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Determinants of risk factors for COVID-19 transmission in densely populated areas: Insights from the first wave of the pandemic

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ABSTRACT

Introduction: COVID-19 spreads quickly, especially in densely populated countries like Indonesia. Understanding transmission factors can support in reducing transmission rates. The purpose of this study is to analyze the various factors that may contribute to the transmission of COVID-19 in Indonesia, especially in the first wave of pandemic.

Methods: This was a cross sectional study design. The sample was selected from the new all record data or the database for recording COVID-19 cases at the health office at the research location by online system. The research was conducted in seven districts and cities across three provinces to obtain an overview of transmission in each regional characteristic. The number of samples was as high as 2,010, with confirmed cases and close contacts in Banda Aceh City, Aceh Besar District, Semarang City, Magelang District, Ternate City, South Halmahera District, and Tidore Islands City. Data analysis was done descriptively and were analyzed using Chi-square and logistic regression with SPSS software.

Results: The multivariate analysis shows that five dominant factors the risk of COVID-19 transmission, there are, age, employment status, activities outside the home, medical history, and vaccination status. Age group of 20-39 years (odds ratio [OR]=1.6-1.7; 95% confidence interval [CI] 1.07-2.71), working of employment status (OR=1.51; 95% CI 1.10-2.07), have a comorbid in medical history (OR=2.39; 95% CI 1.67-3.4), have activities outside home (OR=1.82, 95% CI 1.39-2.39), and have not been vaccinated of COVID-19 (OR=3.03; 95% CI 3.37-3.87) were significantly related with an increased risk of COVID-19 transmission.

Conclusions: productive age, work and activities outside the home, having comorbidities, and not having received COVID-19 vaccination are all risk factors for COVID-19 exposure. Eliminating all of these factors at the same time will undoubtedly be difficult. As a result, cross-sectoral collaboration is needed to control the spread of COVID-19 at the community and individual levels, as well as to support policy interventions to accelerate the elimination of COVID-19 cases.

Keywords: communicable disease, health policy, pandemic, infectious disease transmission, SARS-CoV-2

INTRODUCTION

Corona virus disease 2019 (COVID-19) is still a problem throughout the world, including in Indonesia [1]. By the end of 2021, hundreds of millions of people worldwide had been infected with COVID-19, resulting in five million deaths and significant indirect effects on other diseases [2, 3]. SARS-CoV-2 is the virus that causes COVID-19, which spreads quickly and frequently causes large outbreaks [4, 5]. In Indonesia, the number of new cases has fluctuated in waves [6]. In a period of two years, there have been two peaks of the COVID-19 wave cases. First on 14 July 2021, with 54,517 new cases and a weekly increase of 44.07%, and second one on 16 February 2022 with total of new cases was 64,718 and a weekly increase of 33.79%. Though as of November 14, 2022, it is still continually adding instances at a rate of 16.54% every week on average [7]. The positivity rate in Indonesia, both nationally and provincially, is still below WHO recommendation of 5.00%. The national positivity rate is 27.22% in 2022. Central Java ranks eighth with the highest positivity rate (40.90%), followed by Aceh at 39.40%, and North Maluku ranks sixth with the lowest positivity rate (18.50%). A high positivity rate indicates high transmission, and it is possible that many people in the community have the corona virus but have not been tested [8]. Several outbreak investigation reports indicate that transmission of COVID-19 is very fast and will increasing in closed spaces [4, 5]. Various efforts to prevent the transmission of COVID-19 have been carried out, such as wearing masks, maintaining distance, and washing hands (3M socialization

efforts). Social restrictions include limiting crowds of people, enforcing isolation, as well as closing public service facilities and arrangements [9, 10]. However, new cases are still reported every day until now, in 2023.

Starting in early 2021 the COVID-19 vaccination program began to be implemented throughout Indonesia to reduce the COVID-19 transmission [11]. The main principle of the vaccine is to control the speed of transmission by suppressing the spread of infectious agents and make herd immunity. Until the end of 2021, more than 280 million doses of vaccination had been given [12], and as of June 7, 2022, the national coverage of the COVID-19 vaccine is 62.00% [13]. But it is estimated that more than 70.00%-80.00% of the population must have received the vaccine to achieve herd immunity [14, 15]. At the same time, new variants keep emerge and posing additional risks [16]. Thus, giving vaccines alone is not enough to protect and prevent transmission of COVID-19, other efforts are needed to achieve this.

