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ORIGINAL ARTICLE

Parent's risk preference and childhood vaccination: evidence from Indonesia

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Abstract

A vaccines advisory group to the World Health Organization (WHO) identified complacency, inconvenience in accessing vaccines, and lack of confidence as key reasons for hesitancy. In childhood vaccination, the decision to take a vaccine relies on parents' decisions. Our study explored the relationship between parents' risk aversion and complete childhood vaccination status to identify whether demand contributes to vaccine hesitancy in Indonesia. We examined risk aversion using data from the fifth-wave Indonesian Family Life Survey (IFLS), focusing on parents with extreme risk aversion or fear of uncertainty. The logistic regression shows a negligible relationship between parents' risk aversion and childhood vaccination; nevertheless, parents who fear uncertainty tend to avoid vaccination. The results of this study encourage public health professionals and policymakers to properly design vaccine campaigns with careful consideration of the risk preference dimension of the targeted beneficiaries.

Keywords Childhood vaccination · Parent's vaccine hesitancy · Risk aversion · Fear of uncertainty · Status quo bias

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Key messages

- Our study explored the relationship between parents' risk aversion and complete childhood vaccination status using IFLS data.
- We observed a significant number of parents with fear of uncertainty that relates to status quo bias.
- We find a negligible relationship between parents' risk aversion and childhood vaccination; nevertheless, parents who fear uncertainty tend to avoid vaccination.
- The results of this study encourage a proper vaccine campaign design considering the risk preference dimension of the targeted beneficiaries.

Introduction

In 2017, diphtheria outbreaks occurred in several regions in Indonesia. The Indonesian Health Profile 2017 reported that 51.8% of cases were experienced by children aged 0–9 [1]. In 2018, health authorities found polio in the Southeast Asian Region in some countries, including Indonesia, Myanmar, the Philippines, and Malaysia. It was surprising because polio cases have not been found for over a decade, and diphtheria and polio are vaccine-preventable diseases (VPDs). These cases are from coverage issues in the national vaccination program, which calls for more investigation into vaccine hesitancy behaviour and thus motivates our study. Given the recent spread of COVID-19 and the urgent need to increase vaccine uptake, this study becomes more relevant [2].

Indonesian law (institutional Law No. 36 of 2009, particularly articles 130 and 132) obligates the government to provide free basic vaccination. Upon this law, the government have equipped all district-level health facilities to offer vaccines for all citizen, even in remote areas. Despite extensive socialisation, the 2020 Indonesian Health Profile reported that complete vaccine coverage in 2020 was 82.6%, far below the global vaccination coverage of 92.9% [3]. Indonesia has a lower coverage rate than other Asian Pacific Countries [4], with slight improvement after the decentralisation [5].

Some studies have tried to explain vaccine hesitancy and its determinants, including the prominent 3Cs model (complacency, confidence, and convenience) [6]. *Complacency* occurs when people perceive a low risk of VPDs and do not believe that vaccine is a necessary preventive action. *Confidence* is related to trust in the effectiveness and safety of vaccines. *Convenience* refers to the economic and cultural ease with which a vaccine is delivered to the recipient. Thus, the three determinants affect a person's decision to take up vaccination. Religious feelings and beliefs also play an essential role in decision-making, including vaccine uptake [7]. However, findings on the effect of religion and religiosity remain inconclusive [8, 9].

Approaching the vaccine hesitancy issue from a behavioural economics perspective, Tsutsui et al. suggest that risk aversion and time preference explain decisions on vaccination with a cost and benefits valuation framework [10]. Risk aversion affects the decision for vaccination in two conflicting ways. First, a risk-averse person chooses to have vaccination because of her fear of VPDs, but severe vaccine adverse events (VAEs) hinder her from making such a decision. An empirical study in Germany found higher risk aversion associated with a significantly higher probability of vaccinating, implying the first risk overlaps the second risk [11]. Other studies in France obtained similar results [12]. Thus, if a person is *confident* about vaccines, risk aversion would induce a person to take up vaccination (*positive correlation*).

