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Determinants of Household COVID-19 Cases: The Role of Personal Hygiene, Environment, Individual Characteristics, and Mobility in Gading Village, Surabaya

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Abstract: COVID-19 is a disease caused by the SARS-CoV-2 virus and attacks the human respiratory system. As of 2021, the virus has spread to 226 countries, including Indonesia. East Java Province has the fourth-highest number of cases in Indonesia, while Surabaya City has the highest number of cases in East Java. This study aims to analyze the relationship between Personal hygiene, environmental conditions, individual characteristics, and mobility with COVID-19 cases in households in Gading Village, Tambaksari District, Surabaya City. This study is an observational analytic study using a case-by-case approach. Cross-sectional. The study was conducted in Gading Village, Tambaksari District, Surabaya City, from September 2022 to December 2022. The sample consisted of 85 households selected through a simple random sampling. Data collection was carried out using questionnaires and observations. The results were tested using the chi-squared and Fisher's Exact Test with a significance level of 0.05. The results of the study showed that home ventilation (p=0.036) and residential density (p=0.04) had a significant relationship with COVID-19 cases in households. Meanwhile, no significant association was found with the incidence of COVID-19 in the variables of age (p=0.603), gender (p=0.405), comorbidities (p=0.924), handwashing behavior with soap (p=1.000), mask use (p=0.294), social distancing behavior (p=0.341), environmental cleanliness (p=0.414), and work/learning systems of household respondents (p=0.751). The conclusion shows that home ventilation factors and residential density have a significant relationship with cases of COVID-19 transmission. Therefore, efforts to prevent COVID-19 transmission in the household environment need to focus on improving home ventilation and reducing residential density. In addition, education regarding other risk factors is still necessary to increase public awareness in maintaining overall health and environmental cleanliness.

Keywords: COVID-19; environmental conditions; individual household characteristics; mobility; personal hygiene.

INTRODUCTION

A new infectious disease called Coronavirus Disease 2019 (COVID-19), caused by the SARS-CoV-2 virus and affecting the human respiratory system, was discovered in late 2019 in a market in Wuhan, China[1]. According to data from the World Health Organization (2021)[2], as of 2021, there were 226 countries affected by COVID-19. As of

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December 3, 2021, there were 263,563,622 cases recorded worldwide, with 5,232,562 deaths. Indonesia is one of the countries affected, with the first case reported on March 2, 2020, in Depok City[3]. As of December 3, 2021, Indonesia has recorded 4,257,243 cases of COVID-19, with a death toll of 143,858, ranking 16th in the world for the highest number of cases[2].

At the national level, all 34 provinces have reported positive COVID-19 cases, with East Java Province ranking fourth with 399,493 cases and 29,704 deaths[4]. The first cases in East Java were detected on March 18, 2020, with six of them originating from Surabaya. Surabaya subsequently became the region with the highest number of cases, with 66,978 cases, including seven cases from outside the city[5].

According to Irwan Widyanto, the most common cause of COVID-19 transmission is close contact with family members undergoing self-isolation, with a proportion of 28%[6]. Transmission within the household becomes crucial, especially when individuals who have been active outside the home return without realizing that they have been exposed to the virus. Then, they continue their activities as usual at home and have close contact with other family members[7].

COVID-19 spreads between humans[8] through droplets, which easily enter the body through the mouth, nose, or eyes[9]. Therefore, good personal hygiene practices, such as washing hands with soap, maintaining distance, wearing a mask, and avoiding touching the face, are important to reduce the risk of infection[10].

The SARS-CoV-2 virus can survive in the air (aerosol) for several hours and on inanimate surfaces for several days[11]. Environmental temperature and humidity also affect the virus's survival. Studies indicate that transmission is lower at high temperatures[12]. At 20ºC and 50% humidity, the virus remains detectable for up to 28 days on non-porous surfaces such as glass and steel, but at 40ºC, the virus is no longer infectious after 48 hours[13]. Poor ventilation also prolongs the virus's survival in enclosed spaces[14], while overcrowding and environmental hygiene also increase the risk of transmission[15].

Individual characteristics such as age, gender, and comorbidities also influence susceptibility to COVID-19 infection. Advanced age is correlated with decreased immunity[16]. Men are at higher risk due to differences in their immune systems compared to women[17]. Comorbidities also worsen an individual's immune system[18].

Individual mobility plays a major role in the spread of this disease. Studies show that human mobility influences the risk of COVID-19 infection[19]. The Indonesian government responded by implementing restrictions on community activities, including work-from-home[20] and study-from-home policies[21].