The pandemic that spread in a short time ultimately forced collective efforts to fight COVID-19 by suppressing the movement of the transmission rate [17]. Understanding the factors that contribute to COVID-19 transmission in Indonesia is critical for developing effective anti-virus strategies. The aim of this research is to investigate the various factors that contribute to COVID-19 transmission in Indonesia. We will look at the role of demographic factors like age and gender, as well as non-demographic factors like residency, employment, medical history, and others. We will also investigate the impact of different interventions, such as the vaccination program, on COVID-19 transmission. Moreover, this study was focus on the first wave of the COVID-19 pandemic in Indonesia, which may provide unique insights into the early stages of the country's response to the outbreak. Our findings may have broader implications for other countries dealing with similar pandemic challenges.

METHODS

Study Design

This research was used cross-sectional study design and was conducted in seven districts and cities in three provinces: Aceh Province (Banda Aceh City and Aceh Besar District); Central Java Province (Semarang City and Magelang Regency); and North Maluku Province (Ternate City, South Halmahera Regency, and Tidore Islands City). Data collection was carried out from September to November 2021. The study population consisted of confirmed cases and close contacts in cities and districts in three selected provinces.

Study Participant

Samples are confirmed cases and close contacts in selected districts and cities. Quantitative research samples were taken using non-probability sampling, with purposive sampling method and a total of 2,010 samples were obtained that met the inclusion criteria, namely

(1) confirmed cases starting seven-10 days before the first day of data collection, as evidenced by the results of the swab test reverse transcription polymerase chain reaction (RT-PCR) or rapid diagnostic test (RDT);

(2) close contacts of confirmed cases, have carried out and or are willing to undergo RT-PCR or RDT examinations; and

(3) clinical condition without or mild symptoms.

Clinical conditions refer to Minister of Health of the Republic of Indonesia's Decree, which categorizes conditions as asymptomatic, mild, moderate, or severe. Mild symptoms such as fever, cough, fatigue, anorexia, shortness of breath, myalgias, or other unspecified symptoms that are not associated with viral pneumonia or hypoxia [18]. We excluded people with moderate to severe symptoms from the study because their condition made participation impossible. The selection also considers the dynamics of COVID-19 cases in the field. The first step is to determine the three provinces representing the high, medium, and low case categories to obtain an overview of transmission in each regional characteristic [8]. The next step is determining the representatives of one district and one city in each province that represent the desired characteristics (except for North Maluku). For example, the region of Central Java represents areas with high cases in Semarang City and Magelang Regency. Apart from these factors, the availability of RT-PCR swab test and RDT services is also a consideration. The next step is to select a sample of cases and close contacts for data collection. Quantitative samples were drawn from new all record (NAR) data or COVID-19 case recording databases, as well as from other close contacts in the program manager at the health office of the research site. We are prioritizing cases that occurred within ten days of the first day of data collection. For participants under the age of 20, we obtained information from their parents or guardians.

Variables

The dependent variable in this study is COVID-19 diagnosis, namely yes or no. "Yes" are those who are confirmed positive for COVID-19 based on the results of the RT-PCR or RDT examination performed seven-10 days prior to data collection, and vice versa. "No," referring to those who had negative RT-PCR or RDT results within seven-10 days prior to data collection. Independent variables included age, employment status, medical history, smoking habits, activities outside the home, and COVID-19 vaccination history. Age was divided into seven groups: ≤five years, six-19 years, 20-29 years, 30-39 years, 40-49 years, 50-59 years, and ≥60 years. Employment status is divided into working and not. Medical history is divided into two categories: have comorbid and do not have comorbid, such as hypertension, diabetes, heart disease, autoimmune, chronic obstructive pulmonary disease (COPD), or others. Smoking habits are also divided into smoking and not. Activities outside the home are also divided into yes and not. The criteria for activities outside the home in question were outdoor activities that have a higher risk of contracting COVID-19, especially when individuals are near other people who may be infected, such as attending large gatherings, eating indoors with large crowds, close contact with other people, using public transportation, and traveling to areas with high levels of COVID-19. Similarly, the COVID-19 vaccination history is divided into those who have received the vaccine, either doses 1, 2, or 3, and those who have not.

