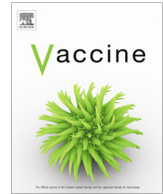




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The connection between COVID-19 vaccine abundance, vaccination coverage, and public trust in government across the globe

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ABSTRACT

This study investigates that how the number of COVID-19 vaccines secured correlates with the vaccination coverage (full and booster) depending on whether or not there is trust in national government across 47 countries. The data are based on global figures as of Nov. 2021 and Feb. 2022 while measures for confidence in government is according to Gallup World Poll, Oct. 2021. The model includes an interaction term of these two predictors, also controls for a range of socio-economic factors and country specific variables. The results indicate a non-linear and mixed relationship between the numbers secured, the public trust, and the vaccination rate. In Feb. 2022, with confidence in government, securing number of vaccines to cover 200% of the population (or more) increased the full vaccination rate by 12.26% (95% CI: 11.70–12.81); where number secured was 300% (or more), the coverage increased by 7.46% (95% CI: 6.95–7.97). Under similar scenarios, rate of booster shots increased by 13.16% (95% CI: 12.62–13.70; $p < 0.01$) and 14.36% (95% CI: 13.86–14.85; $p < 0.01$), respectively. Where the number secured fell below 200%, confidence in government had a revers relationship with the rate of full vaccination (–2.65; 95% CI: –3.32 to –1.99), yet positive with the rate of booster shots (1.65; 95% CI: 1.18–2.12). These results indicate that better success can be achieved by a combination of factors including securing sufficient number of vaccines as well as improving the public trust. Vaccine abundance, however, cannot be translated into greater success in vaccination coverage. This study highlights the importance of efficiency in acquiring vaccine resources and need for improvement in public belief in immunization programmes rather than stock piling.

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1. Introduction

The rapid development of COVID-19 vaccine and its rollout have set an unprecedented record. Since the approval of the Pfizer/BioNTech vaccine by the World Health Organisation (WHO) in December 2020, approximately 11.3 billion doses of vaccines have been administered within 28 months [1]. However, there has been a staggering imbalance in getting access to the vaccine supplies across the world. Some countries, often with higher income, placed early orders of vaccines in volumes that were multiple times the number of their population [2]. Meanwhile, some other countries, often low-income, are yet to vaccinate their medical staff and vulnerable groups, even with a single dose [3]. It is understandable that policymakers prioritize their own nation at the time of crisis. However, the question remains that whether securing abundant

resources can necessarily be translated into a better vaccination coverage when social factors, and in particular, public's confidence in national government is considered.

Confidence in government (CiG) has been commonly reported to be a predictor of public willingness to be vaccinated [4–7]. Despite heterogeneity across countries in terms of cultural norms and setting, CiG was found to be important in studies of high-income (HICs) and also low- and middle-income countries (LMICs) [8–11].

Potential harms from the under and overuse of medical resources have been noted long before the recent pandemic [12]. In relation to the COVID-19 vaccines, there is growing evidence of unused and hard to redistribute stock piles in HICs where the demand has dropped [13,14]. This process is a waste of not only life-saving medical resources but also healthcare funds – both of which could perhaps be placed in better use elsewhere.

The present study investigates to what extent the combination of number of vaccine doses secured at the procurement stage and

Abbreviations: CiG, Confidence in government; GDP, Gross domestic product; HICs, High-income countries; LMICs, Low- and middle-income countries.

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CiG at the recipient end might influence the rate of full vaccination and booster coverage across the globe.

2. Method

In this study, the figures for CiG are obtained from the Gallup World Poll, October 2021 and the question WP139: “Do you have confidence in the national government?” with four response options of “Yes”, “No”, “Don’t know”, and “Refused” [15]. These are transformed to build a binary dummy variable with “Yes” coded as 1, “No” and “Don’t know” as 0 and “Refused” as missing. Although this question was not specifically asked in relation to COVID-19 vaccines, it provides an indicator for the level of public trust in national government and, subsequently, its actions and policies. The data on the number of vaccines secured adjusted for country population in percentage is based on figures provided by the International Monetary Fund (IMF) [16] and vaccine coverage figures (full vaccination per 100 people and booster rates) are based on the data reported by Our World in Data [1]. For the present study, the main focus is placed on two snapshots of these data as of November 2021 and February 2022 (the last day of the month when the data was available). These dates were chosen as November was the closest date to the Gallup poll data, considering any potential lags in vaccine uptake, and February 2022 by when, in many countries, both full vaccination and booster jab programmes were well in place. Fig. 1 illustrates the number of vaccines secured and the ratio of the population that have been fully vaccinated as of February 2022. In this figure, those countries where CiG is lower than 50% are shown in triangles and those above 50% are shown in dots (please see Fig. A1 in Appendix A that depicts a picture of a larger number of countries for which the Gallup data was not available).