Second, a person might perceive a vaccine as risky for health (*less confidence*). In this case, a risk-averse (RA) person will avoid vaccination. Increased perceived vaccine risk leads individuals to avoid vaccinations, especially those that can cause adverse events (such as measles and pertussis) [13]. A qualitative study investigated a group of vaccine-hesitant parents and confirmed that they perceived vaccination risks as more significant than the risks of VPDs [14]. In Indonesia, studies used qualitative in-depth interviews to identify a person's perceptions of convenience, confidence, and complacency [15, 16]. These studies were limited to a specific region and did not consider varying risk preferences among parents. Nevertheless, this aspect is essential because risk-taking parents might still decide not to vaccinate, even if they believe in the high risk of VPDs.

This study explores the relationship between parents' risk aversion (RA) and complete childhood vaccination status in Indonesia. In addition, we introduce fear of uncertainty (FoU) to investigate vaccine hesitancy further. To the best of our knowledge, there is no empirical study documenting the effect of FoU on vaccination uptake. In doing so, we utilised fifth-wave Indonesian Family Life Survey (IFLS) data, focusing on parents with extreme risk aversion or fear of uncertainty.

Data and methods

Data source

We used individual and household data from IFLS, a longitudinal survey that contains comprehensive information about Indonesian families' social, health, and economic condition. The survey was conducted by RAND in cooperation with local research institutions, covering more than 30,000 respondents spread across 13 provinces (out of 27 provinces) in Indonesia. The figures are based on the conditions during the survey. Due to development progress and provincial splits, the recent number of provinces in 2022 is 37. While it covers only half of all provinces, the sample of IFLS represents 83% of the Indonesian population due to the population

density of the selected provinces. The first wave of IFLS was in 1993, and the survey has been repeated every 5–6 years. The current study utilises the fifth wave, conducted in 2014, which uniquely included questions about risk behaviour, unlike the earlier waves.

The residential characteristics are obtained from the Indonesian Village Potential Survey (*Potensi Desa*—PODES), held every 3–4 years by Statistics Indonesia. It covers all village-level government administration areas throughout Indonesia and collects information about the availability of infrastructure and other amenities. Because PODES is not an annual survey, we infer the residential characteristics during children's birth to the closest earlier Podes survey data (Supplemental Material Part A).

Outcome variable

The outcome variable is the childhood vaccination status. While many kinds of vaccines are offered for babies and children, this study covers only the basic vaccine program, a set of vaccines mandated by regulation. The basic vaccination includes one dose of BCG, one dose of Measles, four doses of polio, three doses of DTP, and three doses of Hepatitis B. We categorised the children in the sample as fully vaccinated if they had completed all doses of the basic vaccination.

The data were extracted from two survey sources: the vaccination history listed in children's immunisation cards and the parents' self-report based on memory. The government regulates the schedule, and all children receive these vaccines when they are 12–23 months of age. Thus, we traced children's historical data before they turned 2-years old. After two years of age, children received complimentary (booster) vaccinations not included in the survey.

Independent variables

We define three types of risk preferences: (1) Risk-Averse (RA) if the expected payoff is the same; people who are risk-averse tend to prefer the choice with low risk over high risk; (2) Risk Tolerance (RT) is the reverse, where people prefer the option with high risk over low risk; and (3) Fear of Uncertainty (FoU) for people who avoid any uncertainties.

The survey elicited RA and RT by asking subjects to answer sets of questions (in sets A and B). Each set consisted of five hypothetical questions involving risks: two questions to check whether the subject understood the game and three questions for real elicitation. In each question, the instrument directed subjects to choose between an option with a fixed amount of reward or a probability-based alternative with two different outcomes with equal probability (Supplemental Material Part B).