Data Analysis

This study was used SPSS version 25 for data analysis. The data were analysed using chi-square and logistic regression to

Table 1. Characteristics of respondents

Characteristics	COVID-19				Total (n=2,010)	
	Yes (n=443)		No (n=1,567)			
	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)
Gender						
Male	220	49.70	776	49.50	996	49.60
Female	223	50.30	791	50.50	1,014	50.40
Age						
≤5 years	6	1.40	27	1.70	33	1.60
6-19 years	75	16.90	465	29.70	540	26.90
20-29 years	90	20.30	289	18.40	379	18.90
30-39 years	85	19.20	227	14.50	312	15.50
40-49 years	62	14.00	231	14.70	293	14.60
50-59 years	66	14.90	187	11.90	253	12.60
60 years	59	13.30	141	9.00	200	10.00
Employment status						
Not working	147	33.20	744	47.50	891	44.30
Working	296	66.80	823	52.50	1,119	55.70
Marital status						
Marry	246	55.50	767	48.90	1,013	50.40
Not married yet	160	36.10	735	46.90	895	44.50
Widow/widower	37	8.40	65	4.10	102	5.10
Medical history						
Do not have comorbid	355	80.10	1,437	91.70	1,792	89.15
Have comorbid	88	19.90	130	8.30	218	10.85
Tracing status						
Case	384	86.70	0	0.00	384	19.10
Close contact	59	13.30	1,567	100.00	1,626	80.90

Table 2. Cross distribution of vaccination status with COVID-19 morbidity (symptoms)

Vaccination status	Symptomatic (n=137)		No symptoms (n=306)		Total (n=443)	
	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)
No/not yet vaccinated	113	53.30	99	46.70	212	100.00
Vaccinated						
Vaccinated 1 dosage	20	10.80	165	89.20	185	100.00
Vaccinated 2 dosage	4	8.70	42	91.30	46	100.00
Vaccinated boosters (3 dosage)	-	-	-	-	0	

examine the determinants of COVID-19 cases in Indonesia. To determine the strength of the relationship between the dependent and independent variables, it was assessed using a odds ratio (OR) and 95% confidence interval (CI) with significancy of <0.05.

RESULTS

During the data collection period, people in three provinces who were cases or close contacts of COVID-19 were included in this study. The list of respondents was obtained from daily data on case recording and tracking at the hospital and the health office. The characteristic of the respondents in this study shows that the proportion of gender is relatively balanced between men (49.60%) and women (50.40%). The majority age are children and youth aged six-19 years (26.90%), productive age 20-29 years (18.90%), more than half of whom are workers (55.70%), most of them had no comorbidities (89.15%), have married status (50.40%), and are in close contact with COVID-19 (80.90%). The study also showed that positive cases of Covid-19 were primarily found in women in the 20-29 age group and most of whom were working and married. Another finding is that 13.30% of respondents, or as many as 59 close contact respondents in their development, showed positive test results for COVID-19. Positive cases of COVID-19 with five comorbidities, namely hypertension (57.06%), diabetes (18.36%), heart (9.36%), autoimmune (8.16%) and chronic obstructive pulmonary disease or COPD (7.06%) (**Table 1**).

COVID-19 Vaccination Status

COVID-19 vaccination status of respondents was divided into four categories: not vaccinated, vaccinated dose 1, dose 2, and dose 3 (booster). **Table 2** shows correlation of vaccination status with COVID-19 incidence and morbidity. It can be seen that the more doses received, the lower the proportion of positive COVID-19 cases, even down to zero (recipients of three doses or boosters). The morbidity in COVID-19 cases is explained further by their vaccination status. **Table 2** shows that those who did not receive vaccine had a higher proportion of symptomatic COVID-19 cases (53.30%). On conversely, those who have received vaccine report more without symptoms, and the higher the dose received, the higher the proportion without symptoms (91.30%) on dose 2 vaccine.

Table 3 shows no difference in risk of COVID-19 between people who smoke and those who do not smoke. Whereas people aged 20 and over who have been working and active outside the home in last 14 days, have a history of co-morbidities, and people who have not been vaccinated seem to have a higher risk of getting COVID-19 than comparison group.