For the numbers secured, two set of thresholds are noticeable; a 200% threshold that could suffice full vaccination of the population (assuming the two-dose requirement), and a 300% threshold that exceeds the full vaccination needs, yet could secure the numbers required for providing booster shots¹. Several European countries had the same number of vaccines secured as they acted as a united entity. In order to identify the efficacy of the number of vaccines secured, these two thresholds are used and defined as dummy variables below which countries are coded as 0 and above as 1. This approach allows to investigate that whether securing more vaccine supplies improves the rate of vaccination coverage when CiG is also considered.

Eq. (1) presents the study model that is a multiple regression including an interaction term of number secured and CiG [17]:

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_1 \cdot X_2 + \beta_i X_i + \varepsilon_i \quad (1)$$

where Y_i : % of population fully vaccinated per 100 people / received booster shots; β_1 : coefficient for having CiG when the number of vaccines secured is below the respective dummy threshold; β_2 : coefficient for the number of vaccines secured when there is no confidence in the national government (CiG = 0); β_3 : the interaction term between CiG and the dummies for number of vaccines secured; β_i : coefficients for the covariates included in the model (gender, age, employment, per capital person income quantile, marital status, health status, access to internet, being born in the country, education level, living in urban / rural areas, country population density, GDP per capita); ε_i : error term.

Here, robust standard errors are used to address potential heteroskedasticity and throughout the analyses, the sample weights are applied. Stata 16.1 is used for the analysis.

3. Results

The final dataset covers 47 countries with $N = 47,656$ observations. Descriptive figures for pooled data are presented in Table 1 and other key variables for each country are presented in Appendix A, Table A1. These variables are used as covariates in the main analyses.

Table 2 presents the outcome of running Eq. (1) for November 2021, comparing the results for when the number of vaccines secured is not included (column 2) with when thresholds of 200% (column 3) and 300% are included (column 4). Column 1 illustrates the difference that ex/inclusion of country GDP per capita makes before incorporating the interaction term (the complete list of covariates coefficients is presented in Appendix A, Tables A2).

Without including GDP and the number of vaccines secured into the model, the rate of population fully vaccinated per hundred has a positive and significant correlation with CiG. However, when countries GDP per capita is controlled for, this association becomes reverse. For CiG = 0, the rate of vaccinated increases by 12.33% (95% CI: 11.80–12.86; $p < 0.01$) when the numbers secured are sufficient for 200% of the population (or more). Yet, this rate increases only by 6.84% (95% CI: 6.42–7.26; $p < 0.01$) when the number secured is 300% (or more). When CiG = 1, securing the number by 200% increases the rate of coverage by 15.69% (95% CI: 15.16–16.21; $p < 0.01$); while with securing 300% and more, the coverage increases by 11.34% (95% CI: 10.89–11.79; $p < 0.01$). On the other hand, when the number secured is below 200%, having CiG has a reverse relationship with vaccine coverage, ceteris paribus. In the case that the number of vaccines secured is above 200%, having CiG increases the coverage by 0.66% (95% CI: 0.34–0.99; $p < 0.01$); whereas by 300% and more, CiG = 1 increase the coverage by 0.89% (95% CI: 0.053–1.26; $p < 0.01$).

Table 3 presents the results of running the same model for February 2022 for the rate of full vaccination and also the booster shots per hundred people (for the complete table please see Appendix A, Tables A3 and A4).

