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# Assessment of Rabies Control Attitudes During the COVID-19 Pandemic through Partial Least Square-Structural Equation Modeling

**Sang Gede Purnama[1*], Ni Wayan Arya Utami[1], Made Subrata[1], Putu Erma Pradnyani[2], Karang Agustina[3], IBN Swacita[3]**

[1]Department of Public Health and Preventive Medicine, Faculty of Medicine, Udayana University, Badung, Indonesia, [2]Centre of Public Health Innovation (CPHI), Udayana University, Badung, Indonesia, [3]Faculty of Veterinary Medicine, Udayana University, Badung, Indonesia

**Abstract**

The COVID-19 pandemic disrupts rabies control activities in the community. A new approach is needed to control rabies during the COVID-19 pandemic through digital health interventions by conducting digital surveillance and education. This study aimed to determine key attitude indicators in controlling rabies during the COVID-19 pandemic. A cross-sectional study on 166 participants in Denpasar City with a total of 31 indicators measuring five variables: perceptions of the benefits of rabies control (6 indicators), perceptions of rabies risk (6 indicators), perceptions of obstacles to rabies control (5 indicators), perceptions of the need for technology (7 indicators), and attitudes toward rabies control (7 indicators) were analyzed using partial least square-structural equation modeling. The results revealed that 80.7% of participants owned a dog, and sources of rabies information were from social media (45%), the internet (33.7%), and rabies volunteers (33.1%). The model explained that perception of the benefits of rabies control and the need for technology had a direct effect on attitudes toward rabies control (p-value<0.001 and 0.015). In brief, perceived benefits and the need for technology influence attitudes toward rabies control during the COVID-19 pandemic.

**Keywords**: Bali, COVID-19 pandemic, rabies control

## Introduction

Rabies has killed more than 59,000 people in 150 countries, with 95% of cases occurring in Africa and Asia.[1] Rabies is endemic in eight of 11 countries in the Southeast Asia.[2] According to World Health Organization (WHO) reports, more than 1.5 million people are at risk of being infected with rabies, and 26,000 people die yearly.[2] Rabies is the global burden of disease at 45%.[2] The death rate from rabies in Indonesia is still high, around 100-156 deaths per year.[3] Based on case reports, dogs contribute up to 98% of rabies transmissions, followed by cats and monkeys (2%).[3]

Of 34 provinces in Indonesia, eight provinces are free of rabies (Riau Islands, Bangka Belitung, Papua, West Papua, Special Capital Region of Jakarta, Central Java, Special Region of Yogyakarta, and East Java).[3] In the last five years (2015-2019), 404,306 cases of animal bites transmitting rabies were reported, with 544 deaths.[3] The high mortality from rabies shows that rabies in Indonesia is still a serious public health problem.[4] Bali Island has been a rabies-infected area since 2008, and vaccination efforts were still limited then, and the dog population was high.[5] Since then, the cases have continued to increase and become extraordinary events.[5] The number of dog bite cases in 2018, 2019, and 2020 (up to the 43rd week) was 19,440, 25,440, and 13,370, respectively.[6]

Based on data from the Department of Agriculture and Food Security of Bali Province, the estimated dog population in Bali Province in 2022 is 619,846.[7] The coronavirus disease 2019 (COVID-19) pandemic has reduced vaccination efforts. Many unvaccinated dogs increase the rabies risk transmission.[8] Free-roaming dogs and not being vaccinated are risk factors for the spread of rabies in Bali.[9] The risk factors that make Bali infected with rabies include free-roaming dogs; the presence of other rabid animals such as monkeys, cats, and bats; dogs that are kept but not being fed; puppies obtained from outside the territory; a flow of dogs in and out of the village, and many people that have not received adequate education on rabies.[10]

The Bali Provincial Government has been trying to control rabies, but these efforts are still not optimal. Rabies control must be supported by increasing public

***Correspondence***:* *Sang Gede Purnama, Department of Public Health and Preventive Medicine, Faculty of Medicine, Udayana University, Badung, Indonesia, E-mail: sangpurnama@unud.ac.id, Phone: +62 877-3917-6777*

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awareness, routine vaccination, dog registration, population management, and a quick response to dog bite cases.[11] For this reason, education on controlling rabies and sociocultural program in the local community are needed. The WHO recommends vaccinating at least 70% of the dog population for rabies control.[2] Vaccination can increase herd immunity, requiring integrated supervision and increasing public awareness to care for their dogs.[2]

