure 1, among the recipients with or without adverse reactions after the first dose, the incidences of adverse reactions after the second dose were significantly different (52.2% vs. 8.3%, respectively, $P$< 0.001).

### 3.3. Factors associated with adverse reactions post vaccination

Table 3 indicates that the incidences of adverse effects post vaccination overall and by subgroup of participants. Univariate analysis suggested that position, knowledge of the inactivated vaccine being used in the hospital, concerns about adverse reactions, taking vaccines for family proactively, a history of adverse reactions to other vaccines, health status and sleep quality before vaccination were significant factors affecting adverse reactions after one or two inoculations. Sex, age, history of allergic reactions and underlying disease were associated with adverse reactions to vaccination. Professional title was associated with the risk of adverse reactions for both vaccinations.

The effect of independent associated risk factors on each type of adverse reaction was examined using a multinominal logistic regression model. As depicted in Table 4, after adjustment for confounding factors, professional titles (professor vs. others, OR = 3.39, 95% CI: 1.11–10.41), knowledge of the inactivated vaccine being used in the hospital (yes vs. no, OR = 0.58, 95% CI: 0.37–0.90), worry about adverse reactions (yes vs. no, OR = 2.75, 95% CI: 1.87–4.04), health status before vaccination (general/worse vs. good, OR = 1.94, 95% CI: 1.14–-3.31), adverse reactions to other vaccines (yes vs. no, OR = 4.23, 95% CI: 2.35–7.63), allergic history (yes vs. no, OR = 1.87, 95% CI: 1.06–3.30), and sleep quality before vaccination (bad vs. good, OR = 2.47, 95% CI: 1.51–4.02) were significantly related to adverse reactions from vaccination. In addition, sex (female vs. male, OR = 2.26, 95% CI: 1.12–4.56), professional titles (medium grade vs. others, OR = 3.30, 95% CI: 1.16–9.42; associate professor vs. others, OR = 6.39, 95% CI: 2.05–19.93), knowledge of the inactivated vaccine being used in the hospital (yes vs. no, OR = 0.42, 95% CI: 0.22–0.80), worry about adverse reactions (yes vs. no, OR = 1.84, 95% CI: 1.13–-3.01), taking the vaccine for the family proactively (yes vs. no or not sure, OR = 0.57, 95% CI: 0.36–0.92), adverse reactions to other vaccines (yes vs. no, OR = 5.28, 95% CI: 2.66–10.47), and sleep quality before vaccination (bad vs. good, OR = 2.21, 95% CI: 1.18–4.15) were significantly related to adverse reactions to both injections.

## 4. Discussion

### 4.1. Clinical implications

In this study, we investigated the safety of the adsorbed inactivated SARS-CoV-2 vaccine against COVID-19 produced in Vero cells by Sinovac. This study was conducted in health professionals 18–59 years of age before a nationwide mass vaccination campaign. The incidence of overall adverse reactions post vaccination was 15.6% for the first injection, 14.6% for the second injection, and 7.5% for both inoculations. The most common adverse reactions were localized pain or itching at the injection site, with an incidence of 9.6% after the first dose and 10.7% after the second dose, accounting for 61.8% and 73.0% of adverse reactions, respectively. This rate is much lower than the local adverse reaction rate (19.35%) listed in the vaccine instructions.

Table 2. Distribution of multiple types of adverse reactions after vaccination.

| Adverse reactions | First dose ($n$= 1,526) | | | Second dose ($n$= 1,397) | | |
|---|---|---|---|---|---|---|
| | No. of subjects | Incidence of adverse reactions (%) | Proportion of adverse reactions (%) | No. of subjects | Incidence of adverse reactions (%) | Proportion of adverse reactions (%) |
| **Total adverse reactions** | 238 | 15.6 | 100.0 | 204 | 14.6 | 100.0 |
| **Solicited adverse reactions** | | | | | | |
| **Injection site adverse reactions** (Pain,Induration,Redness,Swelling, or Itch) | 147 | 9.6 | 61.8 | 149 | 10.7 | 73.0 |
| **Systemic adverse reactions** | | | | | | |
| Fatigue | 127 | 8.3 | 53.4 | 91 | 6.5 | 44.6 |
| Muscle pain | 123 | 8.1 | 51.7 | 109 | 7.8 | 53.4 |
| Headache, Dizziness | 92 | 6.0 | 38.7 | 48 | 3.4 | 23.5 |
| Fever | 45 | 2.9 | 18.9 | 14 | 1.0 | 6.9 |
| Vomiting, Diarrhea | 24 | 1.6 | 10.1 | 13 | 0.9 | 6.4 |
| Appetite impaired, Nausea | 21 | 1.4 | 8.8 | 13 | 0.9 | 6.4 |
| Cough, Throat pain | 19 | 1.2 | 8.0 | 7 | 0.5 | 3.4 |
| Allergic reaction, urticaria, rash | 16 | 1.0 | 6.7 | 0 | 0.0 | 0.0 |
| Stuffy, runny nose | 13 | 0.9 | 5.5 | 5 | 0.4 | 2.5 |
| Lymphadenopathy | 10 | 0.7 | 4.2 | 4 | 0.3 | 2.0 |
| **Non-solicited adverse reactions** (Menstruation, Chest pain, Numbness of limbs) | 9 | 0.6 | 3.8 | 4 | 0.3 | 2.0 |