In terms of the full vaccination rate, the direction and scale of coefficients are rather similar to those for November 2021 (columns 1–4 in Tables 2 and 3). For the rate of booster shots, amongst countries that are included in the present study, Iceland had the highest rate as of February 2022 with 67.23%, and the lowest was in Ghana with 0.32% (the chart that depicts the rate of boosters per hundred people and the number of vaccines secured is presented in Appendix A, Fig. A2). Dissimilar to figures for full vaccination rates, the relationship between the rate of boosters and CiG remains positive and significant even when countries’ GDP per capita is controlled for. In the absence of CiG, securing the number of vaccines by 200% (or more), increases the booster rate by 13.37% (95% CI: 12.86–13.89; $p < 0.01$); as the number secured reaches 300% (or more), this rate increases by 16.16% (95% CI: 15.69–16.63; $p < 0.01$). When the number secured is below 200%, having CiG increases the booster rate by 1.65% (95% CI: 1.18–2.12; $p < 0.01$). When CiG = 1, securing the vaccines by 200% increases the rate of boosters by 13.16% (95% CI: 12.62–13.70; $p < 0.01$). Changing this threshold to 300% correlates with a 14.36% (95% CI: 13.86–14.85; $p < 0.01$) increase in the rate of booster shots. Fig. 2 illustrates the margin plots for various scenarios of the interaction term and its relationship with the outcomes (full vaccination and booster rates) as of February 2022.

As it can be seen, the interaction term of CiG and securing vaccines by 200% (or more) for booster shots is not significant (also see Table 3, column 7). Running a linear regression without an interaction term indicates the rate of boosters would increase by 13.27% (95% CI: 12.83–13.71; $p < 0.01$) if the number of vaccines secured

¹ A typical type of vaccine assumed.

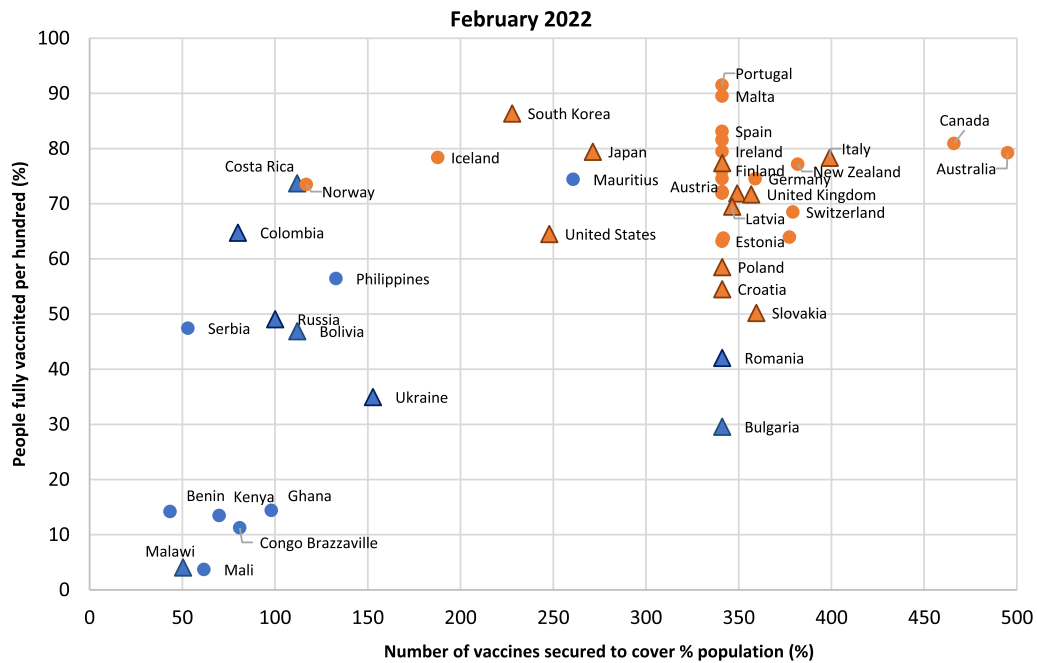


Fig. 1. The number of vaccines secured and the ratio of population that were fully vaccinated as of February 2022. Countries coloured in blue indicate LMICs and orange indicate HICs. Triangles are countries where below 50% of the poll surveys said they have CiG and dots are those where more than 50% said they have CiG. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Table 1
Characteristics of respondents across all 47 countries N = 47,656 (weighted).