Despite the implementation of various policies, the increase in COVID-19 cases is largely originating from family clusters, which pose a threat because they target the smallest unit of society[22]. In the UK, 17,927 cases occurred in households, with 11,952 being single cases and 5,976 being secondary cases[23]. In Surabaya, a tracing analysis of 150 confirmed COVID-19 cases from January 10–17, 2021, found that family clusters were the leading cause, accounting for 28% of cases[6]. An initial survey in Gading Village showed that this area had the highest number of COVID-19 cases in the Gading Community Health Center's work area, with a total of 711 households affected from January to November 2021[24].

Various studies have highlighted the importance of personal hygiene,

environmental factors, and individual characteristics in the spread of COVID-19. Still, studies that comprehensively link these factors simultaneously in the context of family clusters at the community level, especially in densely populated areas such as Gading Village, are very limited.

Therefore, this study aims to analyze the relationship between personal hygiene, environmental conditions, individual characteristics, and mobility with COVID-19 cases in households in Gading Village, Tambaksari District, Surabaya City.

MATERIALS AND METHODS

This study used an observational analytical design, aiming to determine the relationship between variables. Based on the time of data collection, a cross-sectional approach was used. The population in this study was households in Gading Village, Surabaya City, who had experienced COVID-19 cases from September to December 2022. Based on COVID-19 Monitoring data from the Gading Community Health Center (2021), there were 711 households with COVID-19 cases, which served as the target population. Data were obtained by grouping based on domicile addresses in the Gading Community Health Center records.

The sample in this study was households that met the inclusion criteria, namely households with COVID-19 cases (data were collected based on the results of PCR testing conducted at the Gading Community Health Center) and living in the Gading Village, Tambaksari District, Surabaya City, and with household members aged 19–59 years. Exclusion criteria included households with COVID-19 cases but not living in Gading Village and households without members aged 19–59 years. From a total population (N) of 711 households, the sample size in this study was 85 households. The sample was determined using Lemeshow's formula with a 95% confidence level (Z = 1,96), a 10% margin of error (d), and an assumed population proportion (P) of 50%, as no prior studies had been conducted in this population. From each household, one household member who met the inclusion criteria was selected as a respondent. Sampling was carried out using a simple random sampling technique. This study was approved by the Health Research Ethics Committee of the Faculty of Public Health, Universitas Airlangga (Approval No. 71/EA/KEPK/2022), in accordance with the ethical standards for human subject research.

The independent variables in this study consisted of personal hygiene, individual characteristics, environmental conditions, and mobility. Personal hygiene behaviors included handwashing with soap, mask use, and physical distancing. These were measured using a Likert-scale questionnaire, where respondents were asked to answer how often they performed these actions. The assessment was given with a score from 1 to 5 (scoring system using Likert scale). For positively worded statements, response options ranged from 1 (Never), 2 (Almost never), 3 (Sometimes), 4 (Often), to 5 (Very often). Conversely, for negatively worded statements, the scoring was reversed to ensure consistency in interpretation, with one indicating "Very often" and five indicating "Never." This approach allows for a balanced evaluation of both positive and negative constructs within the instrument. Results were categorized as good if the total score was >50% and poor if <50%.

Environmental factors include ventilation, occupancy density, and home cleanliness. Ventilation is measured through direct observation by calculating the

ventilation area relative to the floor area of the house. Ventilation is categorized as adequate if it is ≥10% of the floor area and inadequate if it is <10% (Minister of Health Regulation No. 2 of 2023). Occupancy density is measured by comparing the house area to the number of occupants. It is categorized as dense if it is <9 m² per person and not dense if it is ≥9 m² per person. Home environmental cleanliness is measured using a Likert-scale questionnaire based on the frequency of hygiene activities during the time a household member was infected with COVID-19.

Individual characteristics included age, gender, and comorbidities. Age was categorized into three age groups: 19–30 years, 31–45 years, and 46–59 years. Gender was classified as male and female, while comorbidities were measured by asking whether respondents had any comorbidities. Mobility was measured based on respondents' work or learning systems during the pandemic. Data were collected through a questionnaire, categorized as work from office (WFO) or offline, and work from home (WFH) or online.

The dependent variable in this study was the number of COVID-19 cases in the household. Data were collected through a questionnaire asking whether any family members had been infected with COVID-19 (after another family member had previously contracted it), with responses categorized as yes or no.