Fatigue, muscle pain, headache and/or dizziness were the most commonly reported systemic adverse events. Their incidences were 8.3%, 8.1% and 6.0% after the first dose and 6.5%, 7.8% and 3.4% after the second dose of the vaccine, respectively. These rates were slightly higher than these listed in the vaccine instruction manual, in which 5.91% had fatigue and around 1% had muscle pain and headache. All adverse events reported were mild or moderate in severity. The profile of adverse events reported in this survey is similar to that in the phase 3 clinical trials reported previously [9,10]. There were no adverse events that were absent in the manual.

By 30 March 2021, 268 COVID-19 candidate vaccines had been developed worldwide, 84 candidate vaccines had been evaluated clinically, and 184 candidate vaccines had been evaluated preclinically according to the WHO's draft landscape of COVID-19 candidate vaccines [11]. All known vaccine platforms have been used to develop vaccine candidates, including inactivated vaccines, live attenuated vaccines, subunit vaccines, virus-like particles, nucleic acid vaccines (mRNA vaccines and DNA vaccines), and viral vector vaccines. Inactivated viral vaccines have the advantages of a mature technology, high safety, high success probability and high public acceptance.

To date, five vaccine candidates have been approved in China with conditions or for emergency use, including three technical routes: inactivated virus vaccine, adenovirus vector vaccine and protein subunit. The Sinovac vaccine has been approved for emergency use in several countries, including China, Indonesia, Brazil and Chile. In addition to Sinovac vaccine, two whole-virus inactivated COVID-19 vaccines from the Beijing Institute of Biological Products/Sinopharm [12] and the Wuhan Institute of Biological Products/Sinopharm [13] were approved for emergency use as early as June 2020.

Inactivated SARS-CoV-2 vaccines have a low incidence of adverse reactions compared to other candidate vaccines [14–16]. The overall incidence of adverse events post vaccination with BBIBP-CorV was 29% in a phase 1 clinical trial and 23% in a phase 2 clinical trial [17]. Furthermore, an adenovirus vector vaccine had also shown a favorable safety profile in both phase 1 and 2 human clinical trials [14,18]. This adenovirus vector vaccine needed only a single vaccination with a replication-defective human type 5 adenovirus encoding the SARS-CoV-2 spike protein [19]. Additionally, the protein subunit vaccine has also completed phase 1/2 clinical trials, which showed good immunogenicity and good tolerance [20].

As a promising alternative to traditional vaccine approaches, mRNA vaccines are considered to have high safety [21]. The effectiveness of the mRNA vaccine has been demonstrated for preventing symptomatic COVID-19 in a nationwide mass vaccination setting [22]. However, the recipients had a high local response, with an incidence of mild-to-moderate pain at the injection site greater than 60% irrespective of dose or age. Systemic events such as fatigue and headache were reported in 14%-59% of vaccine recipients [23]. The Moderna COVID-19 vaccine was approved for an Emergency Use Authorization as early as 18 December 2020. The most common adverse event after vaccination was also pain at the injection site, with an incidence of 86.0% [24].