Characteristic		(%/Mean (Sd.))
Gender	Male	48.44
Age		44.87 (18.78)
Employed (any type of employment)	Yes	60.26
Per capita income quintiles	Poorest 20%	19.9
	Second 20%	20.02
	Middle 20%	19.99
	Fourth 20%	19.99
	Richest 20%	20.09
Married/Domestic partner	Yes	53.8
Health problems	Yes	24.34
Access to internet	Yes	83.74
Born in the country	Yes	90.69
Education level	Completed elementary education or less.	21.84
	Secondary, 3-year tertiary secondary education and some education beyond secondary education.	58.1
	Completed four years of education beyond high school and/or received a 4 - year college degree.	20.06
Living in rural/urban area	A rural area or on a farm	17.19
	A small town or village	39.08
	A large city	28.82
	A suburb of a large city	14.9

is 200% (or more) and by 15.32% (95% CI: 14.93–15.71; $p < 0.01$) if the number secured is 300% (or more).

For robustness checks, I re-ran the analyses excluding Canada and Australia that were almost outliers with securing the numbers of vaccines sufficing to cover 466% and 495% of their population in February 2022, respectively, and it returned similar results (please see Appendix A, Table A5)². It is also valid to argue for the role of workforce resources. For this, I tested the model by including the number of nurses per 10,000 people. This did not change the results substantially (Appendix A, Table A5). However, the number of nurses

had a strong correlation with GDP per capita ($r = 0.87$; $p < 0.01$) and its inclusion could be an overfitting of the model, hence, it remained excluded. Further checks of variance inflation factor did not indicate any multicollinearity.

4. Discussion

Following the growing evidence that indicates the importance of CiG in vaccination uptake, the present study investigates how the interaction between this predictor and the number of vaccines secured correlates with the rate of full vaccination and also the booster shots across 47 countries.

The results indicate that the association between number of vaccines secured and rate of full vaccination varies for different scenarios depending on the presence or absence of CiG. Where

² I also replaced CiG with the Gallup National Institutions Index that indicates public confidence in an array of official organisations including the military, the judicial system, the national government and the honesty of elections that returned comparable results.

Table 2

The coefficients of association between the rate of people fully vaccinated per hundred in Nov. 2021 and the interaction between CiG and number of vaccines secured for population by thresholds of 200% and 300%.

	Number secured and GDP excluded (1)	Number secured excluded (2)	Secured 200% or more (3)	Secured 300% or more (4)
CiG = 1	1.89*** (1.43–2.35)	–1.70*** (–2.01 – –1.39)	–2.69*** (–3.26 – –2.12)	–3.61*** (–4.08 – –3.14)
Secured 200% or more = 1			12.33*** (11.80–12.86)	
CiG # Secured 200% or more			3.36*** (2.71–4.01)	
Secured 300% or more = 1				6.84*** (6.42–7.26)
CiG # Secured 300% or more				4.50*** (3.91–5.10)
Constant	16.02*** (14.54–17.50)	8.99*** (7.97–10.01)	11.44*** (10.44–12.43)	10.93*** (9.94–11.92)
Observations	46,819	46,819	46,819	46,819
R-squared	0.35	0.70	0.74	0.73

Robust 95% CI in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

there is no CiG, securing numbers of vaccines by 200% (or more) has a strong correlation with full vaccination rate, yet, when this number reaches 300% (or more), it has a smaller impact. Where there is CiG, the rate of full vaccination increases further by 3.36% (95% CI: 2.71–4.01) and 4.5%. (95% CI: 3.91–5.10), when the numbers secured are 200% and 300%, respectively.

On the contrary, when the number of vaccines secured falls below 200%, CiG has a reverse relationship with the full vaccination rate. This reverse relationship became apparent in the first instance when GDP per capita was controlled for. This could be due to the point that the public in several HICs with relatively high vaccination rates expressed low levels of confidence in their national government at the time of the polling (e.g. only 38.48% of the respondents in the US and 35.84% in Spain said that they have confidence in government while this was 74.9% in Benin where the vaccination rate was terribly low). When the number of vaccines secured is above 200%, having CiG only increases the vaccination rate to a small degree; whereby it is not substantially higher when the number secured reaches 300% (or more). The directions of these relationships are similar in November 2021 and February 2022, with slightly smaller coefficients for the latter.

High inoculation rates despite low CiG in some LMICs, e.g. Costa Rica and Colombia, can perhaps be explained by the effectiveness of their vaccination campaigns and receiving vaccine supplies earlier than many other countries [18,19]. Moreover, primary evidence suggests that the potential for the acceptance of COVID-19 vaccines in these countries was particularly high and probably had roots in their longstanding belief in immunisation programmes [20,21] that could go beyond the public's confidence in present government. Presence or absence of an imbedded belief in immunisation programmes has also been reported as a contributor in the success of vaccination campaign in Portugal [22] and its relative failure in the US [23,24].

