PharmacoEconomics - Open
https://doi.org/10.1007/s41669-023-00442-x

ORIGINAL RESEARCH ARTICLE

Trade-Offs between Vaccine Effectiveness and Vaccine Safety: Personal versus Policy Decisions

Semra Ozdemir[1,2] · Sean Ng[1] · Vinh Anh Huynh[1] · Axel Mühlbacher[3] · Hiang Khoon Tan[4,5,6] · Eric Andrew Finkelstein[1,6]

Accepted: 12 September 2023
© The Author(s) 2023

Abstract

Objective We aimed to investigate whether individuals' trade-offs between vaccine effectiveness and vaccine safety vary if they are asked to consider the perspective of a policymaker making decisions for others compared with the decisions they would make for themselves.

Method A web-enabled discrete choice experiment survey was administered between 1 April and 1 May 2022 to participants recruited from the general population of two Southeast Asian countries (Indonesia and Vietnam). In each country, 500 participants were randomly assigned to make decisions regarding coronavirus disease 2019 (COVID-19) vaccines for others as a policymaker or in a personal capacity for their own use. Vaccines were characterized by three attributes: (1) effectiveness of the vaccine in reducing infection rate; (2) effectiveness of the vaccine in reducing hospitalization among those infected; and (3) risk of death from vaccine-related serious adverse events. A mixed logit model was utilized for analyses.

Results Based on the attributes and levels used in this study, the most important vaccine attribute was the risk of death from vaccine-related adverse events, followed by effectiveness in reducing infection rate and hospitalizations. Compared with personal decisions, the mean probability of choosing a vaccine was (1) lower, and (2) more sensitive to the changes in risk of death from adverse events in policy decisions ($p \leq 0.01$).

Conclusions and Relevance Our results suggest that, in the face of an infectious disease pandemic, individuals are likely to be more risk-averse to vaccine-related deaths when making decisions for others as a policymaker than they would for themselves.

✉ Semra Ozdemir
semra.ozdemir@duke.edu

1 Signature Programme in Health Services and System Research, Lien Centre for Palliative Care, Duke-NUS Medical School, 8 College Road, Singapore 169857, Singapore

2 Department of Population Health Sciences, Duke University, Durham, NC, USA

3 Hochschule Neubrandenburg, Neubrandenburg, Germany

4 Division of Surgery and Surgical Oncology, Singapore General Hospital and National Cancer Centre, Singapore, Singapore

5 SingHealth Duke NUS Global Health Institute, SingHealth Duke NUS Academic Medical Center, Singapore, Singapore

6 Duke Global Health Institute, Duke University, Durham, NC, USA

Key Points for Decision Makers

Individuals prioritized vaccine safety over vaccine effectiveness in both policy making and personal decisions.

Individuals were less likely to choose a vaccine and were more risk-averse to vaccine-related deaths when making policy decisions compared with personal decisions.

Policymakers and health authorities should prioritize clear and transparent communication about the safety profiles of vaccines, particularly when addressing concerns related to serious adverse events.

Published online: 11 October 2023

1 Introduction

During an infectious disease pandemic, governments play an important role in ensuring the availability and acceptability of vaccines [1]. Part of this consists of making value judgments that weigh the expected positive and negative effects for their constituents. In addition, successfully accounting for public preferences would allow health officials to develop strategies directed at successfully promoting vaccines. This is particularly important in developing countries (e.g., Indonesia, Vietnam) where limited healthcare infrastructure and resources increase population vulnerability to pandemic-related infection and death.

Studies conducted among the general population have highlighted several important vaccine-related concerns, namely with regard to their effectiveness in preventing infection and their safety (e.g., vaccine-related adverse events) [2–4]. However, these studies focused on the personal preferences of individuals. It remains unclear if an individual's personal preferences are reflective of how they would make decisions for others when they are placed in positions of responsibility (i.e., when they make decisions in the position of a policymaker).

While there is little research directly examining this, there is indirect evidence that individuals and agents in positions of responsibility may be pressured by social norms to recommend more risk-averse health-related decisions for others than they would otherwise choose for themselves [5–7]. For example, when surrogates and physicians were faced with hypothetical scenarios where they had to recommend treatments for patients, research found that they accepted less risk for patients (compared with themselves) and opted instead for safer treatments [7, 8]. It has been suggested that these self-other differences may be shaped by the social values theory [9], which suggests that decision makers are likely to employ greater caution if they think they will be held accountable for these decisions. In addition, policymakers are confronted with the challenge of making decisions that impact a large number of individuals. In situations involving probabilistic scenarios, such as the risk of death from vaccine-related severe adverse events, while the risk is just a probability at the individual level, a number of individuals in the community are highly likely to die as a result of these adverse events. This further complicates the decision-making process for policymakers.

The primary aim of this study was to investigate how individuals' trade-offs between vaccine effectiveness and vaccine safety deviate if participants are asked to consider the perspective of a policymaker making decisions for others compared with the decisions they would make for themselves. Based on the literature, we would expect individuals evaluating vaccines for others as a policymaker (compared with decisions they would make for personal use) to (1) be less likely to choose a vaccine (over not choosing a vaccine), and (2) focus more on safety than effectiveness. The second objective was to investigate how individual characteristics affect these preferences. We hypothesized that individuals with higher education [10], who were living with vulnerable individuals [11], who worked in essential services [12], and who reported having close friends and/or family who died because of coronavirus disease 2019 (COVID-19) [13, 14] would be more likely to choose a vaccine, while those who believed that the COVID-19 pandemic was a hoax [15] would be less likely to choose a vaccine.

These objectives were examined using a discrete choice experiment (DCE), a health-economics method that has successfully been used in assessing preferences for pharmaceutical and non-pharmaceutical COVID-19 interventions [16–21] and other healthcare products and services [22, 23].