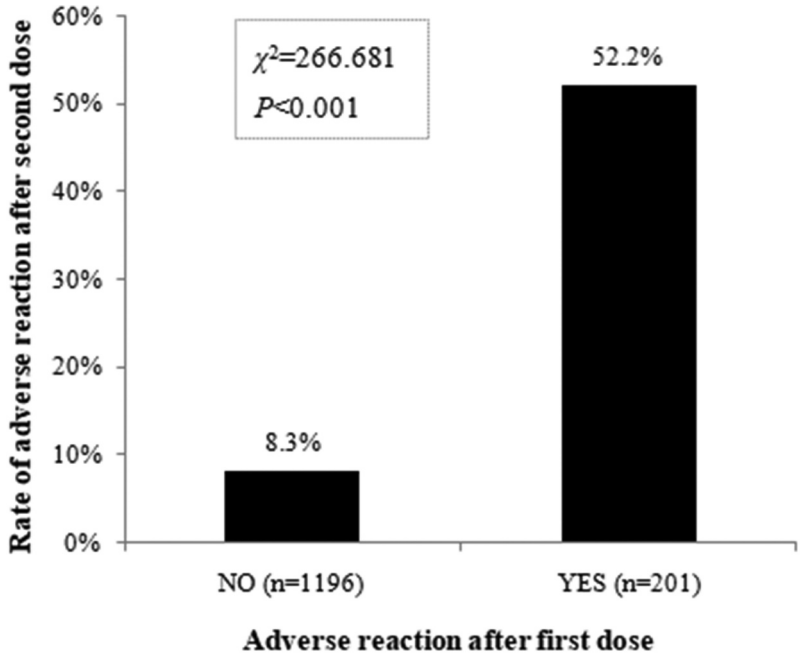


Figure 1. Adverse reaction after the second dose in the participants with or without adverse reaction after the first dose of vaccination.

To our knowledge, this is the first report of the safety of the inactivated vaccine after emergency use in high-risk groups in China. We thought that a self-administered questionnaire could allow for a more comprehensive collection of various adverse events, but the findings still showed a favorable safety profile. Our results may provide population-based pragmatic data on inactivated vaccine safety and boost public confidence in vaccination.

### *4.2. Methodological considerations*

Our study has some limitations. First, the self-administered online questionnaire cannot guarantee the accuracy of the information. We performed a logic check and called back to revise any non-logical data. Second, we are not sure whether the reported adverse events are attributable to the vaccination; thus, the incidence of adverse reactions may be overestimated. Last, the sample was recruited from only one hospital, the response rate was relatively low, and the survey respondents were likely to be younger and healthier than the general population, given that they are young and healthy enough to be employed in health care, which may result in selection bias.

## 5. Conclusions

In conclusion, our study implies that the inactivated COVID-19 vaccine has a favorable safety profile in adults due to the low incidence of self-reported adverse reactions. Pragmatic evidence may boost public confidence in nationwide mass vaccination campaigns. Further large-scale real-world studies in various populations are needed to confirm the safety of COVID-19 vaccines.

## 6. Expert opinion

There is an urgent medical need to implement safe vaccine campaigns to stop the devastating health and socioeconomic consequences of the current COVID-19 pandemic. To date, more than 268 COVID-19 vaccine candidates; including nucleic acid (mRNA and DNA), vectored, live attenuated, subunit, viral like particles, and inactivated vaccines; are currently in use or planned to be used for the prevention of SARS-CoV-2 infection and COVID-19 disease. One important goal within the global vaccination campaign is to convince people to get vaccinated, which would be accelerated by instilling confidence in potential vaccines with safety data for COVID-19 vaccines.

The study found that the inactivated SARS-CoV-2 vaccine, produced in Vero cells and manufactured by Sinovac, had an accepted favorable safety profile in vaccinated individuals. This vaccine showed limited adverse reactions, the most common being minor to moderate localized pain at the site of injection. This positive evidence for safety of the inactivated SARS-CoV-2 vaccine may help to enhance the coverage rate of vaccination in the future.

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## Declaration of interest

The authors have no relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with

Table 3. Univariate analysis of factors associated with adverse reactions in completed two doses vaccinated group (*n*= 1,397).

