VACCINATION AND HOUSEHOLD TRANSMISSION OF COVID-19 IN BALI, INDONESIA

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ABSTRACT

Background: Although vaccination effectively prevents severe outcomes due to COVID-19, its role in preventing household transmission remains unclear. This study aimed to investigate the association between vaccination and household transmission of COVID-19 in Bali, Indonesia.
Subjects and Method: A cross-sectional study was conducted in Bali, Indonesia, in September 2021 as part of the vaccine evaluation program. Total of 1,000 individuals with COVID-19 who resided in high (Denpasar city) and low transmission areas (Karangasem, Gianyar, and Klungkung) for COVID-19 were randomly chosen from the COVID-19 notifications for the period of January to June 2021. The interview was carried out to collect demographic characteristics, vaccination status, index cases, number of household contacts, and number of secondary cases. The secondary attack rate in the household was calculated. Logistic regression was performed to examine the association between COVID-19 transmission rate and vaccination status.
Results: Total of 121 (12.1%) index cases were identified among 1000 selected individuals. The secondary attack rate was slightly higher in high transmission areas (1.82) compared to low transmission areas (1.33). While it is not statistically significant, compared to unvaccinated individuals, the probability of being index cases among those who had been vaccinated were lower both in high transmission area (OR= 0.86; 95% CI=0.52 to 1.43; p= 0.562) and low transmission area (OR= 0.79; 95% CI= 0.40 to 1.57; p= 0.497), respectively. Furthermore, index cases with COVID-19 vaccination in high incidence areas are more likely to be low transmitting COVID19 state (OR=0.65; 95% CI=0.25 to 1.69; p=0.373). While in the Low Incidence Area, index cases with COVID-19 vaccination are more likely to be high transmitting COVID19 state (OR= 3.06; 95% CI=0.75 to 12.56; p= 0.125).
Conclusion: Vaccination may reduce the risk of SARS-CoV-2 transmission within the household.

Keywords: vaccination, COVID-19, the index case, household transmission

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BACKGROUND

The World Health Organization (WHO) has declared COVID-19 as a pandemic since March 2020 (WHO, 2020). As of October 9, 2021, confirmed cases of COVID-19 have reached more than 236 million cases, with 4.8 million deaths worldwide (WHO, 2021). On March 2, 2020, the first positive case of COVID-19 was reported in West Java, Indonesia. Through the

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Decree of the Minister of Health, the Government of Indonesia states that Novel Coronavirus (2019 n-CoV) infection is a disease that can cause outbreaks (Ministry of Health of the Republic of Indonesia, 2020a).

Indonesian data as of 9 October 2021 recorded 4.2 million confirmed cases of COVID-19 and 142,000 deaths. COVID-19 has spread to all provinces in Indonesia (Covid-19 Handling Task Force, 2021).

To establish community immunity (herd immunity) against COVID-19, the government has made a national vaccination regulation through a Minister of Health Regulation since December 2020 (Ministry of Health of the Republic of Indonesia, 2020b). And on January 13, 2021, the vaccination program will begin. Vaccination is believed to be the best and most efficient way to control disease (Remy et al., 2014). The national vaccination program targets health workers, the elderly, public officials, and the general public.

The SARS-CoV-2 virus is highly contagious, with an estimated basic reproductive number (R0) of 2.2 to 2.5 initially discovered in Wuhan (Majumder and Mandl 2020). Variants of concern (VOC) that emerged after the Wuhan strain were known to be easier and faster to transmit (Davies et al., 2021). One of them is the delta variant. This variant is highly contagious, with an estimated transmission rate of 2x that of the previous variant (CDC, 2021a, b).

An environment in a narrow space, such as at home, supports the transmission of COVID-19. The secondary attack rate of SARS-CoV-2 in households is estimated to be higher than that of SARS-CoV and MERS-CoV (Fung et al., 2021). Transmission may occur during self-isolation at home even though household members have been vaccinated. Information regarding the transmission rate of the SARS-CoV-2 virus in post-vaccination households is not widely known, especially in Indonesia.

This study aims to determine the relationship between vaccination status and the incidence of COVID-19 and the relationship between vaccination status and household transmission rates in high and low incidence areas, especially in Bali.

SUBJECTS AND METHOD

1. Study Design

This study used a cross-sectional study design with primary data collection methods for the community. Data collection was carried out in Bali Province in September 2021.

2. Population and Sample

The population is all positive COVID-19 respondents in Bali. The source population is the COVID-19 PCR confirmation case respondent from January to June 2021 obtained from the integrated COVID-19 recording system managed by the Bali Provincial Health Office as of 30 June 2021 (N=56,000). Based on the population data above, selected cases (n= 1000 cases) originating from areas with the highest incidence rate (per 100,000 population), namely: Denpasar City 2,945 per 100,000 population (n= 500 cases) and the lowest, namely: the agglomeration areas of Karangasem, Gianyar, and Klungkung with an average incidence of 1,240 per

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100,000 population) (n=500 cases). Sampling was carried out at simple randomness until it reached the set quota.