This study used questionnaires and observation sheets as data collection instruments. Primary data were obtained through questionnaires and direct observation of respondents and their home environment. Secondary data were obtained from records of the number of COVID-19 cases in Gading Village, obtained from the Gading Community Health Center. The validity of the instrument items was assessed using Pearson's bivariate correlation to evaluate the degree to which each item appropriately measured the intended construct. Reliability testing was conducted using Cronbach's Alpha to determine the internal consistency of the instrument. The test results showed that all items had a calculated r value > 0.5 and were declared valid. Cronbach's alpha value for each variable was > 0.7; thus, all instruments were declared reliable. Bivariate analysis was conducted to determine the relationship between the independent and dependent variables using the chi-square test. A significance level of $p \leq 0.05$ was used for decision making. However, if more than 20% of the expected cell counts were less than 5, the assumptions of the chi-square test were not met, and therefore, Fisher's Exact test was applied instead.

RESULTS AND DISCUSSION

Based on the research results presented in Table 1, of the 85 respondents, the majority were in the 46–59 age group (56 people, 65.9%), followed by 19 (22.4%) in the 31–45 age group, and the remaining 10 (11.8%) in the 19–30 age range. Most respondents were female, 66 (77.6%), while 19 (22.4%) were male. Sixty-five respondents (76.5%) had no comorbidities, while 20 (23.5%) did. Regarding health behaviors, the majority of respondents correctly practiced handwashing with soap (CTPS), correctly used masks (95.3%), and maintained physical distancing (98.8%). In terms of household environment, 54 homes (63.5%) had adequate ventilation, 51 homes (60%) were not classified as densely populated, and 78 households (91.8%) maintained good environmental hygiene. Regarding mobility during the pandemic, 69 respondents (81.2%) worked or studied from home (online), while 16 respondents (18.8%) worked or studied in person (offline). Furthermore, 29 households (34.1%) had family members who

had been infected with COVID-19, while 56 households (65.9%) had no cases of infection.

Furthermore, as shown in Table 2, an analysis of the relationship between age group and COVID-19 case status shows that in the 19–30 age group, two respondents (20.0%) tested positive for COVID-19, and eight others (80.0%) tested negative, for a total of 10 respondents. In the 31–45 age group, seven respondents (36.8%) tested positive and 12 respondents (63.2%) tested negative, for a total of 19 respondents. Meanwhile, in the 46–59 age group, 20 respondents (35.7%) tested positive and 36 respondents (64.3%) tested negative, for a total of 56 people. The chi-square test results for the relationship between age and COVID-19 status in Table 2 show a p-value of 0.603. Because this value is greater than the significance level (α = 0.05), it can be concluded that there is no statistically significant relationship between age group and COVID-19 case status in the population studied in 2022.

Table 1. Respondent Characteristics

No	Variables	Category	Amount (n)	Percentage (%)
1	Age	19–30 years	10	11,8
		31–45 years	19	22,4
		46–59 years	56	65,9
2	Gender	Man	19	22,4
		Woman	66	77,6
3	Comorbidity	Own	20	23,5
		Do not have	65	76,5
4	Handwashing with soap (HHWS) Behavior	Good	84	98,8
		Not good	1	1,2
5	Usage Face mask	Good	81	95,3
		Not good	4	4,7
6	Keeping Distance	Good	84	98,8
		Not good	1	1,2
7	Home Ventilation	Fulfil conditions	54	63,5
		No fulfil conditions	31	36,5
8	Residential Density	Congested	34	40,0
		Not dense	51	60,0
9	Cleanliness Home Environment	Good	78	91,8
		Not good	7	8,2
10	System Work/Study	Work From Home(Online)	69	81,2
		Work From Office(Offline)	16	18,8
11	COVID-19 Cases in Households	Positive	29	34,1
		Negative	56	65,9

Table 2. Chi-square Test of the Relationship Between Age and COVID-19 Cases in 2022

Age (Year)	COVID-19				Total		P value
	Positive		Negative				
	n	%	n	%	n	%	
19 – 30	2	20,0	8	80,0	10	100	0,603
31 – 45	7	36,8	12	12,5	19	100	
46 – 59	20	35,7	36	36,9	56	100	

Table 3. Chi-Square Test of the Relationship Between Gender and COVID-19 Cases in 2022

Type Sex	History of COVID-19				Total		P value
	Positive		Negative				
	n	%	n	%	n	%	
Man	8	42,1	11	57,9	19	100,0	0,405
Woman	21	31,8	45	68,2	66	100,0	

The results of the Chi Square test in Table 3 show that the significance is 0.405, which means that there is no significant relationship between gender and COVID-19 transmission in households.