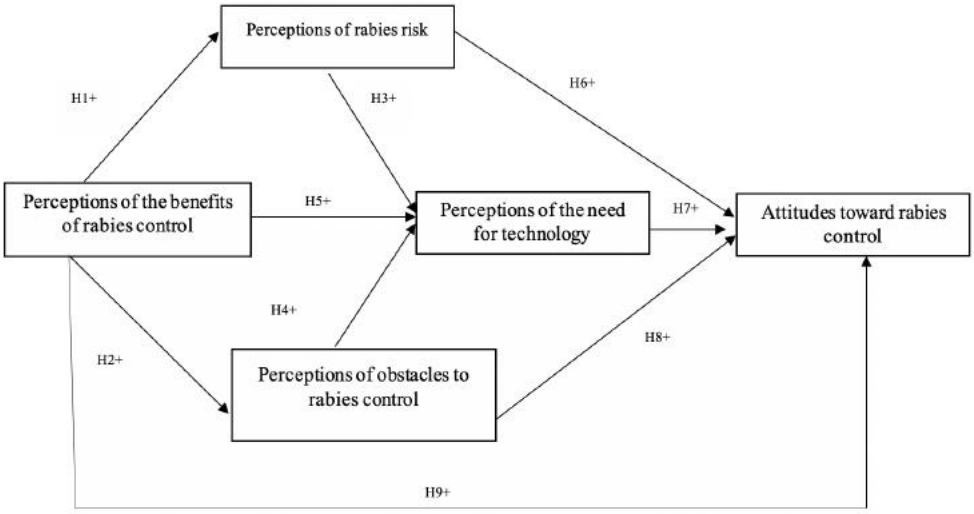
During the COVID-19 pandemic, it has not been easy to vaccinate, and door-to-door education has become a challenge due to social distancing policies. A study of the leading indicators of attitude is needed in controlling rabies during the COVID-19 pandemic.[12,13] Therefore, this study aimed to determine the indicators influencing attitudes toward rabies control with the variables of perceptions of the benefits of rabies control, perceptions of rabies risk, perceptions of obstacles to rabies control, and perceptions of the need for technology.

## Method

This cross-sectional study was conducted in Denpasar City, Bali Province, from July to December 2021. This primary data was collected to assess indicators influencing attitudes toward rabies control. Data collection of an anonymous electronic survey used an online questionnaire with a Likert scale of 1-5—1 (strongly disagree), 2 (disagree), 3 (neutral), 4 (agree), and 5 (strongly agree) using Google Forms. The number of participants who were interviewed was 166 people in Denpasar City. Inclusion criteria included participants aged ≥17 years living in Denpasar City for over six months. Exclusion criteria were participants living outside the study area, aged <17 years, and could not answer the question.

The study permits were obtained from the Denpasar City Health Office and the Mayor. Thus, the data from the Civil Registry Office was provided. The questionnaires were sent via WhatsApp to the participants after completing a consent form and anonymous data. The theoretical model adopted a Health Belief Model (HBM) defining factors influencing health behavior, such as perceptions of health susceptibility, disease severity, health program benefits, perceptions of program constraints, and self-efficacy.[14,15] Therefore, this study used five variables: perceptions of the benefits of rabies control, perceptions of rabies risk, perceptions of obstacles to rabies control, perceptions of the need for technology, and attitudes toward rabies control. Figure 1 describes the relationship between the direct and indirect hypotheses on attitudes toward rabies control.

The structural equation model was analyzed in a two-




**Notes:** The hypothesis from the structural model:
Hypothesis 1 (H1). Perceptions of the benefits of rabies control positively affect the perceptions of rabies risk.
Hypothesis 2 (H2). Perceptions of the benefits of rabies control positively affect the perceptions of obstacles to rabies control.
Hypothesis 3 (H3). Perceptions of rabies risk positively affect the perceptions of the need for technology.
Hypothesis 4 (H4). Perceptions of obstacles to rabies control positively affect the perceptions of the need for technology.
Hypothesis 5 (H5). Perceptions of the benefits of rabies control positively affect the perceptions of the need for technology.
Hypothesis 6 (H6). Perceptions of rabies risk positively affect the attitudes toward rabies control.
Hypothesis 7 (H7). Perceptions of the need for technology positively affect attitudes toward rabies control.
Hypothesis 8 (H8). Perceptions of obstacles to rabies control positively affect attitudes toward rabies control.
Hypothesis 9 (H9). Perceptions of the benefits of rabies control positively affect attitudes toward rabies control.