The final model (risk factors that have a p-value of 0.25 are adjusted for each other to see which is the most dominant

Table 3. Risk factors related to COVID-19 for case respondents & close contacts

Variables	COVID-19				p-value
	Yes (n=443)		No (n=1,567)		
	n	%	n	%	
Age group					
≤5 years	6	1.40	27	1.70	0.000*
6-19 years	75	16.90	465	29.70	
20-29 years	90	20.30	289	18.40	
30-39 years	85	19.20	227	14.50	
40-49 years	62	14.00	231	14.70	
50-59 years	66	14.90	187	11.90	
≥60 years	59	13.30	141	9.00	
Employment status					
Not working	147	33.20	744	47.50	0.000*
Working	296	66.80	823	52.50	
Medical history					
Do not have comorbid	355	80.10	1,437	91.70	0.000*
Have comorbid	88	19.90	130	9.70	
Smoking habits					
Not smoking	373	84.20	1287	82.10	0.351
Smoking	70	15.80	280	17.90	
Activities outside home					
No	110	24.90	625	39.90	0.000*
Yes	333	75.10	942	60.10	
Vaccination status					
No	212	47.90	442	28.20	0.000*
Yes	231	52.10	1,125	71.80	

Note. *p-value<0.05

Table 4. Multivariate analysis of risk factors associated with COVID-19 cases

Variable	OR	95% CI	p-value
Age group			
≤5 years	0.70	0.23-2.16	0.539
6-19 years	1.00	Reference	
20-29 years	1.62	1.07-2.46	0.022*
30-39 years	1.72	1.09-2.71	0.018*
40-49 years	1.28	0.80-2.05	0.304
50-59 years	1.39	0.86-2.23	0.176
≥60 years	1.27	0.75-2.14	0.371
Employment status			
Not working	1.00	Reference	
Working	1.51	1.10-2.07	0.010*
Medical history			
Do not have comorbid	1.00	Reference	
Have comorbid	2.39	1.67-3.40	0.000*
Activities outside home			
No	1.00	Reference	
Yes	1.82	1.39-2.39	0.000*
Vaccination status			
No	3.03	2.37-3.87	
Yes	1.00	Reference	0.000*

Note. OR: Odds ratio; CI: Confidence interval; & *p-value<0.05

factor) shows that five dominant factors increase the risk of COVID-19, there are people aged 20-39 years, people who work, have comorbid, have activities outside the home, and have not been vaccinated. Age group of 20-39 years had an 1.6-1.7 times greater risk of COVID-19 than other groups age (OR=1.6-1.7; 95% CI 1.07-2.71).

In comparison to employment status, the odds of Covid-19 were 1.5 (OR=1.51; 95% CI 1.10-2.07) higher in the working group. Have a comorbid had odds of COVID-19 that were 2.4 times greater than those do not have a comorbid (OR=2.39; 95% CI 1.67-3.4). People who have activities outside home had a 1.8 times (OR=1.82, 95% CI 1.39-2.39) higher risk of COVID-19 than who do not have. When comparing COVID-19 vaccination status, the odds of COVID-19 3.03 (OR=3.03; 95% CI 3.37-3.87) higher in people who do not have vaccination than who have. People who have not been vaccinated have a 2.18-times greater risk of contracting COVID-19 than those who have been vaccinated if they have a history of co-morbidities and work or participate in activities outside the home (**Table 4**).

DISCUSSION

This study found that people between the ages of 20 and 39, also known as the productive working age, have a higher risk of COVID-19. This is consistent with findings in several countries, including California, New Zealand, South Korea, and Indonesia, that the majority of COVID-19 cases are in the 18-39 age group [19-22]. Coronaviruses enter human host cells via the angiotensin converting enzyme 2 (ACE2) receptor via the surface spike (S) glycoprotein. The nasal epithelium of young adults under the age of 60 had higher ACE2 receptor expression levels than that of children. Higher ACE2 expression in young adults may predispose them to coronavirus infections [23]. In addition, adult activities can also be this reason. Adults work and participate in many daily activities. As a result, when they do not fully comply with the COVID-19 control protocol, they are easily infected [22]. Although it is more likely to become infected, productive age has the lowest level of mortality and morbidity among all age groups. This may be influenced by a higher immune level when compared to younger or older age [21, 22]. The productive age group affected by COVID-19 can unknowingly spread the virus to others who are riskier, so it is critical to monitor the transmission of this age group.

Research findings regarding the routine activities of the Indonesian people show that those who work or do activities outside the home, especially activities carried out together in one place, have the most significant risk of contracting COVID-19. Activities in the same room with people infected with the SARS-CoV-2 virus were reported as an essential risk factor for transmission of COVID-19, with the largest percentage occurring in houses/apartments (80.00%) and 34.00% on public transportation [24, 25]. Another study in 2021 explained that of the prevalence of 2.20% of health workers who were identified as having COVID-19 antibodies, as many as 1.50% of them had never been reported to have a history of COVID-19 disease. This proves that everyone has the risk of working with people infected with the SARS-CoV-2 virus but asymptomatic [26]. SARS-CoV-2 virus spreads through the air and can survive for some time on the surface of objects [27], so it makes sense that a closed and narrow room occupied by many people is a good medium for transmitting COVID-19. To reduce the risk of transmission in the workplace, risk management and rearranging the work environment can be implemented, or the best option is to convert the physical office to a virtual office [28-31]. The transmission will decrease when restrictions and contact tracing are implemented in the community [32, 33].