2 Methods

2.1 Study Setting and Participants

Recruitment for the survey occurred in two countries (Indonesia and Vietnam) between April and May 2022 as part of a larger study. These two countries were chosen as one country (Vietnam: 10 average daily cases) had a low number of COVID-19 cases, while the other (Indonesia: 5176 average daily cases) had a high number of cases at the time of the survey conceptualization [24]. However, both countries experienced a spike in the number of daily cases at the beginning of 2022, followed by a decline during the survey administration period (Vietnam: 18,931 average daily cases; Indonesia: 691 average daily cases) [24].

The survey instrument was first developed in English and then translated into Vietnamese and Indonesian. A web-enabled survey was administered by a market research vendor. Participants in each country were recruited to be representative in terms of age, sex, income, and geographic location. To be eligible for the study, panelists had to be at least 21 years of age and be able to read Vietnamese or Indonesian. All respondents provided informed consent. All activities were approved by the National University of Singapore Institutional Review Board (NUS-IRB-2021-401).

Based on Johnson and Orme's suggestion [25, 26], the minimum required sample size was 250 per country. To ensure an adequate number of individuals in terms of age and income, and to sufficiently analyze the expected heterogeneity of the population, the survey was administrated online to approximately 500 individuals in each country.

2.2 Discrete Choice Experiment Survey Development

DCEs are a survey research method used to elicit individuals' preferences for healthcare goods and services [27]. Individuals are asked to select their preferred alternative (e.g., vaccine) from two or more alternatives in a series of choice tasks. The alternatives are defined by a list of selected attributes (e.g., vaccine efficacy, vaccine safety, etc.) and vary from each other by the levels of these attributes.

The design of the experiment allows the analysis of the relationship between at least one independent variable, i.e. the attributes that can be precisely manipulated, and the dependent variable, the choice behavior that can be precisely measured. The design of the study also allows for the control of further variables, such as information about the decision makers, the decision-making process, and assumptions about the decision context. This allows researchers to quantify how individuals trade-off different levels of attributes and how important each attribute is relative to other attributes [28].

The three vaccine-related attributes used in this study were (1) effectiveness of the vaccine in reducing infection rate (50%, 70%, 90%, 99%); (2) effectiveness of the vaccine in reducing hospitalizations among those infected (50%, 70%, 90%, 99%); and (3) risk of death from vaccine-related serious adverse events (1, 10, 50, 200 out of 1 million). The effectiveness in reducing infection rate and safety attributes were selected as they were the most prevalent concerns observed in the extant literature and pretest interviews [2–4]. Effectiveness in reducing hospitalizations was included to reflect the evolving focus of governments from reducing the spread of infection to reducing the number of serious cases that required hospitalizations [29, 30]. The highest levels of effectiveness attributes were selected to account for the maximum potential vaccine effectiveness, while the range of death from serious adverse events was selected to encompass the observed real-world data [31–33]. The lowest levels for effectiveness attributes and the highest level for the vaccine-related serious adverse event attribute were determined based on findings from the pretest interviews, particularly the bidding game used to assess whether individuals were making trade-offs between the attributes.

The survey instrument was first developed in English and then professionally translated into the respective languages by a translation company (see the electronic supplementary material [ESM] for the English survey instrument). The translated versions were reviewed by native-speaking team members to ensure accuracy and appropriateness. The survey instruments were pretested with 10 eligible participants from each country who were quota sampled based on age, sex, and income using convenient sampling. Native-speaking interviewers followed a 'think-aloud protocol' [34], where participants were encouraged to verbalize their thoughts while answering the questions. The aim of these interviews was to evaluate the understandability and appropriateness of the attributes and levels and whether participants could answer the questions as a policymaker. Based on the feedback from the pretest interviews, revisions were primarily made to improve translational and syntactical aspects in order to enhance the understandability of the survey in the relevant languages. In addition, similar questions related to participants' experience with the COVID-19 pandemic were removed to shorten the survey instrument.

To design the choice tasks, we created an experimental design using optimal D-efficiency measures in SAS 9.4 software (SAS Institute, Inc., Cary, NC, USA) [35]. The fractional factorial design resulted in 12 choice tasks, which were then divided into four blocks of three tasks each. Participants were randomly assigned to one of the blocks. Before the DCE choice tasks, two attention-test questions were asked to determine whether individuals paid attention to the survey and if they sufficiently understood the attributes. The first attention-test question provided information on the effectiveness rates of two vaccines and asked participants to identify the vaccine with the higher effectiveness in reducing the infection rate. The second question presented two vaccines similar to the DCE tasks, but with one vaccine superior to the other across all attributes (i.e., dominant-pair test). Participants who answered these questions incorrectly were provided with an explanation to improve clarity and understanding.

Before the broader distribution of the survey, we conducted a soft launch with 50 participants in each country. This step allowed us to evaluate the various aspects of the survey, including the functionality of the survey platform, and participant response patterns. Specifically, we investigated whether the number of those who fail the attention-test questions is reasonable and whether individuals dominated on any of the attributes (indicating lack of trade-offs between attributes) or an alternative (e.g., always choosing Vaccine A). We proceeded with the final launch as no concerns arose during the soft launch phase.

Participants were randomly assigned to one of two versions of the DCE. In the first version, individuals were asked to assume the role of a policymaker and were asked if they would approve the free distribution of one of two vaccine alternatives for use throughout the country ('policy decision' henceforth). They were also given the choice of a 'Do not approve either vaccine' option. In the second version, participants were presented with the same vaccine alternatives but were asked to assume that they had not yet been vaccinated (if they were already vaccinated) and were asked to choose a vaccine for themselves ('personal decision' henceforth). They were presented with the options of 'I would get vaccinated with Vaccine A/B' and an option of 'I would not get vaccinated with either vaccine'. Henceforth, not choosing a

vaccine in a choice task will be labeled as the 'No Vaccine' option. Figure 1 presents an example choice task.