To capture the risk preference more sensitively, we referred to a conventional approach [17] and made a few adjustments to calculate the RA and RT levels. We assigned one score to subjects for each risky option chosen; thus, the maximum score for each set is 3 (we only have three real elicitations). We obtained the value of RA and RT by summing the scores of the two sets of games. We constructed the risk

preference variable by assigning the subject as a RA if she obtains a score less than 3; otherwise, RT.

Many respondents chose a fixed amount over the probability-based alternative in the first question, even though it assured them at least as large as a certain amount. Most respondents also maintained such a choice on the follow-up question. Such a risk attitude is not uncommon, as found in a study in Mexico, although the prevalence was lower [18]. It happens because individual values the probability-based alternative below its worst possible outcome, commonly called the "uncertainty effect" [19]. We marked subjects expressing such an attitude as the FoU because they avoided choosing uncertainty.

Based on 3C models, the significant and positive correlation between RA and the completion of children's vaccination suggests vaccine confidence. In contrast, the significant and negative correlation between FoU and the completion of children's vaccination suggests parents' complacency.

Confounding variables

Because our observation unit is at the individual level, we included several characteristics of parents, children, family composition, and residential estate as confounding variables. The parents' characteristics were time preference (Supplemental Material Part C), age, year of schooling, and self-reported religiosity. A parent is considered religious if he/she reported that she/he practised a religious activity concerning her/his religion in the last week during the survey [20–24]. The child characteristics were gender and birth order [25], and family characteristics were the number of children, per capita income, and the mother's working status [23]. We also included residential characteristics, such as the number of a district's medical facilities, an indicator for urban or rural residential areas, and an indicator for western or eastern regions [23–25] (Supplemental Material Part D).

Statistical analysis

The fifth-wave of IFLS data have a total of 15,344 households. We limit our sample using the following criteria: (1) kids are between the age of 1–15 years old during the survey, (2) both parents are alive and taking care of their children, and (3) parents have historical data of vaccine uptake or able to remember their kid's vaccination status. We excluded 10,471 households and kept 4,863 households that fit our criteria.

We applied the logistic regression to examine the relationship between the dependent variable indicating whether the children had completed doses of the five-basic vaccination and self-reported parental behaviours (RA, RT, and FoU) without sampling weights. The logistic regression is as follows.

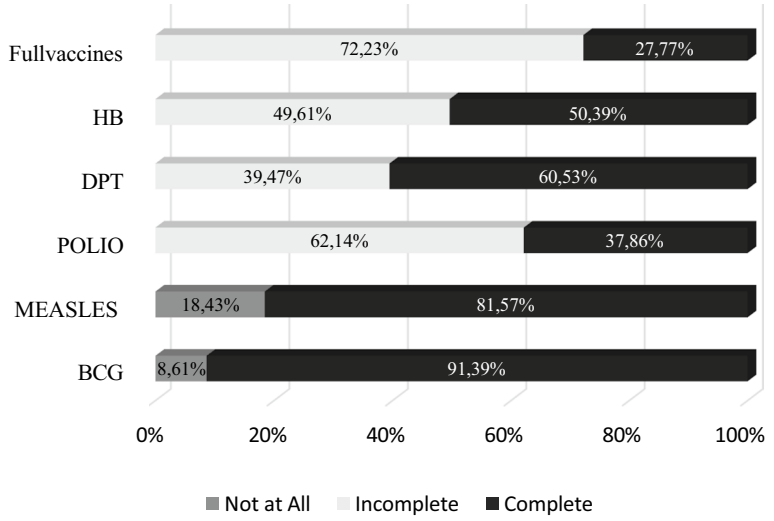

Fig. 1 Vaccine completion among children in Indonesian families

$$Log\frac{P}{1-P} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + \varepsilon_i$$

The variables X were a collection of explanatory variables and confounding factors. We reported the results as odds ratios with 95% CI and at a 5% significance level. Supplemental Material Part E provide information on complete regression using statistical software STATA 64.

