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Physicians’ willingness to be vaccinated with a smallpox vaccine to prevent monkeypox viral infection: A cross-sectional study in Indonesia

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were less willing to be vaccinated than women, adjusted odds ratio (aOR): 0.37; 95% confidence interval (CI): 0.16, 0.87 and aOR: 0.42; 95%CI: 0.27, 0.67, respectively for subsidized and non-subsidized scenario.

Conclusion: Vaccine price and gender are important factors for physicians’ willingness to be vaccinated for smallpox vaccine prevent monkeypox in Indonesia. These findings indicate that achieving high vaccine coverage may require partially or fully subsidized vaccines, along with a clear guideline and recommendation from authorities.

1. Introduction

Monkeypox, caused by the monkeypox virus (MPXV), is a viral zoonotic infection characterized by a pustular rash similar to smallpox and systemic symptoms that range from mild to fatal.1 The first human case was reported in the 1970s in the country now known as the Democratic Republic of the Congo (DRC).2 Following its recognition as a human pathogen, human monkeypox (simply will be called as monkeypox in this article) occurred mostly in the DRC, although the number of cases in other west and central African countries has also been increasing,3 suggesting that this is an emerging infectious disease. Cases of monkeypox also have been reported in non-endemic countries outside Africa. An outbreak occurred among persons in the Midwest of the United States in 2013 who had had contact with ill pet prairie dogs obtained through a common distributor.4 In 2018, imported cases of monkeypox were reported in the United Kingdom5 and Israel.6 In Asia, the first confirmed monkeypox case was reported in Singapore in May 2, 019.7 A recent study revealed a secondary attack rate in the order of 10% in contacts who had not previously been administered a smallpox vaccine.8 The healthcare setting is one important source of transmission; there is approximately one healthcare worker infection for every 100 confirmed monkeypox cases.1 Therefore, healthcare workers are at risk of occupationally-acquired infection with monkeypox virus even in non-endemic countries.

Although there is no licensed medical treatment or monkeypox vaccine, vaccination against smallpox has been proven to be 85% effective in preventing monkeypox.1 However, smallpox vaccination has been discontinued after global smallpox eradication, and the vaccine is no longer available to the general public.9 This has given rise to increasing susceptibility to MPXV infection in the human population, and it is believed that the current re-emergence of monkeypox is due to, in part, the cessation of routine smallpox vaccination.9 In unvaccinated individuals, case fatality rates of monkeypox approach 11%.9 That MPXV has high potential to be transmitted to healthcare workers highlights a potential need to vaccinate these workers.

In summary, there is no currently available monkeypox vaccine although there is high cross-protection with the smallpox vaccine. Accordingly, this present study aimed to investigate healthcare workers’ willingness to be vaccinated with smallpox vaccination to prevent MPXV infection in Indonesia.

2. Methods

2.1. Ethical consideration

The protocol of this study was approved by the Institutional Review Board of the Faculty of Medicine and Health Sciences, Maulana Malik Ibrahim State Islamic University of Malang, Indonesia (055/EC/KEPK-FKIK/2019) in compliance with national legislations and the Declaration of Helsinki.

2.2. Study design and setting

Between May 25, 2019 and July 25, 2019, following previous studies’ approach,10–12 an online-based cross-sectional study was conducted among general practitioners (GPs) in Indonesia. The minimum sample size of this study was estimated to be 382 GPs based on the fact that there are 50,198 GPs in Indonesia in 2019, under the conservative assumptions that 50% were willing to be vaccinated; a 5% margin of error and a 95% confidence interval. Advertisements to participate in the study were distributed to social media and invitations to complete a survey were circulated by email to members of various GP organizations or groups. Those who agreed to participate were provided with detailed information about the study and were asked to provide their consent to participate.

2.3. Study instrument

The survey employed a set of questionnaires to measure the willingness to be vaccinated and various explanatory variables such as sociodemographic data, workplace characteristics, professional characteristics, exposure to monkeypox information and knowledge on monkeypox. The questions were tested in a pilot study among fifteen GPs prior to the actual study.

2.4. Study variables

The dependent variables in this study were: (a) willingness to be vaccinated with a smallpox vaccine in preventing monkeypox in which the vaccine was freely provided by the government; and (b) willingness to be vaccinated with a smallpox vaccine in preventing monkeypox in which the vaccine price was Indonesian Rupiah (IDR) 250,000 (equivalent with US$ 17.9 using a December 2019 exchange rate). The possible responses were “willing” or “non-willing”.