The results showed that in all research areas, most COVID-19 cases had comorbid conditions in the form of hypertension, followed by diabetes mellitus and cardiovascular disease. These results are consistent with other studies that show the “top three” comorbidities of COVID-19 sufferers in Indonesia are hypertension (52.10%), diabetes mellitus (33.60%), and heart disease (20.90%) [22]. The same can be seen based on a

literature review showing that hypertension is the most frequent comorbidity in COVID-19 patients in countries such as China, Italy, and USA [34]. Other studies have found similar results: hypertension is the most common comorbid condition in COVID-19 patients [35], as have studies in Wuhan, Kuwait, and Jakarta [36, 37].

These results of the studies found through literature reviews, which show that hypertension is the main comorbidity of COVID-19. It is even known that there is a relationship between hypertension and the risk of death for COVID-19 patients [38]. Hypertension can worsen the condition of COVID-19 patients by up to 2.5 times [39]. In fact, hypertensive patients who have received additional vaccinations (boosters) are still at risk of developing severe COVID-19 [40]. There is a difference in the study [41], which showed that the most common comorbidities were acute respiratory infections (ARI) and pneumonia, followed by diabetes mellitus and hypertension [41]. The mechanism that exacerbates COVID-19 disease in hypertensive patients, is thought to be due to dysregulation of renin-angiotensin-aldosterone system, inflammation, digestive tract, and immunology [42]. Concomitant conditions of diabetes mellitus ranked second in this study. The incidence of death in people with diabetes mellitus will increase if exposed to the COVID-19 virus. Diabetes mellitus was found to be a comorbid disease in nearly half of COVID-19 patients aged 65 or older who died [43]. Diabetes is also the second-most common co-morbid in various countries, such as China, South Korea, and USA [43].

This study showed that there was no relation between smoking habit and COVID-19 transmission. However, other studies on this topic have yielded conflicting results. Some studies have suggested that smoking, which can damage the lungs and weaken the immune system, may be a risk factor for COVID-19 transmission. Like study in Surabaya, Indonesia found that smoking habits have a significant but weak correlation with COVID-19 transmission risk [44]. Other research has discovered no link between smoking and COVID-19 transmission. Such as findings from Saudi Arabian study that found no relation between COVID-19 swab results and smoking status [45]. Furthermore, while the relation between smoking and SARS-CoV-2 infection is unclear, there is evidence of a direct relationship between cigarette smoking and COVID-19 severity, with smokers nearly doubling their risk of COVID-19 progression and death compared to nonsmokers [46]. A variety of factors, such as the prevalence of smoking in the population, the types of tobacco products used, and other demographic and health-related factors, may influence the relationship between smoking and COVID-19 transmission. As a result, more research is required to better understand the relationship between smoking and the transmission of COVID-19.

This study found that vaccination has a relationship with COVID-19, where people who have not been vaccinated have a higher risk of getting COVID-19 than who have been vaccinated. In addition, the morbidity rate without the vaccine is higher than with the vaccine. Similar to other studies, the incidence rate for COVID-19 is higher in people who have not been vaccinated compared to those who have been vaccinated [47]. Another study also stated that vaccination was shown to reduce the overall attack rate to 4.60% from 9.00% without vaccination [48]. Vaccinated people were 54.00% less likely to report headaches, 64.00% less likely to report fatigue, and 68.00% less likely to report muscle pain than unvaccinated people [49]. People who have been infected with COVID-19 also have a higher chance of reinfection if they are not fully vaccinated. When compared to natural immunity alone, vaccination can reduce the risk of reinfection in half [50-52]. In accordance with the way vaccines work, namely forming immunity earlier before being exposed to the real virus.