**Figure 1. The Structural Hypothesis of Attitude towards Rabies Control**

**Table 1. Data Description Indicator**

| Composite | Indicator | Definition |
|---|---|---|
| Perceptions of the benefits of rabies control | Var1a | The rabies vaccination program is beneficial for villages |
| | Var1b | Dog registration is very useful for the village |
| | Var1c* | Sterilization can limit the breeding of dogs |
| | Var1d | Public education is very important |
| | Var1e* | Treatment of free-roaming dogs needs to be done |
| | Var1f* | The program helps reduce throwing away dogs |
| Perceptions of rabies risk | Var2a* | I am at risk of being infected with rabies |
| | Var2b* | Rabies is a deadly disease |
| | Var2c* | Rabies is a disease for which there is no cure |
| | Var2d* | Everyone is at rabies risk |
| | Var2e | My family is afraid of getting infected with rabies |
| | Var2f | Tourists are afraid of being infected with rabies |
| Perceptions of obstacles to rabies control | Var3a* | People do not want to take good care of dogs |
| | Var3b* | Not willing to vaccinate dogs |
| | Var3c | Limited program funding |
| | Var3d | Rabies volunteers are limited in number |
| | Var3e | Limited vaccine schedule |
| Perceptions of the need for technology | Var4a | Information technology is very helpful |
| | Var4b | Have an Android phone to support activities |
| | Var4c | Accustomed to using social media such as Facebook, Instagram, YouTube, and others |
| | Var4d | Accustomed to using WhatsApp to communicate |
| | Var4e* | Rabies information can be found on the internet |
| | Var4f* | Willing to fill in data via the internet or cellphone |
| | Var4g* | Willing to share rabies prevention information with family and environment |
| Attitudes toward rabies control | Var5a | Willing to vaccinate dogs |
| | Var5b* | Sterilizing free-roaming dogs |
| | Var5c* | Owners who do not take good care of dogs will be penalized |
| | Var5d | First aid when bitten by a dog is to wash the wound for 10-15 minutes with running water and soap |
| | Var5e | First aid when bitten by a dog is to seek immediate health care |
| | Var5f | There is a need for health education related to rabies |
| | Var5g | Supporting rabies control program activities |

**Note:** *These indicators were not included in latent variables due to the multicollinearity criteria of PLS-SEM.

step process. The first step described the results of the measurement model. Determine the relationship between constructions and indicators related to the structural model containing the relationship between constructs or model hypotheses. This sequence ensured that the measurement scale was valid and reliable before trying to reach conclusions about the hypotheses included in the structural model. This study used the free version of Smart-PLS software version 3.

Table 1 describes the indicators tested using the partial least square-structural equation modeling (PLS-SEM). Total of 31 indicators measuring five variables: perceptions of the benefits of rabies control (6 indicators), perceptions of rabies risk (6 indicators), perceptions of obstacles to rabies control (5 indicators), perceptions of the need for technology (7 indicators), and attitudes toward rabies control (7 indicators).

## Results

The characteristics of participants in this study were mostly aged 17-24 years (25.3%), male (57.8%), private employees (57.8%), and went to senior high school (55.4%). Based on dog ownership, 80.7% of participants owned a dog. Based on the source of information, most participants obtained information through social media (45.2%), internet (33.7%), health workers (33.7%), rabies volunteers (33.1%), television (15.1%), newspaper (5.4%), and radio (3.6%) (Table 2).

The composite measurement model in mode A (attitude) was assessed regarding individual item reliability, construct reliability, convergent validity, and discriminant validity. First, the reliability of each item was analyzed through a loading factor. The total loading factor of 0.839 has exceeded the cut-off value. Second, Cronbach's alpha and composite reliability were used to evaluate construct reliability. The construct exceeded these three measurements' recommended cut-off value of 0.7. All three convergent validity was proved because the construct's extracted mean-variance (AVE) was higher than 0.50. The measurement model met the criteria. Presents discriminant validity results through the Heterotrait-Monotrait (HTMT) correlation ratio. All constructs reached discriminant validity because the confidence interval did not contain a zero value, meaning each variable

differed.

The composite measurement model in mode B was assessed regarding collinearity between indicators, significance, and relevance of the outer weights. First, removing the indicator was carried out when the indicator exceeded the value of the variance impact factor (VIF = 3). As a result of this process, only the indicators shown in Table 1 were without collinearity. Second, the relevance of the weights was analyzed. Figure 2 shows the relevance of indicators in construction for latent variables. Finally, to assess significance, it was possible to start a bootstrap with 10,000 sub-samples, whether the outer weights differed significantly from zero. Indicators with insignificant weights but significant loadings of 0.50 or higher were considered relevant (Table 3).