In relation to booster shots, the interaction term did not seem to be significant and higher rates of coverage were strongly correlated with the numbers secured reaching 200% or more, yet securing number by 300% or more increased this coefficient by a small amount. Here, CiG had a positive correlation with the rate of booster shots but was much smaller when compared to the effect from the numbers secured.

Undoubtedly, CiG plays a critical role in increasing the public's acceptance of vaccines [25]. The present study, however, indicates that this association is not linear and that CiG, in conjunction with other factors such as the number of vaccines secured, can produce better outcomes.

At the early stages of the pandemic, it was understandable that many countries hedged on various possibilities to secure their access to the supplies of approved vaccines [26]. It seems, however, that this competition has not slowed down. By March 2022, for example, Australia and Switzerland secured the number of vaccines sufficient to cover 990% and 837% of their populations, respectively, while only 45% and 42% of the population in these countries had booster shots. This stands in contrast with Chile, which secured approximately half of this number (438%), but 83% of its population received booster shots. The available evidence in terms of CiG in Chile, however, indicates a downward trend in this region in recent years [27]. Similar to other examples, the success of vaccine coverage in this country has been linked to the development of a robust immunisation system after experiencing the H1N1 flu pandemic in 2009. It should be noted though that during the present pandemic, despite high rates of vaccinations, the country suffered from high rates of casualties due to the emergence of new variants [28].

This study does not propose an optimum number of vaccines needed to have a successful vaccination campaign, however, it illustrates that securing large number of doses does not necessarily mean better coverage. In line with calls for an equitable global distribution of resources and action plans [29], the present study may help to turn the focus from merely acquiring more supplies to resource optimization and further investment in public trust. Indeed, oversupply might lead to the availability of vaccines being taken for granted and, perhaps, shunned. It is essential to increase the public awareness towards the importance of immunisation programmes and the critical role of the individual's active participation which when unwavering could help with increasing the vaccination uptake, on top of the acquisition of sufficient resources to meet the population needs.

5. Study limitations

The present study is based on two snapshots of a dynamic process. Yet, these snapshots were taken at the points when in many countries, particularly in HICs, vaccination campaigns had already been established for some time. Additionally, the dataset included more evidence from HICs than LMICs. As the aim here is to investigate the interaction between trust and securing high number of vaccine doses, the latter variable had more relevance to the situation in HICs. Also, CiG is based on a single item question that might not be as comprehensive as a composite multi-item score. Nonetheless, it provides an efficient cross-country indicator for

Table 3

The coefficient of association between the rate of people fully vaccinated / received booster shots per hundred in Feb. 2022 and the interaction between CiG and number of vaccines secured for population by thresholds of 200% and 300%.

	Full vaccination				Booster shots			
	Number secured and GDP excluded (1)	Number secured excluded (2)	Secured 200% or more (3)	Secured 300% or more (4)	Number secured and GDP excluded (5)	Number secured excluded (6)	Secured 200% or more (7)	Secured 300% or more (8)
CiG = 1	1.94*** (1.50–2.38)	–1.21*** (–1.53 – –0.89)	–2.65*** (–3.32 – –1.99)	–2.63*** (–3.19 – –2.06)	4.10*** (3.64–4.55)	0.44*** (0.12–0.77)	1.65*** (1.18–2.12)	2.11*** (1.63–2.58)
Secured 200% or more = 1			8.71*** (8.13–9.29)				13.37*** (12.86–13.89)	
CiG # Secured 200% or more			3.55*** (2.81–4.29)				–0.22 (–0.80–0.37)	
Secured 300% or more = 1				4.51*** (4.04–4.99)				16.16*** (15.69–16.63)
CiG # Secured 300% or more				2.95*** (2.28–3.62)				–1.80*** (–2.37 – –1.23)
Constant	24.26*** (22.81–25.71)	18.09*** (17.00–19.18)	20.29*** (19.18–21.40)	19.25*** (18.14–20.36)	13.65*** (12.12–15.19)	1.24** (0.19–2.28)	2.27*** (1.29–3.25)	1.34*** (0.44–2.24)
Observations	46,819	46,819	46,819	46,819	40,973	40,973	40,973	40,973
R-squared	0.35	0.65	0.67	0.66	0.17	0.59	0.65	0.70

Robust 95% CI in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1.

