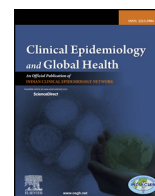




Elsevier has created a [Monkeypox Information Center](#) in response to the declared public health emergency of international concern, with free information in English on the monkeypox virus. The Monkeypox Information Center is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its monkeypox related research that is available on the Monkeypox Information Center - including this research content - immediately available in publicly funded repositories, with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the Monkeypox Information Center remains active.



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

Harapan Harapan^{a,b,c,*}, Abdul M. Setiawan^d, Amanda Yufika^e, Samsul Anwar^f, Sri Wahyuni^g, Febrivan W. Asrizal^h, Muhammad R. Sufriⁱ, Reza P. Putra^a, Nanda P. Wijayanti^j, Salwiyadi Salwiyadi^k, Razi Maulana^{l,m}, Afriyani Khusnaⁿ, Ina Nusrina^o, Muhammad Shidiq^p, Devi Fitriani^q, Muharrir Muharrir^a, Cut A. Husna^r, Fitria Yusri^g, Reza Maulana^a, Naoya Itoh^s, Mohd Andalas^{a,l,m}, Abram L. Wagner^t, Mudatsir Mudatsir^{a,b,c}

^a Medical Research Unit, School of Medicine, Universitas Syiah Kuala, Banda Aceh, Aceh, 23111, Indonesia

^b Tropical Disease Centre, School of Medicine, Universitas Syiah Kuala, Banda Aceh, Aceh, 23111, Indonesia

^c Department of Microbiology, School of Medicine, Universitas Syiah Kuala, Banda Aceh, Aceh, 23111, Indonesia

^d Department of Microbiology, Faculty of Medicine and Health Sciences, Maulana Malik Ibrahim State Islamic University of Malang, Malang, East Java, 65144, Indonesia

^e Department of Family Medicine, School of Medicine, Universitas Syiah Kuala, Banda Aceh, Aceh, 23111, Indonesia

^f Department of Statistics, Faculty of Mathematics and Natural Sciences, Universitas Syiah Kuala, Banda Aceh, Aceh, 23111, Indonesia

^g Faculty of Medicine, Universitas Malikussaleh, Lhokseumawe, Aceh, 24531, Indonesia

^h Mohammad Natsir Hospital, Solok, West Sumatra, 27361, Indonesia

ⁱ Banda Aceh Port Health Office, Ministry of Health, Aceh Besar, Aceh, 23352, Indonesia

^j Sabang Hospital, Sabang, Aceh, 23522, Indonesia

^k Department of Internal Medicine, School of Medicine, Universitas Syiah Kuala Banda Aceh, Aceh, 23111, Indonesia

^l Department of Obstetrics and Gynecology, School of Medicine, Universitas Syiah Kuala, Banda Aceh, Aceh, 23111, Indonesia

^m Department of Obstetrics and Gynecology, Zainoel Abidin Hospital, Banda Aceh, Aceh, 24415, Indonesia

ⁿ Meuraxa Hospital, Banda Aceh, Aceh, 23231, Indonesia

^o Department of Health Service, District Health Office, Aceh Besar, Aceh, 23912, Indonesia

^p Nusa Jaya Public Health Center, Halmahera Timur, North Maluku, 97863, Indonesia

^q Teunom Public Health Center, Aceh Jaya, Aceh, 23653, Indonesia

^r Department of Microbiology, Universitas Malikussaleh, Lhokseumawe, Aceh, 24531, Indonesia

^s Division of Infectious Diseases, Aichi Cancer Center Hospital, 1-1 Kanokoden, Chikusa-ku Nagoya, 464-868, Japan

^t Department of Epidemiology, University of Michigan, Ann Arbor, MI, MI 48109, USA

ARTICLE INFO

Keywords:

Monkeypox
Monkeypox vaccine
Healthcare provider
Willingness to be vaccinated
Vaccine acceptance

ABSTRACT

Background: Although there is no licensed vaccine for monkeypox, smallpox vaccine has been shown to be 85% effective in preventing the monkeypox. This study was conducted to assess the willingness of frontline healthcare providers to be vaccinated with smallpox vaccine to prevent monkeypox.

Methods: A cross-sectional study was conducted in Indonesia. The willingness was assessed under two scenarios: fully subsidized and non-subsidized vaccine. Explanatory variables such as sociodemographic profile, workplace and professional characteristics, and knowledge of monkeypox were collected. A logistic regression assessed the influence of these explanatory variables on participants' willingness.