The path coefficients and their 10,000 resampling bootstrap significance levels are reported in Table 3 and Figure 2. In addition, Table 3 shows that the VIF constructs range from 1,000 to 1,700, indicating no collinearity between variables. In addition, this study also assessed the quality by examining the overall predictive relevance of the model with a Q2 value above zero, indicating a fit in the prediction model. The coefficient of determination (R2) also exceeded 0.1 for endogenous latent variables, so the construct had an acceptable predictive power quality.

Table 4 also shows that variables 1 (perceptions of the benefits of rabies control) and 4 (perceptions of the need for technology) have a direct effect on variable 5 (attitudes toward rabies control) (p-value<0.001 and 0.015). Variables 1 and 4 were positively related to variable 5. The indirect effect could be seen from the Variance Accounted For (VAF) value. The VAF value indicated that the mediated proportion from variables 1 to variable 5 through variable 4 was 0.27 or 27% (see the indirect effect in Table 4).

**Table 2. Sociodemographic Characteristics of Participants**

| Variable | Category | n | % |
|---|---|---|---|
| Age (years) | 17-24 | 42 | 25.3 |
| | 25-29 | 17 | 10.2 |
| | 30-34 | 15 | 9 |
| | 35-39 | 16 | 9.6 |
| | 40-44 | 24 | 14.5 |
| | 45-49 | 26 | 15.7 |
| | 50-54 | 13 | 7.8 |
| | 55-59 | 9 | 5.4 |
| | >60 years | 4 | 2.4 |
| Sex | Male | 96 | 57.8 |
| | Female | 70 | 42.2 |
| Education | Primary school | 1 | 0.6 |
| | Junior high school | 11 | 6.6 |
| | Senior high school | 92 | 55.4 |
| | Diploma | 23 | 13.9 |
| | Bachelor's degree | 33 | 19.9 |
| | Master's degree | 6 | 3.6 |
| Occupation | Unemployed | 7 | 4.2 |
| | Civil servant | 8 | 4.8 |
| | Private sector worker | 96 | 57.8 |
| | Housewife | 12 | 7.2 |
| | Student | 6 | 3.6 |
| | College student | 7 | 4.2 |
| | Entrepreneur | 19 | 11.4 |
| | Teacher | 4 | 2.4 |
| | Village head | 3 | 1.8 |
| | Farmer | 3 | 1.8 |
| | Veterinarian | 1 | 0.6 |
| Dog ownership | No | 32 | 19.3 |
| | Yes | 134 | 80.7 |
| Source of information | Social media | 75 | 45.2 |
| | Internet | 56 | 33.7 |
| | Newspaper | 9 | 5.4 |
| | Radio | 6 | 3.6 |
| | Television | 25 | 15.1 |
| | Rabies volunteers | 55 | 33.1 |
| | Health workers | 56 | 33.7 |

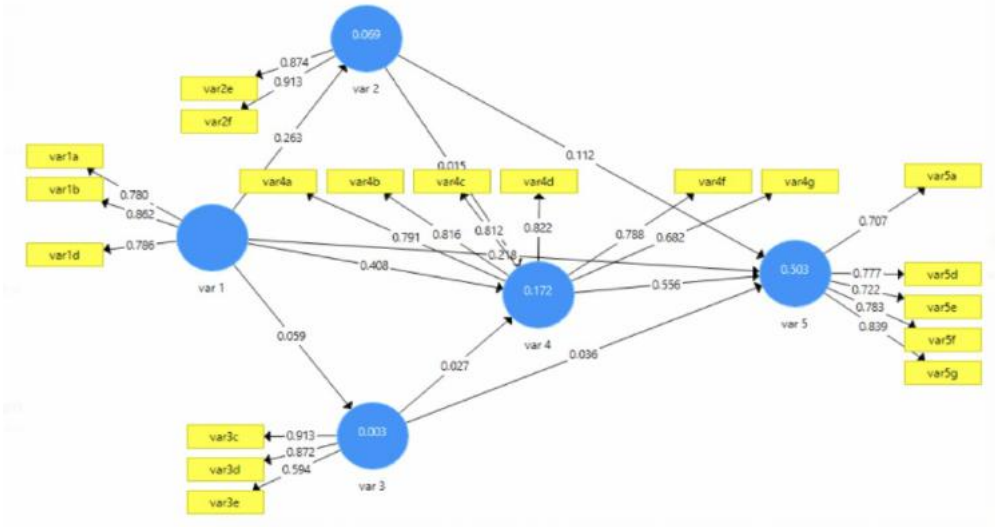



**Figure 2. Model Results of Partial Least Square-Structural Equation Modeling**

## Discussion

This study was valuable as it developed an up-to-date instrument to measure attitudes toward rabies control by modifying the HBM. The indicators that made up the attitudes toward rabies control were being willing to vaccinate dogs, first aid when there was a bite wound, education on rabies, and supporting a particular program for rabies control. This study also found that the perceptions of the benefits of rabies control and the need for technology directly affected people's attitudes toward rabies control (p-value<0.001 and 0.015). Most participants agreed that the existence of information technology benefited them during COVID-19. The perceived benefits of implementing a digital system in controlling rabies were the speed of information, the ease of mapping dog density, the ease of recording data, and reducing data bias.