3. Study Variables

The dependent variable is the transmission of COVID-19 transmission in the household. The independent variable was vaccination status.

4. Operational Definition of Variables

Determination of Index Cases and Secondary Cases

Interviews were conducted to obtain information on individual characteristics; date confirmed positive for COVID-19, date of vaccination, number of household members in the household, number of households positive for COVID-19, and vaccination status. ART is determined according to the Central Bureau of Statistics definition. Namely, people are still present and have lived in the house for at least six months.

The index case was determined based on the most minor or earliest case in each household among all dates of positive confirmation of COVID-19 on ART. Secondary cases are cases of COVID-19 that occurred after the index case in the household happened within a span of fewer than 14 days from the index case. In one home, only one index case is determined.

Interviews were also aimed at knowing the vaccination status of each index case and secondary case. To validate the vaccination status of the respondents, the data on vaccination records obtained from the Ministry of Health of the Republic of Indonesia was used.

Vaccination status was seen from the date of vaccination of the first dose of ART, considering that at least ART had been vaccinated. If the date of vaccination is less than the date of positive confirmation, it is determined that ART is confirmed positive with the status of being vaccinated (vaccination breakthrough).

Transmission Rate

The secondary attack rate is defined as the number of secondary cases caused by the index case. In contrast, the transmission rate is defined as low if the index case only infects one household member and high if it infects more than one household member.

5. Instruments Study

A structured questionnaire was used for the study instrument, which included the date of positive confirmation from household members and vaccination status in each household.

6. Data analysis

Simple logistic regression analysis was performed to see the relationship between the sample's vaccination status (independent variable) and the COVID-19 infection status (infectious and non-infectious) with high and low incidence areas stratification. Only index cases were analysed for the transmission rate, cases were analysed with the dependent variable transmission rate (low and high). The independent variable was the vaccination status of index cases with high and low incidence area stratification.

7. Research Ethics

Research ethics were obtained from the Ethics Committee of the Health Research and Development Agency of the Ministry of Health of the Republic

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of Indonesia number LB: 02.01/2/-KE.533/2021 dated 27 August 2021 because it used human subjects as data sources.

RESULTS

1. Vaccination and Transmission Status

In low incidence areas, a total of 49 samples out of 500 people were defined as index cases because they infected at least one of the other household members. When viewed from the number, the number of groups that have been vaccinated is less than those who are not vaccinated, but when viewed as a proportion, the group that has been vaccinated in the index case is 25% infectious, while in the opposite group 29%. So that statistically, looks not significant (p> 0.050) the relationship between vaccination status and the infectivity of the respondents.

Table 1. Vaccination status and transmission of COVID-19 in low incidence areas

Vaccination Status	Not Infectious		Infectious		OR	95% CI	p
	N	%	N	%			
No	320	70.95	37	75.51			
Yes	131	29.05	12	24.49	0.79	0.40 to 1.57	0.497

In high incidence areas, a total of 72 samples out of 500 people were defined as index cases because they infected at least one of the other household members. In proportion, it is almost similar between the positive infectious group (index cases) and the non-infecting case group. The group that had been vaccinated in the index case infected 39%, while in the other group, it was 43%.

Statistically, there was no significant (p>0.050) relationship between vaccination status and the infectivity of the respondents.

2. Index Case and Characteristics

Table 2. Vaccination status and transmission of COVID-19 in high incidence areas

Vaccination Status	Not Infectious		Infectious		OR	95% CI	p
	N	%	N	%			
No	246	57.48	44	61.11			
Yes	182	42.52	28	38.89	0.86	0.52 to 1.43	0.562

When compared between low incidence and high incidence, it can be seen that there is a slight difference in the proportion of people who have been vaccinated and infected, in areas of high incidence more than the proportion of people who have been vaccinated and infected, in areas of low incidence.

Furthermore, when viewed from the number of infected household members, it also appears that transmission only occurred in 15% in areas of high incidence and 10% in areas of low incidence. Seventy-two index cases were found in high incidence areas with a total of 131 other

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household members who were infected so that the secondary attack rate in high incidence areas was 1.82, and 49 index cases in low incidence areas with 65 other household members infected so that the transmission rate in low incidence areas is 1.33 (table 3).