Results: Out of 510 received participants' responses, 407 (79.8%) were analyzed. With a fully subsidized vaccine scenario, 381 (93.6%) of the participants were willing to be vaccinated and in an unadjusted analysis, gender, education, monthly income, and type of workplace were associated with willingness. With a non-subsidized vaccine (i.e. the vaccine price was US\$ 17.9), the proportion who were willing to be vaccinated decreased to 71.9%. In adjusted analyses for both scenarios, gender was the only independent predictor for willingness; men

* Corresponding author. Medical Research Unit, School of Medicine, Universitas Syiah Kuala, Jl. T. Tanoeh Abe, Darussalam, Banda, Aceh, 23111, Indonesia.

E-mail addresses: harapan@unsyiah.ac.id (H. Harapan), abdul.malik.setiawan@kedokteran.uin-malang.ac.id (A.M. Setiawan), amandayufika@gmail.com (A. Yufika), samsul.anwar@unsyiah.ac.id (S. Anwar), sri.wahyuni@unimal.ac.id (S. Wahyuni), febrivanwahyu.asrizal@gmail.com (F.W. Asrizal), naldi.sufri@gmail.com (M.R. Sufri), prasetyaboy@gmail.com (R.P. Putra), puput_sbg@yahoo.com (N.P. Wijayanti), salwiyaditheleader@gmail.com (S. Salwiyadi), dr.razee@gmail.com (R. Maulana), afriyanikhusna@gmail.com (A. Khusna), inakrams@yahoo.com (I. Nusrina), siddiqtselousen@gmail.com (M. Shidiq), devifitriani.y@gmail.com (D. Fitriani), muharrir.mdh@gmail.com (M. Muharrir), cutasmalhusnadr@gmail.com (C.A. Husna), fitriayusri1006@gmail.com (F. Yusri), rezamaulana@unsyiah.ac.id (R. Maulana), itohnaoya0925@ybb.ne.jp (N. Itoh), andalas@unsyiah.ac.id (M. Andalas), awag@umich.edu (A.L. Wagner), mudatsir@unsyiah.ac.id (M. Mudatsir).

<https://doi.org/10.1016/j.cegh.2020.04.024>

Received 7 March 2020; Accepted 26 April 2020

Available online 30 April 2020

2213-3984/ © 2020 INDIACLEN. Published by Elsevier, a division of RELX India, Pvt. Ltd. All rights reserved.

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 reemerging 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.¹ 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 reemergence of monkeypox is due to, in part, the cessation of routine smallpox vaccination.⁹ In unvaccinated individuals, case fatality rates of monkeypox approach 11%.⁸ 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

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 five 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 ⁸ (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	
			OR (95% CI)	p-value	OR (95% CI)	p-value
Gender						
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		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		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		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.^{15,16,23–26} 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.

Funding

None.

Declaration of competing interest

The authors declare that they have no competing interests.

Acknowledgments

We would like to thank to physicians' professional organizations in Indonesia.