2.3 Statistical Analysis

The attribute levels were effects coded. We also included an alternative specific constant (ASC) for choosing the 'No Vaccine' option, indicating the utility associated with choosing this option. Since there were two versions of the survey, interaction effects were created between the attribute levels and a dummy variable indicating the 'personal decision' version. We ran separate models for each country.

To analyze the data, we used a mixed logit model, which allows for heterogeneous preferences. Initially, all attributes were assumed to be random and normally distributed. The attributes without significant standard deviations (SDs) in the random parameters were then assumed to be non-random. We used 1000 Halton draws for the final model estimations.

We also allowed preference heterogeneity by creating interaction effects between preference weights and attitudes towards COVID-19 beliefs (believing that the COVID-19 pandemic was a hoax) and individual characteristics (education, living with vulnerable individuals [i.e., at least 65 years of age, with chronic health conditions or poor health], having worked in essential services, having close friends and/or family who died because of COVID-19). We first included all the interaction effects in the model but those that were not significant were excluded from the final model.

We calculated the relative importance of vaccine attributes and the 'No Vaccine' option by taking the difference between the best and worst levels of an attribute and scaling this difference by the sum of all attribute/covariate differences [36]. These calculations were conducted at the individual level, utilizing individual-specific coefficients. For policy decisions, we computed the average of the individual-level relative attribute importance among respondents assigned to the policy version. For personal decisions, we calculated the average of the individual-level relative attribute importance among respondents assigned to this version. These calculations were carried out separately for each country. This method accounts for varying interaction effects within the models.

We also calculated the probability of approving (policy decision) or choosing (personal decision) a vaccine compared with not choosing one. Similar to the process for calculating relative attribute importance, these probabilities were estimated at the individual level and were subsequently averaged across policy and personal decisions. Furthermore, we calculated how the probabilities of approving/choosing a vaccine changed in response to variations in vaccine attributes.

3 Results

3.1 Sample Characteristics

The mean age of the individuals was 39 years (SD 11) for Vietnamese participants and 41 years (SD 12) for Indonesian participants. Half of the participants were female. Most were married (71%), had a university degree (90%/75% for Vietnam/Indonesia), and were employed (88%/86% for Vietnam/Indonesia). 59%/49% of Vietnamese/Indonesian participants reported living with vulnerable people; 28%/33% of Vietnamese/Indonesian participants in the sample reported working in essential services, and 98%/97% of Vietnamese/Indonesian participants received the COVID-19 vaccine. 19% of Vietnamese and 43% of Indonesian participants reported having family or friends who died because of COVID-19, whereas 16%/6% of Vietnamese/Indonesian participants agreed that COVID-19 was a hoax perpetuated by those in power for profit. The Vietnamese sample was younger, more educated, had a higher rate of COVID-19 vaccination, had more people living with vulnerable individuals, and had fewer people whose family/friends died of COVID-19 ($p \leq 0.05$) (Table 1). None of the personal characteristics were significantly different between the two versions of the survey (policy vs. personal decisions) in each country (ESM Table S1).

Regarding respondents' attention, 20%/21% of individuals failed to provide the correct answer for one of the questions in the Vietnamese/Indonesian samples, and 4%/2% failed to provide the correct answer for both questions. These rates are within the range of the findings from other DCE studies [37]. Participants who failed these tests were not excluded from the analytical sample but received additional explanations to improve understanding.

3.2 Preferences for Coronavirus Disease 2019 (COVID-19) Vaccines

Table 2 displays the preference weights**.** The weights assigned to vaccine attributes were centered on zero (i.e., effects coded). The *p* values associated with the levels of vaccine attributes indicate the difference compared with the worst level of each attribute (i.e., omitted category). Higher weights indicated a higher preference for that outcome. On average, participants from both countries preferred higher effectiveness in reducing infection rate, higher effectiveness in reducing hospitalizations, and lower risk of death from vaccine-related adverse events. Participants from both countries also generally preferred choosing a vaccine to not choosing one.

Policy Decisions Version:
In the next 3 questions, we will show you hypothetical vaccines for COVID-19. We will ask you to make decisions as if you were a **policy maker.** We will ask whether or not you would approve the free distribution of one of the two COVID-19 vaccines for use throughout the country.

	Vaccine A	Vaccine B
Effectiveness of the vaccine in reducing infection rate	**99%**	**50%**
Effectiveness of the vaccine in reducing hospitalizations among those infected	**90%**	**70%**
Chance of death from vaccine-related serious adverse events	**200** out of every 1 million people die from the vaccine	**1** out of every 1 million people die from the vaccine

If you were a policy maker, what would you choose?

☐ Approve Vaccine A

☐ Approve Vaccine B

☐ Do not approve either vaccine

Personal Decisions Version:
In the next 3 questions, we will show you hypothetical vaccines for COVID-19. We will ask you to make decisions for **yourself**. We will ask whether or not you would get vaccinated with one of the two vaccines.