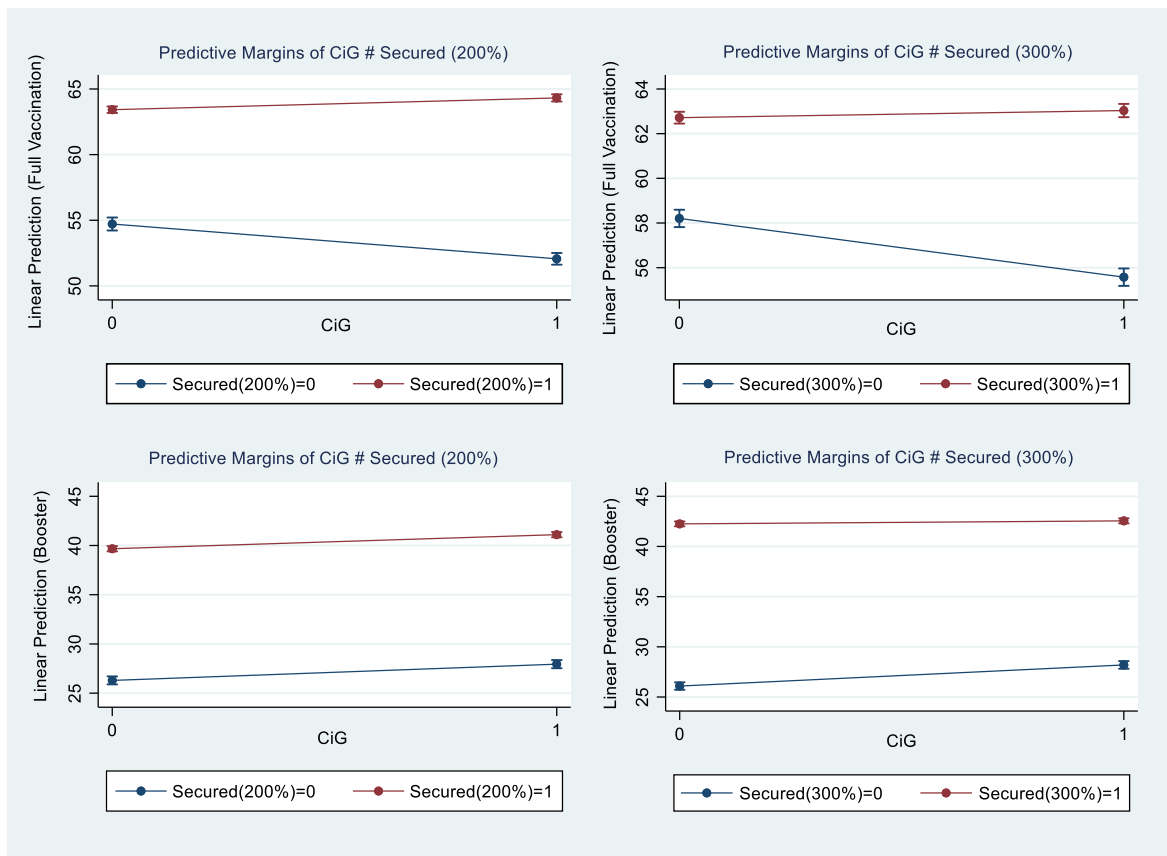


Fig. 2. Interaction plot between CiG and number of vaccines secured for full vaccination/booster rate per hundred in Feb. 2022.

the degree to which public have confidence in their government at the time of the survey. It also should be noted that vaccination coverage depends on a wide range of regional factors, such as infrastructure and healthcare service delivery, that calls for future studies.

6. Conclusion

This study finds a fine balance between the number of vaccine doses secured at the procurement point and the rate of uptake at the recipient end, combined with the public’s level of confidence in the national government. The results indicate that although securing sufficient resource matters, ordering more doses does not necessarily mean better vaccination coverage and efforts should be made to increase the public’s confidence in government and in particular, their belief in immunisation programmes in general.

7. Ethics committee approval

Not applicable.

8. Patient and public involvement

Not applicable.

Declaration of Competing Interest

The author declares that she has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.vaccine.2022.09.011>.

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