References

- Beer EM, Rao VB. A systematic review of the epidemiology of human monkeypox outbreaks and implications for outbreak strategy. *PLoS Neglected Trop Dis.* 2019;13(10):e0007791.
- Marennikova SS, Seluhina EM, Mal'ceva NN, Ladjny JD. Poxviruses isolated from clinically ill and asymptotically infected monkeys and a chimpanzee. *Bull World Health Organ.* 1972;46(5):613–620.
- Durski KN, McCollum AM, Nakazawa Y, et al. Emergence of monkeypox - west and central Africa, 1970–2017. *MMWR Morb Mortal Wkly Rep.* 2018;67(10):306–310.
- Reed KD, Melski JW, Graham MB, et al. The detection of monkeypox in humans in the Western Hemisphere. *N Engl J Med.* 2004;350(4):342–350.
- Vaughan A, Aarons E, Astbury J, et al. Two cases of monkeypox imported to the United Kingdom, September 2018. *Euro Surveill.* 2018;23(38).
- Erez N, Achdout H, Milrot E, et al. Diagnosis of imported monkeypox, Israel, 2018. *Emerg Infect Dis.* 2019;25(5):980–983.
- Ng OT, Lee V, Marimuthu K, et al. A case of imported Monkeypox in Singapore. *Lancet Infect Dis.* 2019;19(11):1166.
- Jezeq Z, Szczeniowski M, Paluku KM, Mutombo M. Human monkeypox: clinical features of 282 patients. *J Infect Dis.* 1987;156(2):293–298.
- Nalca A, Rimoin AW, Bavari S, Whitehouse CA. Reemergence of monkeypox: prevalence, diagnostics, and countermeasures. *Clin Infect Dis.* 2005;41(12):1765–1771.
- Harapan H, Aletta A, Anwar S, et al. Healthcare workers' knowledge towards Zika virus infection in Indonesia: a survey in Aceh. *Asian. Pac J Trop Med.* 2017;10(2):189–194.
- Harapan H, Aletta A, Anwar S, et al. Attitudes towards Zika virus infection among medical doctors in Aceh province, Indonesia. *J Infect Public Health.* 2018;11(1):99–104.
- Harapan H, Rajamoorthy Y, Utomo PS, et al. Knowledge and attitude towards pregnancy-related issues of Zika virus infection among general practitioners in Indonesia. *BMC Infect Dis.* 2019;19(1):693.
- Harapan H, Anwar S, Bustaman A, et al. Community willingness to participate in a dengue study in aceh province, Indonesia. *PLoS One.* 2016;11(7):e0159139.
- Harapan H, Mudatsir M, Yufika A, et al. Willingness to participate and associated factors in a Zika vaccine trial in Indonesia: a cross-sectional study. *Viruses.* 2018;10(11).
- Harapan H, Anwar S, Setiawan AM, Sasmono RT, Aceh Dengue S. Dengue vaccine acceptance and associated factors in Indonesia: a community-based cross-sectional survey in Aceh. *Vaccine.* 2016;34(32):3670–3675.
- Hadisoemarto PF, Castro MC. Public acceptance and willingness-to-pay for a future dengue vaccine: a community-based survey in Bandung, Indonesia. *PLoS Neglected Trop Dis.* 2013;7(9):e2427.
- Harapan H, Mudatsir M, Yufika A, et al. Community acceptance and willingness-to-pay for a hypothetical Zika vaccine: a cross-sectional study in Indonesia. *Vaccine.* 2019;37(11):1398–1406.
- Mina S, Jabeen M, Singh S, Verma R. Gender differences in depression and anxiety among atopic dermatitis patients. *Indian J Dermatol.* 2015;60(2):211.
- Panebianco A, Sampogna F, Iemboli ML, et al. A screening programme for dermatologists as a guide to request psychological consultation in routine clinical practice. *Eur J Dermatol.* 2018;28(3):326–331.
- Harapan H, Setiawan A, Yufika A, et al. Knowledge of human monkeypox viral infection among general practitioners: A cross-sectional study in Indonesia. *Pathog Glob Health;* 2020:68–75.
- Violet NA, Stamm L, Herrington J, et al. United States travelers' concern about Zika infection and willingness to receive a hypothetical Zika vaccine. *Am J Trop Med Hyg.* 2018;98(6):1848–1856.
- Painter JE, Plaster AN, Tjersland DH, Jacobsen KH. Zika virus knowledge, attitudes, and vaccine interest among university students. *Vaccine.* 2017;35(6):960–965.
- Jaspers L, Budiningsih S, Wolterbeek R, Henderson FC, Peters AA. Parental acceptance of human papillomavirus (HPV) vaccination in Indonesia: a cross-sectional study. *Vaccine.* 2011;29(44):7785–7793.
- Khurana S, Sipsma HL, Caskey RN. HPV vaccine acceptance among adolescent males and their parents in two suburban pediatric practices. *Vaccine.* 2015;33(13):1620–1624.
- Khan AA, Varan AK, Esteves-Jaramillo A, et al. Influenza vaccine acceptance among pregnant women in urban slum areas, Karachi, Pakistan. *Vaccine.* 2015;33(39):5103–5109.
- Harapan H, Fajar JK, Sasmono RT, Kuch U. Dengue vaccine acceptance and willingness to pay. *Hum Vaccines Immunother.* 2017;13(4):786–790.
- Harapan H, Setiawan AM, Yufika A, et al. Confidence in managing human monkeypox cases in Asia: A cross-sectional survey among general practitioners in Indonesia. *Acta Tropica.* 2020;206:105450.