Several explanatory variables were assessed in this study and were categorized as follows. Sociodemographic data included gender, age (classified into ≤ 30-year-old and > 30-year-old), educational attainment [medical doctor and medical doctor with master or doctorate degree], type of job [GP and GP who were also specialist resident], current location [western and central-eastern part of Indonesia], and monthly income [less than IDR 5 million and IDR 5 million or more, equivalent with US$ 358.3 and US$ 358.3 or more, respectively]. Workplace characteristics included type of workplace [community health center (known as Puskesmas), private clinic, private hospital and public hospital], and location of health facilities [district, regency and province]. Medical professional characteristics included location of alma mater university [Java and non-Java (Sumatera and others)], the length of medical experience [less than 5 year and at least 5 years] and attendance at local, national and international conference in the last five months. Participants were also asked whether they had ever received information about monkeypox during their medical education and whether they had heard about monkeypox prior to the survey.

Respondents’ knowledge of monkeypox and their self-confidence to diagnose and treat the monkeypox cases were also assessed. Knowledge was measured using 21 questions covering epidemiology, causative agent, transmission, signs and symptoms, and management of monkeypox. The knowledge of each participant was dichotomized as good and poor based on an 80% cut-off (i.e. 17 questions correct). Self-confidence was assessed using three questions whether they had confidence: (a) to diagnose monkeypox cases based on their current knowledge and skills; (b) to treat monkeypox cases based on their current knowledge and skills; and (c) to diagnose monkeypox cases based on the available facilities in their workplace. For each question, participants were classified as “confident” or “not confident,” and
participants were dichotomized into having "good" confidence if they responded "confident" to all questions.

2.5. Statistical analysis

To explore the possible explanatory variables associated with willingness to be vaccinated under each scenario (i.e., the subsidized and non-subsidized vaccine), a two-step logistic regression analysis was employed. All explanatory variables were analyzed separately in unadjusted logistic regression models. Then variables with $p \leq 0.25$ in this step were entered into a multivariable analysis. Unadjusted and adjusted odds ratios (aOR) were interpreted in relation to a reference category. Significance was assessed at $\alpha = 0.05$ and all analyses were performed using SPSS for Windows (Version 22, Chicago, IL, USA).

3. Results

3.1. Participants' characteristics

We received 510 responses during the survey, and 103 were excluded due to missing information; leaving 407 (79.8%) respondents in the final sample. A majority of the participants (68.6%) were 30-years old or younger and half (51.6%) earned less than five million IDR (Table 1). Less than 15% of the respondents graduated from universities.