	Vaccine A	Vaccine B
Effectiveness of the vaccine in reducing infection rate	**99%**	**50%**
Effectiveness of the vaccine in reducing hospitalizations among those infected	**90%**	**70%**
Chance of death from vaccine-related serious adverse events	**200** out of every 1 million people die from the vaccine	**1** out of every 1 million people die from the vaccine

What would you choose for yourself? (Assume you have not yet been vaccinated)

☐ I would get vaccinated with Vaccine A

☐ I would get vaccinated with Vaccine B

☐ I would not get vaccinated with either vaccine

Fig. 1 Sample DCE choice task. *DCE* discrete choice experiment, *COVID-19* coronavirus disease 2019

Table 1 Sample characteristics

Characteristics	Vietnam [$n = 534$]	Indonesia [$n = 526$]	p Value
Age, years [mean (SD)]	39.2 (10.9)	41.4 (12.1)	0.00
Female	260 (48.7)	266 (50.6)	0.52
Education level			<0.01
Below University	53 (9.9)	130 (24.7)	
University and above	481 (90.1)	396 (75.3)	
Marital status			
Married	381 (71.3)	374 (71.1)	0.93
Employed	472 (88.4)	452 (85.9)	0.23
Working in essential services			0.11
I work in essential services	147 (27.5)	173 (32.9)	
I do not work in essential services	304 (56.9)	268 (51.0)	
I do not know	83 (15.5)	85 (16.2)	
Vaccinated	526 (98.5)	508 (96.6)	0.04
Have a pre-existing or chronic health condition	114 (21.3)	107 (20.3)	0.69
COVID-19 is a hoax (somewhat agree or strongly agree)	79 (14.8)	65 (12.4)	0.25
Live with vulnerable people (elderly >65 years of age, have chronic health conditions or poor health)	315 (59.0)	257 (48.9)	<0.01
Have close friend(s) and/or family member died of COVID-19	102 (19.1)	228 (43.3)	<0.01

Data are expressed as *n* (%) unless otherwise specified

SD standard deviation, *COVID-19* coronavirus disease 2019

In the Vietnamese sample, although individuals in both versions preferred choosing a vaccine over not choosing one, the 'No Vaccine' option resulted in a bigger utility decline when making personal decisions compared with when making policy decisions ($p < 0.05$). In the Indonesian sample, compared with personal decisions, policy decisions were much more sensitive to the changes in the risk of death from adverse events ($p < 0.05$). In other words, an increase in the risk of adverse events resulted in a bigger utility decline when making policy decisions compared with when making personal decisions (Table 2).

Figure 2 presents the mean relative importance of the three vaccine attributes and the 'No Vaccine' option. For both countries, the factor that contributed the most to utility was the 'No vaccine' option. Among the three attributes, the risk of death from adverse events was the most important attribute, followed by effectiveness in reducing infection rate and reducing hospitalizations. For both samples, the risk of death from serious adverse events was more important for policy decisions than it was for personal decisions. In addition, the 'No Vaccine' option was more important in personal decisions such that individuals were much less likely to choose this option in personal decisions compared with policy decisions.

Regardless of making personal or policy decisions, essential workers in the Vietnamese sample were more likely to choose a vaccine ($p < 0.05$), and individuals who thought the COVID-19 pandemic was a hoax in the Indonesian sample were less likely to choose a vaccine ($p < 0.05$). In addition, those who lived with vulnerable people in Indonesia were more likely to choose a vaccine as a personal decision ($p < 0.05$) (Table 2).

3.3 Probabilities of Approving/Choosing a COVID-19 Vaccine

Consistent with our hypothesis, the mean probability of approving/choosing any vaccine was lower for policy decisions than it was for personal decisions for all comparisons except one. These probabilities were significantly different for 16 of 22 comparisons ($p \leq 0.05$) [ESM Table S2]. The mean probability of approving the worst vaccine profile in the design as a policymaker was 76% (95% confidence interval [CI] 73–80%) for both Vietnam and Indonesia. In contrast, the mean probability of choosing the same vaccine in a personal capacity was 95% (95% CI 93–97%) for Vietnam and 90% (95% CI 87–93%) for Indonesia (Fig. 3).

For both policy and personal decisions, improving the safety of the vaccine resulted in the largest increase in the mean probability of approving/choosing a vaccine. Consistent with our hypothesis, individuals were more sensitive to the changes in the risk of adverse events when making policy decisions compared with when making personal decisions ($p \leq 0.05$). In policy decisions, reducing the risk of death from adverse events from 200 to 1 out of 1 million increased the mean probability of vaccine approval by 18/19