Table 3. Number of infected household members by area of incidence and number of infected household members

Number of infected households	High incidence				Low Incidence			
	Index case		Infected household		Index case		Infected household	
	N	%	N	%	N	%	N	%
0	428	85.6	0	0	451	90.2	0	0
1	39	7.8	39	29.8	37	7.4	37	56.9
>1	33	6.6	92	70.2	12	2.4	28	43.1

Index cases are respondents who can infect other household members. One hundred twenty-one index cases infect other household members from 1000 samples (12.1%) or another language. One in ten people who are positive for COVID-19 infects other household members in the house.

Table 4. Characteristics of index cases by area of incidence

Characteristics	High incidence		Low Incidence	
	N	%	N	%
Sex				
Male	44	61.11	32	65.31
Female	28	38.89	17	34.69
Age				
18-30	11	15.28	7	14.29
31-40	13	18.06	8	16.33
41-50	12	16.67	3	6.12
51-60	16	22.22	9	18.37
61-70	16	22.22	15	30.61
>70	4	5.56	7	14.29
Job				
Civil servants	14	19.44	10	20.41
Entrepreneur/ Trader	34	47.22	19	38.78
Farmers/Fishermen		0.00	7	14.29
Housewife	5	6.94	5	10.20
Not Working	19	26.39	8	16.33
Transmission Rate				
Low (infected one person)	39	54.17	37	75.51
High (infected >1 person)	33	45.83	12	24.49

If we look at the characteristics of the index cases, we will get results like table 4, wherein in both high and low incidence areas, the male sex is more infectious than the female sex. Regarding vaccination status, both regions have the same number of index cases that have not been vaccinated.

3. Index Case Vaccination Status and Transmission Rate

In terms of transmission, in the index case group that had been vaccinated in a low incidence area, seven people only infected one household, and five people infected more than 1, from the index case group who had not been

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vaccinated the most. Thirty people can infect one person, and seven people can infect more than one household (Table 5). However, when viewed from the statistics, there was no relationship between the vaccination status of the index cases and the rate of transmission (p>0.050).

Table 5. Vaccination status and index case transmission rate by low incidence area

Vaccination Status	Low transmision rate		High transmision rate		OR	95%CI	p
	N	%	N	%			
No	30	81.08	7	58.33			
Yes	7	18.92	5	41.67	3.06	0.75 to 12.56	0.125

In the index case group vaccinated in the high incidence area, 17 people infected 1 other household, and 11 people infected more than 1 household. From the unvaccinated index case group in the high incidence area, 22 index cases infected 1 household, and 22 other people infected more than 1 household. However, as in low-incidence areas, statistically, there was no correlation between the vaccination status of the index cases and the rate of transmission (p > 0.050).

Table 6. Vaccination status and transmission rate of index cases by high incidence area

Vaccination Status	Low Transmission Rate		High Transmission Rate		OR	95%CI	p
	N	%	N	%			
No	22	57.69	22	24.14			
Yes	17	42.31	11	75.86	0.65	0.25 to 1.69	0.373

DISCUSSION

We found that the secondary transmission rate was still below 2%, this is different from Li et al. (2020), which reported a household secondary transmission rate of 16.3%. This rate is also lower than the household rate of the 2009 influenza A (H1N1) pandemic, which was stated at 13% (Chauchemez, 2009). This is possible because the ability to trace close contacts or contact tracing for COVID-19 cases in Indonesia is still below standard. The standard is to look for 30 close contacts in the past week (Thomas, 2021). In addition, further research is needed on the factors that can explain why the second transmission rate in Bali is low.

Vaccine breakthrough is defined as the infection of a person who has been vaccinated (CDC, 2021). With the infection of people who have been vaccinated, the possibility of infecting still exists. However, based on the results of this study, the number of index cases that have been vaccinated and infected is lower than the number of index cases that have not been vaccinated. This means vaccination does not prevent confirmed positive people for COVID-19 from transmitting COVID-19.

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This study also shows no relationship between index cases that have been vaccinated and those that have not been vaccinated with high and low incidence areas. This means that wherever people with a positive COVID-19 status are located (with the status of being vaccinated or those who have not been vaccinated, they can still transmit COVID-19).

COVID-19 patients who have been vaccinated may still infect others. As long as there is a pandemic/ endemic, health protocols such as wearing masks, maintaining distance, washing hands with soap, avoiding crowds and reducing mobility, still need to be implemented. In addition, vaccinations must still run so that healthy people are not easily infected. (effectiveness of vaccines).

The secondary attack rate in the high incidence area was 1.82 and in the low incidence area 1.33. The index case vaccination status was not associated with transmission in high and low incidence areas. There is a relationship between people who have not been vaccinated in low and high incidence areas and the number of infected people.

AUTHOR CONTRIBUTION

AS, PWD and TP served as the main contributors. EA and EHF as member contributors. AS and PWD as drafters. RA and EHF as data curation and analysis. PWD Methodology. AS TP writing drafting. AS PWD TP writing review.

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CONFLICT OF INTEREST

None.

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