| Table 1 | Unadjusted and adjusted logistic regression analysis showing predictors of willingness to receive a free smallpox vaccine among general practitioners in Indonesia (Willing vs. Unwilling) ($n = 407$). |
|---|---|
| Variable | n (%) | Willing n (%) | Unadjusted | Adjusted |
| | | | OR (95% CI) | p-value | OR (95% CI) | p-value |
| Gender | | | | | | |
| Female (R) | 279 (68.6) | 268 (96.1) | 1 | 1 |
| Male | 128 (31.4) | 113 (88.3) | 0.31 (0.14, 0.69) | 0.004 | 0.37 (0.16, 0.87) | 0.023 |
| Age group | | | | | | |
| > 30 years (R) | 128 (31.4) | 120 (93.8) | 1 | – |
| ≤ 30 years | 279 (68.6) | 261 (93.5) | 0.97 (0.41, 2.29) | 0.938 |
| Educational attainment | | | | | | |
| General practitioner (GP) (R) | 385 (94.6) | 363 (94.3) | 1 | 1 |
| GP with master's or doctoral degree | 22 (5.4) | 18 (81.8) | 0.27 (0.09, 0.88) | 0.029 | 0.48 (0.13, 1.82) | 0.279 |
| Type of job | | | | | | |
| GP (R) | 353 (86.7) | 330 (93.5) | 1 | – |
| GP and specialist resident | 54 (13.3) | 51 (94.4) | 1.19 (0.34, 4.09) | 0.788 |
| Current location | | | | | | |
| Western Indonesia (R) | 285 (70.0) | 271 (95.1) | 1 | 1 |
| Central and eastern Indonesia | 122 (30.0) | 110 (90.2) | 0.47 (0.21, 1.06) | 0.068 | 0.57 (0.24, 1.38) | 0.211 |
| Monthly income (Indonesian Rupiah) | | | | | | |
| < 5 million (R) | 210 (51.6) | 202 (96.2) | 1 | 1 |
| ≥ 5 million | 197 (48.4) | 179 (90.9) | 0.39 (0.17, 0.93) | 0.033 | 0.56 (0.22, 1.42) | 0.219 |
| Type of workplace | | | | | | |
| Community health center (R) | 102 (25.1) | 97 (95.1) | 1 | 1 |
| Private clinic | 90 (22.1) | 78 (86.7) | 0.34 (0.11, 0.99) | 0.048 | 0.45 (0.14, 1.42) | 0.174 |
| Private hospital | 68 (16.7) | 67 (98.5) | 3.45 (0.40, 30.23) | 0.263 | 4.60 (0.51, 41.26) | 0.173 |
| Public hospital | 147 (36.1) | 139 (94.6) | 0.90 (0.28, 2.82) | 0.851 | 1.01 (0.31, 3.33) | 0.991 |
| Location of workplace | | | | | | |
| District (R) | 129 (31.7) | 118 (91.5) | 1 | – |
| Regency | 152 (37.3) | 144 (94.7) | 1.68 (0.65, 4.31) | 0.282 |
| Province | 126 (31.0) | 119 (94.4) | 1.59 (0.59, 4.23) | 0.358 |
| Location of alma mater university | | | | | | |
| Sumatera and others (R) | 350 (86.0) | 328 (93.7) | 1 | – |
| Java | 57 (14.0) | 53 (93.0) | 0.89 (0.30, 2.68) | 0.834 |
| Medical practice experience (years) | | | | | | |
| < 5 year (R) | 294 (72.2) | 275 (93.5) | 1 | – |
| ≥ 5 year | 113 (27.8) | 106 (93.8) | 1.05 (0.43, 2.56) | 0.921 |
| Attended a province-level conference | | | | | | |
| No (R) | 136 (33.4) | 127 (93.4) | 1 | – |
| Yes | 271 (66.6) | 254 (93.7) | 1.06 (0.46, 2.44) | 0.893 |
| Attended a national-level conference | | | | | | |
| No (R) | 256 (62.9) | 241 (94.1) | 1 | – |
| Yes | 151 (37.1) | 140 (92.7) | 0.79 (0.35, 1.77) | 0.571 |
| Attended an international-level conference | | | | | | |
| No (R) | 388 (95.3) | 362 (93.3) | 1 | – |
| Yes | 19 (4.7) | 19 (100.0) | 1 × 10^6 (0.00, NA)^a | 0.998 |
| Had you ever received information of monkeypox during medical education | | | | | | |
| Never (R) | 339 (83.3) | 314 (92.6) | 1 | 1 |
| Yes | 68 (16.7) | 67 (98.5) | 5.33 (0.71, 40.06) | 0.104 | 4.33 (0.56, 33.44) | 0.160 |
| Had you ever heard about monkeypox before | | | | | | |
| Never (R) | 33 (8.1) | 31 (93.9) | 1 | – |
| Yes | 374 (91.9) | 350 (93.6) | 0.94 (0.21, 4.17) | 0.936 |
| Knowledge of monkeypox | | | | | | |
| Poor (R) | 369 (90.7) | 346 (93.8) | 1 | – |
| Good | 38 (9.3) | 35 (92.1) | 0.78 (0.22, 2.71) | 0.691 |
| Confidence in management of monkeypox | | | | | | |
| Poor (R) | 365 (89.7) | 342 (93.7) | 1 | – |
| Good | 42 (10.3) | 39 (92.9) | 0.87 (0.25, 3.05) | 0.833 |

^a Model was unable to be estimated.
located in Java and 70% of the participants resided in western part of Indonesia. Few (68, 16.7%) GPs had heard about monkeypox during medical education, although the vast majority of respondents (91.9%) had heard monkeypox prior to the survey. In this study, 9.3% of participants had good knowledge of monkeypox and 10.3% had good confidence in facing monkeypox cases.

3.2. Willingness to be vaccinated and its associated factors

When the vaccine is freely provided by government, 381 (93.6%) of the participants were willing to be vaccinated. In an unadjusted analysis, gender, education, monthly income, and type of workplace were associated with the willingness to be vaccinated (Table 1). Females, GPs without an advanced degree, those who earned less than US$ 358.3 and those who were working in private clinics had higher willingness compared to males, GPs who were also specialist residents, those who earned US$ 358.3 or more and those who were working in the community health centers, respectively. In the adjusted analysis, only gender was associated with willingness to be vaccinated. Men were less willing to be vaccinated than women (aOR: 0.37; 95%CI: 0.16, 0.87, p = 0.023) (Table 1).