Table 2 Preferences for COVID-19 vaccines: mixed logit estimates

	Preference weights			SD of preference weights		
	Coefficient	SE	*p* Value	Coefficient	SE	*p* Value
Vietnam						
Effectiveness of the vaccine in reducing the infection rate						
99%	0.693	0.288	0.004[a]	1.128	0.557	0.043
90%	1.159	0.399	0.003[a]	1.800	0.628	0.004
70%	− 0.561	0.275	0.043[a]	0.355	0.700	0.612
50%	− 1.291	0.437		–	–	–
Effectiveness of the vaccine in reducing hospitalizations among those infected						
99%	0.774	0.299	0.008[a]	1.122	0.567	0.048
90%	0.155	0.206	0.034[a]	0.950	0.458	0.038
70%	− 0.010	0.172	0.034[a]	0.897	0.506	0.077
50%	− 0.919	0.371				
Risk of death from adverse events						
1 in 1,000,000	2.818	0.969	0.003[a]	2.201	0.826	0.008
10 in 1,000,000	0.951	0.319	0.002[a]	1.469	0.701	0.036
50 in 1,000,000	− 0.588	0.234	0.005[a]	0.057	0.385	0.882
200 in 1,000,000	− 3.180	1.066				
ASC for 'no vaccine'	− 6.442	2.052	0.002	5.272	1.831	0.004
ASC for 'no vaccine' * personal decision[b]	− 3.208	1.428	0.025	–	–	–
ASC for 'no vaccine' * working in essential services[c]	− 5.829	2.627	0.027	–	–	–
Indonesia						
Effectiveness of the vaccine in reducing the infection rate						
99%	0.854	0.353	0.005[a]	1.158	0.557	0.038
90%	1.438	0.506	0.004[a]	1.754	0.675	0.009
70%	− 0.567	0.294	0.022[a]	0.235	0.401	0.558
50%	− 1.724	0.599				
Effectiveness of the vaccine in reducing hospitalizations among those infected						
99%	0.711	0.280	0.009[a]	1.450	0.559	0.009
90%	− 0.334	0.257	0.277[a]	0.232	0.441	0.598
70%	0.424	0.271	0.026[a]	0.152	0.521	0.771
50%	− 0.801	0.348				
Risk of death from adverse events						
1 in 1,000,000	5.184	1.609	0.001[a]	2.806	0.986	0.004
10 in 1,000,000	2.037	0.604	0.001[a]	1.658	0.658	0.012
50 in 1,000,000	− 1.526	0.507	0.004[a]	0.054	0.416	0.897
200 in 1,000,000	− 5.696	1.754				
Risk of death from adverse events * personal decision[b]						
1 in 1,000,000	− 1.523	0.636	0.011[a]	–	–	–
10 in 1,000,000	− 0.591	0.360	0.017[a]	–	–	–
50 in 1,000,000	0.442	0.364	0.118[a]	–	–	–
200 in 1,000,000	1.672	0.699		–	–	–
ASC for 'no vaccine'	− 10.127	2.890	0.001	6.749	1.951	0.001
ASC for 'no vaccine' * COVID-19 is a hoax[c]	4.551	2.002	0.023	–	–	–
ASC for 'No Vaccine' * Personal decision * Living with vulnerable with people[b,c]	− 4.355	2.161	0.044	–	–	–

COVID-19 coronavirus disease 2019, *SD* standard deviation, *SE* standard errors, *ASC* alternative specific constant

[a]*p* Values for the main-effects attribute levels are for comparisons with the worst (omitted) level of each attribute as they were effects coded. The remaining *p* values are for comparisons with 0

[b]A significant estimated interaction effect with 'personal decision' indicates that the mean preference for that covariate was different when making personal decisions than it was when making policy decisions

[c]A significant estimated interaction effect with personal characteristics indicates that the mean preference for that covariate varies based on that personal characteristic

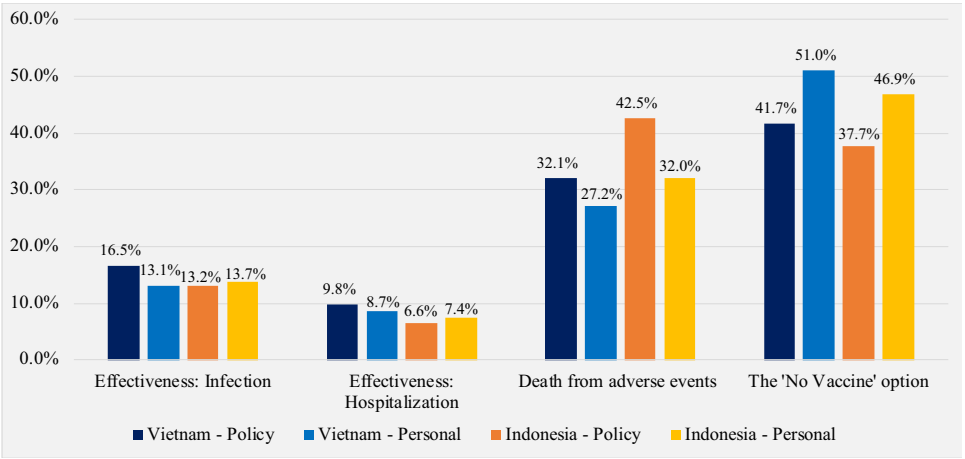


Fig. 2 Relative importance of vaccine attributes and the 'No Vaccine' option (sums to 100% for each subsample)

percentage points in Vietnam/Indonesia. In personal decisions, the same improvement in vaccine safety resulted in 3.3/6.5 percentage-point increases in the mean probability of choosing a vaccine for Vietnam/Indonesia (Fig. 3).

Similarly, improving the effectiveness in reducing the risk of infection rate from 50 to 99% increased the probabilities by 13/12 percentage points for policy decisions for Vietnam/Indonesia as compared with 2/4 percentage points for personal decisions. Improving the effectiveness in reducing the risk of hospitalizations from 50 to 99% increased the probabilities by 11 and 9 percentage points for policy decisions for Vietnam and Indonesia, respectively, but only 1–3 percentage points for personal decisions (ESM Tables S2A and S2B present the CIs).