| | | | Adverse reaction in any vaccination | | | Adverse reaction in both vaccination | | |
|---|---|---|---|---|---|---|---|---|
| Variables | Category | n | Incidence (%) | $\chi^2$ | P | Incidence (%) | $\chi^2$ | P |
| **Total** | | 1397 | 21.5 | | | 7.5 | | |
| **Sex** | | | | | | | | |
| | Male | 290 | 15.2 | 8.62 | **0.003** | 4.8 | 3.806 | 0.051 |
| | Female | 1107 | 23.1 | | | 8.2 | | |
| **Age(years)** | | | | | | | | |
| | 18 ~ 29 | 417 | 21.3 | 8.922 | **0.030** | 7.9 | 4.135 | 0.247 |
| | 30 ~ 39 | 559 | 24.7 | | | 8.8 | | |
| | 40 ~ 49 | 328 | 16.2 | | | 5.8 | | |
| | 50 ~ 60 | 93 | 21.5 | | | 4.3 | | |
| **Total service time (years)** | | | | | | | | |
| | 0 ~ 4 | 479 | 21.3 | 2.305 | 0.680 | 7.1 | 1.959 | 0.743 |
| | 5 ~ 9 | 267 | 19.5 | | | 6.7 | | |
| | 10 ~ 14 | 250 | 23.6 | | | 9.6 | | |
| | 15 ~ 19 | 221 | 23.5 | | | 7.2 | | |
| | ≥20 | 180 | 19.4 | | | 7.2 | | |
| **Education level** | | | | | | | | |
| | Junior Secondary and below | 121 | 18.2 | 8.019 | 0.091 | 4.1 | 7.977 | 0.092 |
| | Senior Secondary | 108 | 13.0 | | | 2.8 | | |
| | Junior College | 217 | 19.4 | | | 6.5 | | |
| | Undergraduate | 814 | 23.2 | | | 8.6 | | |
| | Graduate | 137 | 24.1 | | | 9.5 | | |
| **Position** | | | | | | | | |
| | Doctor | 249 | 20.5 | 18.895 | **0.001** | 8.0 | 20.267 | **<0.001** |
| | Nurse | 723 | 23.2 | | | 7.6 | | |
| | Medical Technician | 86 | 18.6 | | | 8.1 | | |
| | Pharmacist | 23 | 52.2 | | | 30.4 | | |
| | Administrative support staff | 316 | 16.8 | | | 5.1 | | |
| **Professional titles** | | | | | | | | |
| | Internship | 90 | 14.4 | 10.483 | 0.063 | 4.4 | 14.158 | **0.015** |
| | Primary grade | 485 | 22.9 | | | 8.0 | | |
| | Medium grade | 362 | 22.9 | | | 9.7 | | |
| | Associate professor | 145 | 26.2 | | | 11.0 | | |
| | Professor | 63 | 23.8 | | | 1.6 | | |
| | Others | 252 | 15.9 | | | 4.0 | | |
| **Body mass index (kg/m$^2$)** | | | | | | | | |
| | Thin | 114 | 25.4 | 3.807 | 0.283 | 9.6 | 3.312 | 0.346 |
| | Normal weight | 888 | 21.4 | | | 6.6 | | |
| | Overweight | 322 | 18.9 | | | 8.4 | | |
| | Obesity | 73 | 27.4 | | | 11.0 | | |
| **Underlying disease** | | | | | | | | |
| | No | 1253 | 20.6 | 5.633 | **0.018** | 7.2 | 1.943 | 0.163 |
| | Yes | 144 | 29.2 | | | 10.4 | | |
| **Take medication before vaccination** | | | | | | | | |
| | No | 1317 | 21.1 | 1.827 | 0.176 | 7.4 | 0.753 | 0.385 |
| | Yes | 80 | 27.5 | | | 10.0 | | |
| **Knowledge of inactivated vaccine being used in the hospital** | | | | | | | | |
| | Yes | 1106 | 23.2 | 9.779 | **0.002** | 8.4 | 6.085 | **0.014** |
| | No | 291 | 14.8 | | | 4.1 | | |
| **Worry about adverse reactions** | | | | | | | | |
| | No | 643 | 12.1 | 61.683 | **<0.001** | 4.8 | 12.447 | **<0.001** |
| | Yes | 754 | 29.4 | | | 9.8 | | |
| **Take vaccine for the family proactively** | | | | | | | | |
| | Yes | 1016 | 18.0 | 27.175 | **<0.001** | 6.0 | 12.367 | **0.002** |
| | No | 30 | 36.7 | | | 10.0 | | |
| | Not sure | 351 | 30.2 | | | 11.7 | | |
| **Adverse reactions to other vaccines** | | | | | | | | |
| | No | 1323 | 19.4 | 62.186 | **<0.001** | 6.7 | 22.366 | **<0.001** |
| | Yes | 74 | 58.1 | | | 21.6 | | |
| **Allergic reaction** | | | | | | | | |
| | No | 1313 | 20.6 | 9.025 | **0.003** | 7.4 | 0.518 | 0.472 |
| | Yes | 84 | 34.5 | | | 9.5 | | |
| **Health status before vaccination** | | | | | | | | |
| | Good | 1288 | 19.7 | 30.12 | **<0.001** | 7.1 | 4.828 | **0.028** |
| | General/Worse | 109 | 42.2 | | | 12.8 | | |
| **Sleep quality before vaccination** | | | | | | | | |
| | Bad in two doses | 198 | 32.8 | 40.745 | **<0.001** | 10.1 | 7.774 | **0.021** |
| | Bad in one dose | 131 | 35.9 | | | 12.2 | | |
| □ | Good | 1068 | 17.6 | | | 6.5 | | |