Results and discussion

Descriptive statistics

The total number of children we observed was 6773 from 4863 two-parent families living in 1090 districts in Indonesia (about 14% of all districts). All children had at least one of the five-basic vaccines (as stated in the Data and Methods section). However, as presented in Fig. 1, only approximately 28% of children completed basic vaccination. The completion of each type of vaccine varied. Vaccines with only one dose have a higher completion rate, such as BCG and measles, with 82% and 91% coverage, respectively. BCG is most likely higher performance because parents perceived tuberculosis as a common severe disease. Among the multiple shot vaccines, polio has the best performance with 62% coverage, while DPT has the least.

Complete vaccination means that children get full doses of all basic vaccines (one dose of BCG, one dose of Measles, four doses of polio, three doses of DTP, and three doses of Hepatitis B.)

Table 1 Descriptive statistics for risk preference and basic vaccines completion

Parents' risk preference/ child vaccine status	Fear of uncertainty (FoU)		Risk-averse (RA)		Risk tolerant (RT)		Total (*N*)
	(*n*)	(%)	(*n*)	(%)	(*n*)	(%)	
Mother	**2140**	**31.60**	**2554**	**37.71**	**2079**	**30.70**	**6773**
Incomplete*	1584	74.02	1712	67.03	1483	69.17	**4734**
Complete	556	25.98	842	32.97	641	30.83	**2039**
Father	**1766**	**26.07**	**2296**	**33.90**	**2711**	**40.03**	**6773**
Incomplete*	1298	73.50	1570	68.38	1866	68.83	**4734**
Complete	468	26.50	726	31.62	845	31.17	**2039**

*We include no-take-up for the one-dose-vaccines (BCG, Measles) in this category

Table 1 presents the statistics descriptive of risk preference for three types of risk preferences: Risk-Averse (RA) if the expected payoff is the same; people who are risk-averse tend to prefer the choice with low risk over high risk. Risk tolerance (RT) is the reverse, where people prefer the option with high risk over low risk. Fear of Uncertainty (FoU) for people who avoid any uncertainties. There was no stark difference between the proportions of mothers exhibiting FoU, RA, and RT behaviours; however, a higher gap was observed (73.50%) for fathers who fear uncertainty, while RA and RT only around 68%; and 40% of children had fathers who are RT.

Table 1 also shows the tabulation of vaccination status for each type of risk preference. Only one-fourth of the children completed their vaccinations. Although they get a dose of the vaccine, they do not finish the series until they complete all doses. There was no stark difference between FoU, RA, and RT parents for the completeness of vaccination.

Logistic regression

Table 2 presents the logistic regression model results that allowed us to delve into the relationship between risk preference and the decision to complete vaccination after controlling for some variables. Here the dependent variables are whether children had completed the vaccination series. The independent variables include parents' risk preferences, child characteristics, household characteristics, and residential characteristics.

The result shows that the RA from both parents does not significantly correlate with vaccination completeness. While their relationship is positive, our study can only suggest that parents' confidence in vaccines seems sufficiently weak to contribute to children's vaccination status.

Table 2 The results of the logistic regression models indicate the likelihood of a child's completion of mandatory vaccines

Variables	Odd ratio	Std. Err	[95% conf. interval]	
Mother's risk aversion	1.064	0.0690802	0.937	1.209
Father's risk aversion	1.016	0.0633263	0.899	1.148
Mother's fear of uncertainty	0.834**	0.0587608	0.727	0.958
Father's fear of uncertainty	0.882	0.062103	0.769	1.013
Mother's time preference	1.120	0.0916889	0.954	1.315
Father time preference	0.974	0.080667	0.828	1.145
Mother's age	1.017**	0.0548593	0.915	1.130
Father's age	0.963**	0.0438906	0.881	1.053
Mother's years of schooling	0.852**	0.0351925	0.786	0.924
Father's years of schooling	0.982	0.0514311	0.886	1.088
Child's Gender	1.020	0.0073152	1.006	1.035
Birth order	1.013	0.0063692	1.001	1.025
Number of children	1.044**	0.0099955	1.025	1.064
Per capita income	1.001	0.0089762	0.983	1.019
A working mother	0.904	0.0503971	0.810	1.008
Number of a district's medical facility	1.002**	0.0003584	1.001	1.003
Residential area	0.990	0.0596684	0.880	1.114
Residential region	0.818**	0.0608715	0.708	0.947
Mother's religiosity	1.029	0.0702409	0.900	1.176
Father's religiosity	1.082	0.0680158	0.956	1.224
Constant	0.154**	0.1187129	0.035	0.695
Observations	**6773**			