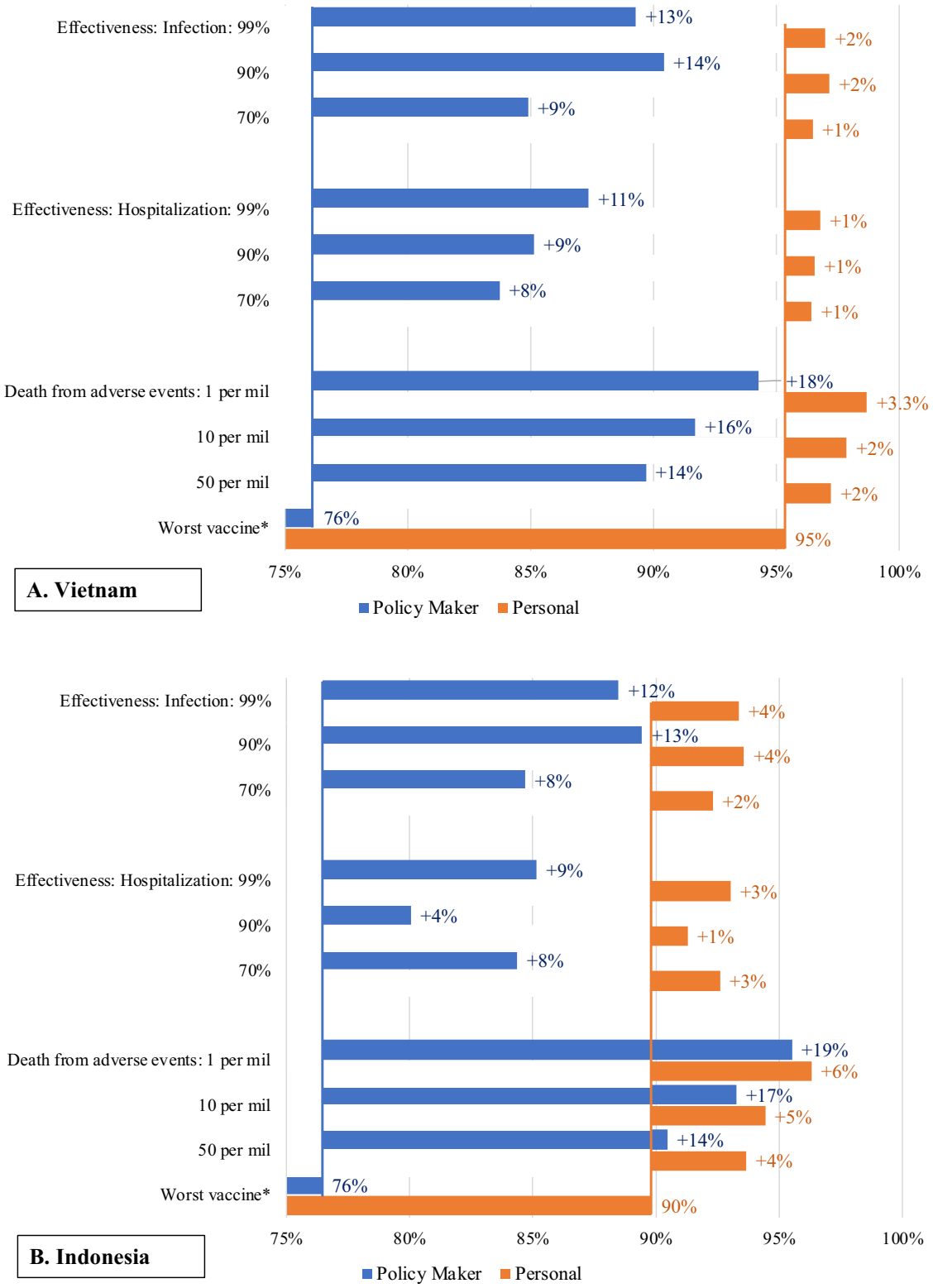
4 Discussion

The primary aim of this study was to investigate how individuals traded-off between COVID-19 vaccine effectiveness and vaccine safety in two different capacities—as a policymaker compared with a personal decision. In both decision-making capacities, individuals preferred vaccines that were more effective in reducing the infection rate and hospitalizations and had a lower risk of death from vaccine-related adverse events. However, contrasting some past studies, our findings indicated that participants considered vaccine safety more important than its effectiveness [4]. While it is important to note that a direct comparison between studies cannot be made as results are dependent on the attributes and levels used in each study, our findings suggest that there remain substantial concerns regarding vaccine safety among the public.

However, the level of risk aversion differed when decisions were made in a policy-making capacity compared with in a personal capacity. Consistent with our hypotheses and in line with the social values theory [7–9], we found that individuals were less likely to approve a vaccine for others when acting as policymakers than they would choose for personal use. Supporting these findings, decisions made in the capacity of a policymaker were more sensitive to the changes in the risk of death from vaccine-related adverse events compared with personal decisions. This heightened sensitivity could be attributed to the fact that in a society individuals will die, with certainty, as a result of vaccine-related adverse events as long as the risk pool is large and the probability is non-zero. This represents a concrete and tangible risk that policymakers face when making decisions on behalf of the community. In contrast, at the individual level, the risk of death is perceived as a probability that may or may not materialize after a choice is made. If the risk is low, individuals may down-weight this probability toward zero and thus believe there may be no adverse consequences from their decision.

This propensity towards risk averseness at the societal level can be seen in the handling of the AstraZeneca and Johnson & Johnson COVID-19 vaccines. For example, although the European Medicines Agency (EMA) suggested that the benefits of the vaccines outweighed their risks (i.e., severe blood clots) [38], several countries such as Denmark and Norway suspended their use [39].

Analyses also highlighted participant characteristics that were significantly associated with vaccine preferences. Vietnamese essential workers, regardless of decision-making type, were more likely to choose a vaccine. It is understandable that this subgroup of workers would want to take additional steps (e.g., vaccination) to protect not only themselves and their loved ones but



*Reference vaccine profile (i.e., worst vaccine profile): Effectiveness in reducing risk of infection rate: 50%, Effectiveness in reducing hospitalizations: 50%, Risk of death from vaccine-related adverse events: 200 per 1 million.

Fig. 3 Changes in the probability of approving vaccine as a policymaker or choosing vaccine personally based on changes in vaccine attribute levels

also the community given the increased risks of exposure faced by them during a pandemic [40]. Supporting past research [41], we also found that Indonesian individuals who thought the COVID-19 pandemic was a hoax were less likely to choose a vaccine for themselves and others. These results were unsurprising as these individuals would also not believe in the necessity and benefits of vaccination. Indonesian individuals who lived with vulnerable people were also more likely to choose a vaccine for personal use. Participants living with individuals who are especially vulnerable to the virus would naturally want to take steps to protect their loved ones.