Table 4. Multinominal logistic regression of factors associated with adverse reactions in completed two doses vaccinated group (n = 1,397).

| | Adverse reaction in any vaccination vs. No adverse reaction | | | Adverse reaction in both vaccination vs. No adverse reaction | | |
|---|---|---|---|---|---|---|
| Variables | OR | 95%CI | P | OR | 95%CI | P |
| Sex (Female vs. male) | 1.38 | 0.82–2.34 | 0.223 | 2.26 | 1.12–4.56 | **0.023** |
| Age(years) | | | | | | |
| 18–30 vs. 50–60 | 0.94 | 0.38–2.36 | 0.902 | 2.22 | 0.57–8.74 | 0.253 |
| 30–40 vs. 50–60 | 1.26 | 0.57–2.78 | 0.567 | 1.85 | 0.55–6.21 | 0.316 |
| 40–50 vs. 50–60 | 0.66 | 0.31–1.39 | 0.274 | 1.28 | 0.39–4.26 | 0.684 |
| Position 1. Administrative support staff | 1.00 | - | | 1.00 | - | |
| 2.Doctors | 0.71 | 0.31–1.59 | 0.402 | 0.65 | 0.25–1.72 | 0.389 |
| 3.Nurses | 0.81 | 0.39–1.67 | 0.569 | 0.43 | 0.18–1.02 | 0.055 |
| 4.Medical technicians | 0.62 | 0.24–1.59 | 0.318 | 0.68 | 0.22–2.04 | 0.490 |
| 5.Pharmacists | 2.09 | 0.57–7.63 | 0.263 | 3.43 | 0.95–12.4 | 0.060 |
| Professional titles 1. Others | 1.00 | - | | 1.00 | - | |
| 2.Internship | 0.79 | 0.28–2.24 | 0.656 | 1.27 | 0.30–5.34 | 0.745 |
| 3.Primary grade | 1.26 | 0.60–2.64 | 0.546 | 2.68 | 1.00–7.16 | 0.050 |
| 4.Medium grade | 0.94 | 0.42–2.11 | 0.883 | 3.30 | 1.16–9.42 | **0.025** |
| 5.Associate professor | 2.00 | 0.82–4.85 | 0.126 | 6.39 | 2.05–19.93 | **0.001** |
| 6.Professor | 3.39 | 1.11–10.41 | **0.033** | 1.04 | 0.10–10.67 | 0.974 |
| Knowledge of inactivated vaccine being used in the hospital (yes vs. no) | 0.58 | 0.37–0.90 | **0.016** | 0.42 | 0.22–0.80 | **0.008** |
| Worry about adverse reactions (yes vs. no) | 2.75 | 1.87–4.04 | **0.000** | 1.84 | 1.13–3.01 | **0.014** |
| Take vaccine for the family proactively (yes vs. no or not sure) | 0.81 | 0.57–1.17 | 0.269 | 0.57 | 0.36–0.92 | **0.020** |
| Health status before vaccination (General/ Worse vs. Good) | 1.94 | 1.14–3.31 | **0.015** | 1.75 | 0.86–3.58 | 0.124 |
| Adverse reactions to other vaccines (yes vs. no) | 4.23 | 2.35–7.63 | **0.000** | 5.28 | 2.66–10.47 | **0.000** |
| Allergic history (yes vs. no) | 1.87 | 1.06–3.30 | **0.031** | 1.33 | 0.59–3.01 | 0.491 |
| Underlying disease (yes vs. no) | 1.38 | 0.82–2.34 | 0.224 | 1.80 | 0.93–3.51 | 0.082 |
| Sleep quality before vaccination | | | | | | |
| Bad in two doses vs. Good | 1.46 | 0.93–2.30 | 0.101 | 1.25 | 0.68–2.29 | 0.476 |
| Bad in one dose vs. Good | 2.47 | 1.51–4.02 | **0.000** | 2.21 | 1.18–4.15 | **0.013** |

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## Author contributions

M-X Zhang and T-H Tung conceived the study. T-T Zhang, G-F Shi, Y-M Zheng and F-M Cheng collected the data. M-X Zhang was responsible for the coding of the analyses. M-X Zhang and T-H Tung analyzed and interpreted the data. M-X Zhang wrote the first draft of the paper and interpreted the relevant literature. T-H Tung, T-T Zhang, G-F Shi, Y-M Zheng, F-M Cheng, and H-X Chen edited and approved the final manuscript.

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