**$p < 0.05$

Discussion

We observe that a significant portion of the survey participants exhibits FoU, people who preferred a fixed amount over a probability-based alternative even though the worst possible payoff is at least as large as a fixed amount. There are three explanations for this behaviour: gambling averse, extreme risk aversion, and cognitive barrier/risk incomprehension [26, 27]. Whatever the interpretations of such behaviour, the consequences are the same: they prefer to status quo. Fear of the unknown [28], or as we abbreviate it, FoU, relates to status quo bias. In the vaccination context, the status quo, like *complacency*, induces parents not to take up vaccination.

We found a negative association between parents' fear of uncertainty and completing the full series of mandated vaccines, although the statistical significance is only in mothers. If these parents are unfamiliar with vaccines, they likely think they will add uncertainty to their children's health. They tend to avoid any choice that comes with uncertainty and thus prefer the familiar status quo—avoidance of

vaccination. In general, our results suggest complacency contributes more than confidence to parents' vaccine hesitancy.

Aside from the main variable of interest, it is essential to note district's medical facilities correlate positively with vaccine completion. Households who live in western regions, which are more affluent than eastern regions, are also positively correlated. This highlight the importance of access to medical facilities. An additional notable finding is that children from larger households seem more likely to have completed vaccination.

Religious parents seem not to correlate with the children's vaccination status. This result conflicts with the previous study by E. Lahav, S. Shahrabani, et al. [29] but is similar to results in other studies in Indonesia [7, 30]. The latter studies indicate the importance of vaccine inconveniences in childhood vaccination, especially in the eastern region.

Our study's implications align with those of other studies that providing information regarding the vaccine's risk may not be enough to persuade parents to make decisions to vaccinate their children [14, 31]. Parents may be risk-averse and fear uncertainty, so the vaccination campaign should consider this. A previous study in the United States (US) and Japan [10, 32] found that RA increases the willingness to take up the vaccine, meaning that people are confident with vaccination.

Study limitations

The major limitation of our study is that a significant amount of data on children'svaccination is based on parents' memory. Parents' recall bias reduces the study'saccuracy. Another limitation is that elicitation of parent's risk preference survey wasconducted in 2014, while the children's vaccination takes up might happen before orafter the survey. It could be that vaccination affect parents' risk preference; thus, riskpreferences are not entirely exogenous or simply that risk preferences could changeover time. Finally, the IFLS elicit parents' risk preference based on the hypotheticallottery that parents might not respond truthfully.

Conclusion

Our study found a negligible correlation between parents' risk aversion and deciding to take up children's vaccines. At the same time, there is a strong negative correlation between mothers' fears of uncertainty and children's vaccination. It suggests that complacency contributes more than confidence. With this regard, a vaccine campaign should be properly designed with careful consideration of the risk preference dimension of the targeted beneficiaries. Given that FoU explains the behaviour of maintaining the status quo, public health professionals and policymakers should give more attention to familiarising vaccines at an early age. Hence, people consider vaccination a social norm, even before becoming parents. Socialisation in high school and university can be an excellent start to normalise basic vaccination programs. Furthermore, although most parents decide to have their children take at least

one mandated dose of vaccine, a considerable number fail to complete all doses. Thus, Indonesia needs to improve vaccination comfort in time and place to increase many parents' commitments to cover all the compulsory vaccines.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1057/s41271-022-00375-5.

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