When the healthcare workers would have to pay US$ 17.9 for the vaccine, the proportion of the respondents who were willing to be vaccinated decreased to 293 (71.9%). Gender was the only factor associated with the willingness to be vaccinated in both unadjusted and adjusted analysis (Table 2). In adjusted analysis, compared to women, Table 2

Unadjusted and adjusted regression analysis showing predictors of willingness to receive an unsubsidized smallpox vaccine among general practitioners in Indonesia (Willing vs. Unwilling) (n = 407).

| Variable                                      | n (%)   | Willing n (%) | Unadjusted | Adjusted |
|-----------------------------------------------|---------|---------------|------------|----------|
| Gender                                        |         |               | OR (95% CI) | p-value  |
| Female (R)                                    | 279 (68.6) | 217 (77.8)    | 1          | 1        |
| Male                                          | 128 (31.4) | 76 (59.4)     | 0.42 (0.27, 0.66) | < 0.001 | 0.42 (0.27, 0.67) | < 0.001 |
| Age group                                     |         |               |            |          |
| > 30 years (R)                                | 128 (31.4) | 95 (74.2)     | 1          |          |
| ≤ 30 years                                    | 279 (68.6) | 198 (71.0)    | 0.85 (0.53, 1.36) | 0.498    |
| Educational attainment                        |         |               |            |          |
| General practitioner (GP) (R)                 | 385 (94.6) | 279 (72.5)    | 1          |          |
| GP with master's or doctoral degree           | 22 (5.4) | 14 (63.6)     | 0.67 (0.27, 1.63) | 0.372    |
| Type of job                                   |         |               |            |          |
| GP (R)                                        | 353 (86.7) | 256 (72.5)    | 1          |          |
| GP and specialist resident                    | 54 (13.3) | 37 (68.5)     | 0.83 (0.44, 1.53) | 0.542    |
| Current location                              |         |               |            |          |
| Western Indonesia (R)                         | 285 (70.0) | 206 (72.3)    | 1          |          |
| Central and eastern Indonesia                 | 122 (30.0) | 87 (71.3)     | 0.95 (0.60, 1.53) | 0.842    |
| Monthly income (Indonesian Rupiah)           |         |               |            |          |
| < 5 million (R)                               | 210 (51.6) | 147 (70.0)    | 1          |          |
| ≥ 5 million                                   | 197 (48.4) | 146 (74.1)    | 1.23 (0.80, 1.89) | 0.356    |
| Type of workplace                             |         |               |            |          |
| Community health center (R)                   | 102 (25.1) | 74 (72.5)     | 1          |          |
| Private clinic                                | 90 (22.1) | 55 (61.1)     | 0.60 (0.32, 1.09) | 0.093    | 0.66 (0.35, 1.23) | 0.188 |
| Private hospital                              | 68 (16.7) | 55 (80.9)     | 1.60 (0.76, 3.37) | 0.216    | 1.78 (0.83, 3.81) | 0.137 |
| Public hospital                               | 147 (36.1) | 109 (74.1)    | 1.09 (0.61, 1.92) | 0.778    | 1.28 (0.71, 2.31) | 0.408 |
| Location of workplace                         |         |               |            |          |
| District (R)                                  | 129 (31.7) | 92 (71.3)     | 1          |          |
| Regency                                       | 152 (37.3) | 108 (71.1)    | 0.99 (0.59, 1.66) | 0.961    |
| Province                                      | 126 (31.0) | 93 (73.8)     | 1.13 (0.65, 1.97) | 0.656    |
| Location of alma mater university             |         |               |            |          |
| Sumatera and others (R)                       | 350 (86.0) | 249 (71.1)    | 1          |          |
| Java                                          | 57 (14.0) | 44 (77.2)     | 1.37 (0.71, 2.66) | 0.347    |
| Medical practice experience (years)           |         |               |            |          |
| < 5 year (R)                                  | 294 (72.2) | 208 (70.7)    | 1          |          |
| ≥ 5 year                                      | 113 (27.8) | 85 (75.2)     | 1.26 (0.77, 2.06) | 0.369    |
| Attended a province-level conference          |         |               |            |          |
| No (R)                                        | 136 (33.4) | 98 (72.1)     | 1          |          |
| Yes                                           | 271 (66.6) | 195 (72.0)    | 1.00 (0.63, 1.57) | 0.983    |
| Attended a national-level conference          |         |               |            |          |
| No (R)                                        | 256 (62.9) | 182 (71.1)    | 1          |          |
| Yes                                           | 151 (37.1) | 111 (73.5)    | 1.13 (0.72, 1.77) | 0.600    |
| Attended an international-level conference    |         |               |            |          |
| No (R)                                        | 388 (95.3) | 281 (72.4)    | 1          |          |
| Yes                                           | 19 (4.7) | 12 (63.2)     | 0.65 (0.25, 1.70) | 0.383    |
| Had you ever received information of monkeypox during medical education | | | |
| Never (R)                                     | 339 (83.3) | 238 (70.2)    | 1          |          |
| Yes                                           | 68 (16.7) | 55 (80.9)     | 1.80 (0.94, 3.43) | 0.077    | 1.67 (0.86, 3.25) | 0.131 |
| Had you ever heard about monkeypox before     |         |               |            |          |
| Never (R)                                     | 33 (8.1) | 24 (72.7)     | 1          |          |
| Yes                                           | 374 (91.9) | 269 (71.9)    | 0.96 (0.43, 2.14) | 0.922    |
| Knowledge of monkeypox                        |         |               |            |          |
| Poor (R)                                      | 369 (90.7) | 269 (72.9)    | 1          |          |
| Good                                          | 38 (9.3) | 24 (63.2)     | 0.64 (0.32, 1.28) | 0.206    | 0.86 (0.55, 1.34) | 0.495 |
| Confidence in management of monkeypox         |         |               |            |          |
| Poor (R)                                      | 365 (89.7) | 264 (72.3)    | 1          |          |
| Good                                          | 42 (10.3) | 29 (69.0)     | 0.85 (0.43, 1.71) | 0.654    |
men had lower odds of being willing to take the vaccine (aOR: 0.42; 95%CI: 0.27, 0.67, p < 0.001).