Table 4. Chi-square Test of the Relationship Between Comorbidities and COVID-19 Cases in 2022

Comorbidity	COVID-19				Total		P value
	Positive		Negative				
	n	%	n	%	N	%	
Own	7	35,0	13	65,0	20	100,0	0,924
Don't Have	22	33,8	43	66,2	65	100,0	

The results of the Chi Square test in Table 4 show that the significance is 0.924, which means that there is no significant relationship between comorbidities and COVID-19 cases in households.

Table 5. Fisher Exact Test for the Relationship Between Handwashing Behavior and COVID-19 Cases in Households in 2022

Hand washing behavior	COVID-19				Total		P value
	Positive		Negative				
	n	%	n	%	n	%	
Good	29	34,5	55	65,5	84	100,0	1,00
Not good	0	0,0	1	100,0	1	100,0	

The results of the Fisher Exact test in Table 5 show that the significance level is 1.00, so it can be This means that there is no significant relationship between handwashing behavior and COVID-19 cases in households.

Table 6. Fisher Exact Test for the Relationship Between Mask Use and COVID-19 Cases

Behavior face mask	COVID-19				Total		P value
	Positive		Negative				
	n	%	n	%	n	%	
Good	29	35,8	52	64,2	81	100,0	0,294
Not good	0	0,0	4	100,0	4	100,0	

Table 6 shows that the significance value is 0.294, which means there is no significant relationship between mask use and COVID-19 cases in households.

Table 7. Fisher Exact Test for the Relationship Between Physical Distancing and COVID-19 Cases in 2022

Behavior Keep your distance	COVID-19				Total		P value
	Positive		Negative				
	n	%	n	%	n	%	
Good	28	33,3	56	66,7	84	100,0	0,341
Not good	1	100,0	0	0,0	1	100,0	

Table 7 shows that the significance is 0.341, which means that there is no relationship between maintaining distance and COVID-19 cases in households.

Table 8 Chi Square Test of Home Ventilation Variables with COVID-19 in 2022

Ventilation House	COVID-19				Total		P value
	Positive		Negative				
	n	%	n	%	n	%	
Fulfil conditions	14	25,9	40	74,1	54	100,0	0,036
No fulfil conditions	15	48,4	16	51,6	31	100,0	

The results of the Chi Square test in Table 8 show that the p value is 0.036, which means there is a relationship between home ventilation and COVID-19 cases in households.

Table 9. Chi-square Test between Residential Density Variables and COVID-19 Cases in 2022

Residential Density	COVID-19				Total		P value
	Positive		Negative				
	n	%	n	%	n	%	
Congested	16	47,1	18	52,9	34	100,0	0,04
Not Dense	13	25,5	38	74,5	51	100,0	

The results of the Chi Square Test in Table 9 show that the p value is 0.04, which means there is a relationship between residential density and COVID-19 cases in households.

Table 10. Fisher Exact Test for the Relationship between Environmental Hygiene Variables and COVID-19 in Households in 2022

Environmental Hygiene	History of COVID-19				Total		P value
	Positive		Negative				
	n	%	n	%	N	%	
Good	28	35,9	50	51,4	78	100,0	0,414
Not good	1	14,3	6	4,6	7	100,0	

In Table 10 it can be seen that the value p value of 0.414 (>0.05), which shows that there is no significant relationship between environmental cleanliness and COVID-19 in households.

Table 11. Chi Square test of the Relationship between the Work System of Individual Households and COVID-19 in 2022

System respondent's work/study	COVID-19				Total		P value
	Positive		Negative				
	n	%	n	%	n	%	
Work From Home (WFH) / Online	23	33,3	46	66,7	69	100,0	0,751
Work From Office (WFO) / Offline	6	37,5	10	62,5	16	100,0	

The results of the Chi Square test in Table 11 show that the significance is 0.751, which means that there is no significant relationship between the respondents' work/learning system and COVID-19 cases in the household.

The results of this study indicate that there is no significant relationship between individual characteristics (age, gender, and comorbidities) and cases of COVID-19 in households. For the age variable, bivariate analysis yielded a p-value of 0.603, indicating no association between age and COVID-19 cases. This finding aligns with research conducted by[25], as well as research in Iran, which stated that all age groups are equally susceptible to COVID-19 infection[26]. However, this finding does not align with findings by[27], which stated that individuals over 60 years of age have a higher risk of infection.