Our study findings should be interpreted within its limitations. First, individuals in these countries are not directly involved in making policy decisions as was required of them in our study. However, participants reported having no trouble answering the policy question during the pretest interviews. Second, since we directly asked respondents how they would make decisions as a policymaker, our findings may or may not reflect how the public would like their policymakers to make decisions. Third, in order to manage the cognitive burden on respondents, we did not include several other vaccine-related attributes such as non-fatal adverse effects, which may have influenced participants' decisions. Fourth, the sample used in our study overrepresented individuals with a university degree, which is not representative of the broader population in the countries under study. This discrepancy can be attributed to the use of a web panel for data collection. Other studies found that individuals with lower education were less likely to get vaccinated compared with those with higher education [42]. Fifth, our findings may not be generalizable to other countries, especially those with lower vaccination rates, higher vaccine hesitancy, or with different political and sociocultural systems. Sixth, the absence of long-term effectiveness data for COVID-19 vaccines during the study period led us to omit the duration of vaccine effectiveness as an attribute. Seventh, the survey did not provide detailed information about the policymaker and their role, which might have resulted in varying interpretations among survey participants. However, the instructions clearly stated that respondents, as policymakers, would be making decisions regarding the approval of free vaccine distribution throughout the country. Last, as with any survey, there is a possibility of strategic bias, where individuals may misrepresent their preferences to influence the decision-making process when answering the DCE questions. However, we have no a priori expectation regarding in which direction individuals might have misrepresented their preferences; therefore, we believe this is not a major concern for this study.

5 Conclusion

By investigating how the public differently trade-off vaccine effectiveness and safety when evaluating COVID-19 vaccines, our findings demonstrated that individuals exhibited greater aversion to serious adverse events when making decisions for others as a policymaker compared with when making the same decision in a personal capacity. This finding may stem from the fact that policymakers are confronted with a tangible number of deaths at the population level, whereas the risk may or may not materialize at the individual level, especially for small probabilities. These findings might suggest that the public would like their policymakers to carefully evaluate the safety and effectiveness of vaccines when making vaccine-related decisions. These can be important deliberations for governments to consider when enacting vaccine policies or developing media communication campaigns regarding vaccines. Policymakers and health authorities should prioritize clear and transparent communication about the safety profiles of vaccines, particularly when addressing concerns related to serious adverse events. Public health campaigns promoting vaccination should consider the nuanced risk perceptions associated with decision-making roles.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s41669-023-00442-x.

Acknowledgements The authors would like to thank Juan Marcos Gonzalez, Reed Johnson, Jui-Chen Yang, and Karen Groothuis-Oudshoorn for their suggestions on the framing of the choice questions.

Declarations

Data availability statement The data and code that support the findings of this study are available from the corresponding author upon reasonable request.

Author contributions SO: conceptualization, methodology, formal analysis, writing—original draft, writing—review and editing, supervision. SN: writing—original draft, writing—review and editing. VAH: formal analysis, writing—original draft. AM: methodology, writing—review and editing. THK: resources, funding acquisition, writing—review and editing. EAF: conceptualization, methodology, writing—review and editing.

Funding The authors acknowledge the support of the Pandemic Impact and Resilience Fund by the Musim Mas Group, through the Singapore General Hospital Health Development Fund (Grant no. FRGR01PNDM20).

Conflicts of interest Semra Ozdemir, Sean Ng, Vinh Anh Huynh, Axel Mühlbacher, Tan Hiang Khoon, and Eric Andrew Finkelstein report no conflicts of interest.

Ethics approval All activities were approved by the National University of Singapore Institutional Review Board (NUS-IRB-2021-401).

Informed consent Informed consent was obtained from all individual participants included in the study.

Consent for publication (from patients/participants) Participants were informed in the consent form that the data from this study would be analyzed as group data and will be published.

Open Access This article is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License, which permits any non-commercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by-nc/4.0/.