Even though, vaccination cannot be considered a single variable determining the transmission rate. One confounding factor for the transmission rate must be regarded as the entry of the variant of concern for COVID-19, which triggered an explosion of cases. The detection of alpha and delta variants at the end of April 2021 is closely related to an increase in extreme instances in Central Java. Likewise, the situation with an increase in cases since the delta variant was detected on May 11 in the province of Aceh and on July 15 in the North Maluku region has been similar. Therefore, early detection in variant of concern through whole genome sequencing (WGS) is crucial for strengthening efforts to prevent its spread in the community [53]. Unfortunately, the mechanism for sending samples to WGS is still voluntary and depends on the commitment of implementers in their respective regions. The effect of vaccines is known to reduce the risk of disease in vaccinated individuals and society at large. This vaccine's indirect effects, or "indirect effects," are known as herd protection [54]. Several studies have shown the success of vaccination in eliminating various infectious diseases, for example, in Gambia, which was victorious against infections caused by Haemophilus influenza type B bacteria with a HiB vaccination coverage of only around 70.00%. Such herd protection can occur when a sufficient proportion of the herd has immunity [55].

At the time of the study, there were still gaps in the COVID-19 vaccine administration. There are still people who have not received or refuse to receive the COVID-19 vaccine, either dose 1, dose 2, or dose 3. One of the most common challenges is a lack of public awareness about vaccination. The underlying factor is resistance due to the influence of COVID-19 hoaxes, both those directly related to vaccines and those that are not [56]. Based on the release of the results of the recapitulation by the Ministry of Communication and Information, at least 1,970 hoaxes related to COVID-19 had been identified that had spread in Indonesia by November 3, 2021 [57].

People's perception of COVID-19 risk in the context of health literacy will be determined by their attitude toward exposure to COVID-19 misinformation [58]. Although the initial survey of vaccination acceptance in September 2020 stated that two-thirds of people were willing to receive vaccinations, those who express refusal generally have doubts about the COVID-19 vaccine, with considerations of safety, effectiveness, and halal vaccines [59]. This makes vaccination coverage in Indonesia, especially in the study locations until the end of the observation period, namely October 2021, still far from the national vaccination target of 70%, where herd immunity is estimated to be achieved [60]. Various strategies to accelerate the achievement of vaccines have been carried out by local governments, starting from the level of the health office to village officials [58]. But the challenge in Indonesia that is quite serious at the moment is the level of vaccination acceptance.

Although the effect of vaccination on reducing transmission rates has not yet been quantified, program managers and health care workers in the field have noticed a difference in improve healthcare COVID-19 cases. For example, it was thought that the decrease in the number of cases occurred in the Aceh Region after vaccination coverage improved. Health workers at the hospital also reported that the

manifestations of symptoms were lighter in COVID-19 patients, especially those with comorbidities. These advancements were very encouraging for health workers because they reduced the workload in the field.

CONCLUSIONS

The results of our study show that being of productive age (namely, 20-39 years), being work and activities outside the home, having comorbid, and have not received COVID-19 vaccination, are risk factors for exposure to COVID-19. It will undoubtedly be difficult to eliminate all of these factors at the same time in order to break the chain of COVID-19 spread. Community-level changes include establishing a safe work environment and keeping public spaces free of the risk of COVID-19 transmission. Meanwhile, at the individual level, it is necessary to increase awareness about complying with health protocols and controlling co-morbidities, especially hypertension and diabetes mellitus. Government intervention in the control of health information pertaining to the spread and management of COVID-19 is essential, even determining the success of the future COVID-19 control campaign. Collaboration across sectors is still required, not just for vaccination administration but also for additional COVID-19 control initiatives. Strengthening from various sectors such as government and workplaces are needed. Governments can provide by implementing policies and mobilizing resources to support COVID-19 control initiatives, while workplaces can create a safe environment for their workers.

Practice Implications

Our findings support the suggestion that structured policies from individual until community level to reduce COVID-19 transmission rate should be considered in the long run. The Ministry of Health is commonly the government agency in charge of implementing and enforcing public health policies, including policies to control COVID-19 transmission. However, other government agencies and departments, such as the Ministry of Home Affairs, Ministry of Transportation, Ministry of Education, and others, may also be involved in the pandemic response.

Limitation of the Study

The study employed a cross-sectional design, which limited the ability to establish causality or determine the direction of the relationship between variables. Second, the study did not consider other potential confounding variables such as socioeconomic status, living conditions, and access to healthcare, all of which could be factors in COVID-19 transmission.

Author contributions: IN, MS, PA, & LA: conception or design of work, data collection, data analysis & interpretation, drafting article, & final approval of version to be submitted; **FE:** conception or design of work, data analysis & interpretation, critical revision of article, supervision, & final approval of version to be submitted; & **AB:** data analysis & interpretation, critical revision of article, supervision, & final approval of version to be submitted. All authors have agreed with the results and conclusions.

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Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

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