Gender also had no significant association with COVID-19 incidence (p = 0.405). This is in line with research by Daud (2022) and Putri, Putra, and Mariko (2021), which stated that men and women have relatively equal risks[28,29]. However, these results differ from research by Ernawati (2021), which stated that men are at higher risk due to a tendency toward less hygienic living behavior[30].

For the comorbidity variable, a p-value of 0.924 indicates no significant association. Research in Ternate by Ndera, Supriyatni, and Rahayu (2021) stated that not all comorbidities contribute to an increased risk of infection[31]. However, other studies have shown that comorbidities such as Parkinson's disease, cancer, diabetes, and cardiovascular disease increase the risk of death or ICU admission[32]. Furthermore, hypertension, type 2 diabetes mellitus, COPD, pulmonary tuberculosis, and chronic heart failure are significantly associated with the severity of COVID-19 infection, while asthma is not[33].

Regarding personal hygiene, no significant association was found between

handwashing, mask use, and physical distancing with the incidence of COVID-19 in households. The Fisher Exact test for handwashing showed p = 1.00. This is supported by Asda and Sekarwati (2020) and the CDC (2024b), which stated that handwashing can only prevent around 20% of respiratory infections[34,35]. However, research by Maharani et al. (2022) showed the opposite result[36].

Mask use also showed no significant association (p = 0.294). This may be because the majority of respondents (76 out of 85) used masks properly. Elgersma (2023) also found no strong association between mask use and infection risk[37]. Conversely, other studies have shown that mask type influences infection risk[38]. In fact, surgical masks have been shown to increase the risk of infection by up to 50%[39].

Physical distancing behavior was also not significantly correlated with COVID-19 incidence (p = 0.341). The majority of respondents maintained adequate physical distancing, and the effectiveness of these measures depends on various factors. Adzic (2022) stated that ventilation was more effective than physical distancing[40]. Research in Hong Kong showed that rapid antigen testing and vaccination were more effective than social distancing in reducing infection incidence[41].

However, from environmental factors, it was found that home ventilation (p = 0.036) and residential density (p = 0.04) had a significant relationship with COVID-19 cases. People who live in homes with inadequate ventilation are at 3.8 times greater risk of infection[42]. Poor air circulation causes the accumulation of aerosol particles that carry the virus[43]. Other studies also support the idea that adequate ventilation can prevent COVID-19[44]. Small droplets that become aerosols can float in the air for a long time[45,46,47].

Overcrowding is also a significant risk factor. People living in crowded housing have a 4-fold higher risk of infection[42,48]. Associated with limited space for movement, which allows transmission through droplets[49]. According to the Indonesian Minister of Health Regulation Number 2 of 2023, the minimum area per person is 9 m2[50].

In contrast, home environmental cleanliness was not significantly associated with COVID-19 cases (p = 0.414). This may be because the study only assessed the frequency of home cleaning, without considering the type of disinfectant used. The CDC (2024b) and Kampf et al. (2020) state that the effectiveness of a disinfectant depends on its ingredients, such as ethanol, hydrogen peroxide, or sodium hypochlorite[35,51]. Studies in well-ventilated and humidified environments also found no virus on surfaces[52].

The study also showed that mobility, whether working from home or in person, was not associated with COVID-19 incidence (p = 0.751). This suggests that implementing health protocols when outside the house remains an important factor in reducing the risk of infection[53,54].

The findings of this study contribute to the existing body of knowledge regarding the relationship between personal hygiene, environmental conditions, individual characteristics, and mobility with the incidence of COVID-19 at the household level. Furthermore, the results may provide valuable insights for improving personal hygiene practices and household environmental conditions, thereby enabling communities to better protect themselves and other household members from infectious diseases. In addition, this study may serve as a representation of community conditions, offering evidence-based input for policymakers in the development of targeted and effective public health interventions.

This study's limitations include the lack of categorization by comorbidity type, the lack of assessment of mask type, and the lack of assessment of disinfectant type. These could potentially influence the analysis results. Therefore, further research with more detailed measurements is needed.

CONCLUSION

The results of the study indicate that environmental factors, such as home ventilation (p=0.036) and residential density (p=0.04), have a significant relationship with the incidence of COVID-19 at the household level. In contrast, personal hygiene, individual characteristics, and mobility factors did not show an important relationship. These findings emphasize the importance of interventions focused on improving ventilation quality and reducing residential density as key steps in preventing transmission. This study recommends that the public ensure that ventilation conditions and residential density comply with health standards. Further research suggests including variables such as the type of comorbidities, mask use, and disinfectant use in data collection to obtain more accurate results.

CONFLICT OF INTEREST

In this study there is no conflict of interest

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