References

1. Attwell K, Hannah A, Leask J. COVID-19: talk of 'vaccine hesitancy'lets governments off the hook. Nature. 2022;602(7898):574–7.
2. Aw J, et al. COVID-19 vaccine hesitancy—a scoping review of literature in high-income countries. Vaccines. 2021;9(8):900.
3. Roy DN, et al. Potential factors influencing COVID-19 vaccine acceptance and hesitancy: a systematic review. PLoS ONE. 2022;17(3): e0265496.
4. Amani A, et al. A systematic review on COVID-19 vaccine preferences using discrete choice experiments. medRxiv. 2022:2022.06.12.22276299.
5. Batteux E, Ferguson E, Tunney RJ. Do our risk preferences change when we make decisions for others? A meta-analysis of self-other differences in decisions involving risk. PLoS ONE. 2019;14(5):e0216566.
6. Polman E, Wu K. Decision making for others involving risk: a review and meta-analysis. J Econ Psychol. 2020;77:102184.
7. Garcia-Retamero R, Galesic M. Doc, what would you do if you were me? On self-other discrepancies in medical decision making. J Exp Psychol Appl. 2012;18(1):38–51.
8. Ubel PA, Angott AM, Zikmund-Fisher BJ. Physicians recommend different treatments for patients than they would choose for themselves. Arch Intern Med. 2011;171(7):630–4.
9. Stone ER, Allgaier L. A social values analysis of self-other differences in decision making involving risk. Basic Appl Soc Psychol. 2008;30(2):114–29.
10. Craig BM. United States COVID-19 vaccination preferences (CVP): 2020 hindsight. Patient. 2021;14(3):309–18.
11. Achrekar GC, et al. Assessing COVID-19 booster hesitancy and its correlates: an early evidence from India. Vaccines (Basel). 2022;10(7):1048.
12. Okubo R, et al. COVID-19 vaccine hesitancy and its associated factors in Japan. Vaccines (Basel). 2021;9(6):662.
13. Khubchandani J, et al. COVID-19 morbidity and mortality in social networks: does it influence vaccine hesitancy? Int J Environ Res Public Health. 2021;18(18):9448.
14. Rane MS, et al. Determinants and trends of COVID-19 vaccine hesitancy and vaccine uptake in a national cohort of US adults: a longitudinal study. Am J Epidemiol. 2022;191(4):570–83.
15. Ripp T, Röer JP. Systematic review on the association of COVID-19-related conspiracy belief with infection-preventive behavior and vaccination willingness. BMC Psychol. 2022;10(1):66.
16. Lambooij MS, et al. Consistency between stated and revealed preferences: a discrete choice experiment and a behavioural experiment on vaccination behaviour compared. BMC Med Res Methodol. 2015;15(1):19.
17. Smith LE, Carter B. Parental preferences for a mandatory vaccination scheme in England: a discrete choice experiment. Lancet Reg Health Eur. 2022;16:100359.
18. Schwarzinger M, et al. COVID-19 vaccine hesitancy in a representative working-age population in France: a survey experiment based on vaccine characteristics. Lancet Public Health. 2021;6(4):e210–21.
19. Fung LWY, et al. COVID-19 vaccination preferences of university students and staff in Hong Kong. JAMA Netw Open. 2022;5(5): e2212681.
20. Mühlbacher AC, Sadler A, Jordan Y. Population preferences for non-pharmaceutical interventions to control the SARS-CoV-2 pandemic: trade-offs among public health, individual rights, and economics. Eur J Health Econ. 2022;23(9):1483–96.
21. Hess S, et al. The path towards herd immunity: Predicting COVID-19 vaccination uptake through results from a stated choice study across six continents. Soc Sci Med. 2022;298: 114800.
22. Ryan M, Gerard K, Amaya-Amaya M. Using discrete choice experiments to value health and health care, vol. 11. Berlin: Springer Science & Business Media; 2007.
23. Viney R, Lancsar E, Louviere J. Discrete choice experiments to measure consumer preferences for health and healthcare. Expert Rev Pharmacoecon Outcomes Res. 2002;2(4):319–26.
24. Our Word in Data. Coronavirus pandemic country profile. 2022. https://ourworldindata.org/coronavirus/country/vietnam?country=VNM~IDN. Accessed Apr 2022.
25. Johnson R, Orme B. Getting the most from CBC. Sequim: Sawtooth Software research paper series, Sawtooth Software. 2003. 2019.
26. Orme B. Sample size issues for conjoint analysis studies. Sequim: Sawtooth Software technical paper, 1998.
27. Bridges JF, et al. Conjoint analysis applications in health—a checklist: a report of the ISPOR good research practices for conjoint analysis task force. Value Health. 2011;14(4):403–13.
28. Lancsar E, Savage E. Deriving welfare measures from discrete choice experiments: inconsistency between current methods and random utility and welfare theory. Health Econ. 2004;13(9):901–7.
29. Rising D, Liang A. Singapore strategy of living with COVID raises concern, hope. Singapore: Associated Press; 2021.
30. Shammas B, et al. More states ease mask mandates, citing lower infection, hospitalization numbers. Washington, DC: Washington Post; 2022.
31. Liu Q, et al. Effectiveness and safety of SARS-CoV-2 vaccine in real-world studies: a systematic review and meta-analysis. Infect Dis Poverty. 2021;10(1):132.
32. Rosenblum HG, et al. Safety of mRNA vaccines administered during the initial 6 months of the US COVID-19 vaccination programme: an observational study of reports to the Vaccine Adverse Event Reporting System and v-safe. Lancet Infect Dis. 2022;22(6):802–12.
33. Arbyn M, et al. Prophylactic vaccination against human papillomaviruses to prevent cervical cancer and its precursors. Cochrane Database Syst Rev. 2018;5(5):CD009069.
34. Whitty JA, et al. A think aloud study comparing the validity and acceptability of discrete choice and best worst scaling methods. PLoS ONE. 2014;9(4): e90635.
35. Johnson FR, et al. Experimental design for stated-choice studies. In: Kanninen BJ, editor., et al., Valuing environmental amenities

using stated choice studies: a common sense approach to theory and practice. SpringerLink: London; 2007. p. 159–202.
36. Gonzalez JM. A guide to measuring and interpreting attribute importance. Patient-Patient-Centered Outcomes Res. 2019;12(3):287–95.
37. Johnson FR, Yang J-C, Reed SD. The internal validity of discrete choice experiment data: a testing tool for quantitative assessments. Value Health. 2019;22(2):157–60.
38. European Medicines Agency. COVID-19 Vaccine AstraZeneca: benefits still outweigh the risks despite possible link to rare blood clots with low blood platelets. 2021. https://www.ema.europa.eu/en/news/covid-19-vaccine-astrazeneca-benefits-still-outweigh-risks-despite-possible-link-rare-blood-clots. Accessed Jan 2022.
39. Reuters. Denmark, Norway and Iceland suspend AstraZeneca COVID shots after blood clot reports. 2021. https://www.reuters.com/article/us-health-coronavirus-denmark-idUSKBN2B319K. Accessed Jan 2022.
40. Milligan WR, et al. Impact of essential workers in the context of social distancing for epidemic control. PLoS ONE. 2021;16(8):e0255680.
41. Triwardani R. Indonesian officials and media fight vaccine hesitancy, misinformation. Asian Polit Policy. 2021;13(4):635–9.
42. Marzo RR, et al. Hesitancy in COVID-19 vaccine uptake and its associated factors among the general adult population: a cross-sectional study in six Southeast Asian countries. Trop Med Health. 2022;50(1):4.