4. Discussion

To the best of our knowledge, this is the first study reporting willingness to be vaccinated with smallpox vaccine to prevent monkeypox infection among first-line healthcare workers. We found that the willingness is very high, approximately 94%, if the vaccine was provided freely by government. However, this rate decreased by 21.9% if the market price of the vaccine was US$ 17.9. This indicates that vaccine price is an important variable that needs to be considered if the government had a goal of achieving high vaccination coverage.

The present study found that the willingness to be vaccinated was higher in women compared to men. In Indonesia, studies have demonstrated that women were more supportive to participate in health-related studies.13,14 However, studies have found conflicting results about the role of gender on vaccine acceptance.15–17 One study in the general population found that being female was associated with a higher vaccine acceptance,15 while no association was observed in other studies.16,17 The importance of gender on willingness to be vaccinated may be influenced more by the nature of the disease (monkeypox affects mainly to the skin) rather than a high knowledge among women. There are at least two justifications for this. First, skin-related issues may be more concerning for women; studies have found that women have more anxiety about skin-related diseases.18,19 Second, our data indicate that knowledge of monkeypox is not associated with willingness to be vaccinated (Tables 1 and 2), and a previous analysis found that the level of knowledge of monkeypox did not differ by gender.20

Interestingly, the present study found that knowledge of monkeypox is not associated with willingness to be vaccinated. Previously, some studies demonstrated that a good knowledge of a certain disease is associated with vaccine acceptance,17,21,22 but other studies found no such discernible relationship.13,14,23–26 These conflicting findings may be influenced by some factors such as: (a) the characteristics of the diseases; (b) the type of participants included in the studies; (c) whether the studies assess acceptance of real world or hypothetical vaccines; and (d) the type of questions used to measure knowledge along with how knowledge was classified. In a previous study, compared to the knowledge on the disease itself, attitude to the disease was a stronger driver for acceptance of a vaccine.15 Unfortunately, physicians’ attitude was not measured in this study.

This study had some limitations. The measured willingness to be vaccinated was only a stated behavioral intention and therefore may not reflect or predict actual revealed willingness. In this study, previous smallpox vaccine status was not included in the analysis and therefore the results should be interpreted in the context that all healthcare workers are assumed to require vaccination. Finally, sampling bias might exist in this study in which healthcare workers from less developed regions with poor internet connection might be less well represented, as reported previously.20,27

5. Conclusion

If the monkeypox vaccine was fully subsidized by government, 93.6% of frontline healthcare providers in Indonesia would be willing to be vaccinated to prevent monkeypox infection. This number decreased to 71.9% if the vaccine was not subsidized. Being female is the only independent predictor for willingness to be vaccinated for both subsidized and non-subsidized vaccines. This suggests that partial or full subsidy from government might necessary to achieve high vaccine converge.

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Declaration of competing interest

The authors declare that they have no competing interests.

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