This study showed that 80.7% of participants owned a dog. Previous studies have shown that the relatively high population of dogs in Bali relates to cultural aspects—house guards and ritual facilities.[16-18] Sources of rabies information mainly came from social media (45%), the internet (33.7%), health workers (33.7%), and rabies volunteers (33.1%). Social media and the internet are information media easily accessible today to get health or other news.[19-22] Rabies volunteers and health workers are also essential in providing information to the public because they are an integral part of elevating public knowledge of rabies. Previous studies have found that outreach efforts to provide information are faster and more precise with volunteers and health workers in the field.[23]

The concept of one health in the prevention and control of rabies is to combine the prevention of zoonotic diseases with animal welfare and public health approaches.[24-26] It is essential to involve the community and other sectors in implementing rabies control and prevention independently. During the COVID-19 pandemic, many changes were made to all sectors, including the rabies program. Previous studies found that COVID-19 interfered with rabies surveillance and vaccination activities.[8,27] Many studies have been conducted in the community to examine knowledge, attitudes, and practices regarding rabies prevention.[15,16,28,29] During COVID-19, to know the attitude model for controlling rabies is

**Table 3. Significance of Weights**

| Variable | Original Sample (O)* | t | Loading | Lo95 | Hi95 |
|---|---|---|---|---|---|
| Var1a | 0.344 | 6.659 | 0.780 | 0.228 | 0.439 |
| Var1b | 0.405 | 8.885 | 0.862 | 0.326 | 0.500 |
| Var1d | 0.486 | 6.008 | 0.786 | 0.343 | 0.658 |
| Var2e | 0.510 | 4.479 | 0.874 | 0.262 | 0.651 |
| Var2f | 0.607 | 4.956 | 0.913 | 0.458 | 0.825 |
| Var3c | 0.572 | 1.407 | 0.913 | -0.269 | 0.983 |
| Var3d | 0.448 | 1.152 | 0.872 | -0.295 | 0.971 |
| Var3e | 0.146 | 0.363 | 0.594 | -0.278 | 0.958 |
| Var4a | 0.301 | 9.716 | 0.791 | 0.244 | 0.362 |
| Var4b | 0.219 | 10.616 | 0.816 | 0.182 | 0.259 |
| Var4c | 0.166 | 8.341 | 0.812 | 0.123 | 0.202 |
| Var4d | 0.212 | 10.367 | 0.822 | 0.170 | 0.248 |
| Var4f | 0.179 | 7.394 | 0.788 | 0.132 | 0.225 |
| Var4g | 0.168 | 8.521 | 0.810 | 0.125 | 0.210 |
| Var5a | 0.249 | 8.296 | 0.707 | 0.198 | 0.312 |
| Var5d | 0.249 | 8.961 | 0.777 | 0.191 | 0.307 |
| Var5e | 0.243 | 6.796 | 0.722 | 0.173 | 0.311 |
| Var5f | 0.255 | 9.124 | 0.783 | 0.201 | 0.302 |
| Var5g | 0.305 | 9.892 | 0.839 | 0.244 | 0.367 |

**Notes:** T-statistic and 95% bias-corrected confidence interval performed by a bootstrapping procedure with 10,000 replications, Lo95 = Lower case of 95% CI, Hi95 = Higher case of 95% CI, Var 1 = Perceptions of the Benefits of Rabies Control, Var 2 = Perceptions of Rabies Risk, Var 3 = Perceptions of Obstacles to Rabies Control, Var 4 = Perceptions of the Need for Technology, Var 5 = Attitudes toward Rabies Control.

**Table 4. Whole Sample Results**

| Effect | | Path | t | p-value | Lo95 | Hi95 | $f^2$ | VAF | VIF | $R^2$ | $Q^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Direct effect | Var 1 → Var 2 | 0.263 | 2.749 | 0.006 | 0.107 | 0.473 | 0.074 | | 1.000 | 0.069 | |
| | Var 1 → Var 3 | 0.059 | 0.671 | 0.502$^{ns}$ | -0.151 | 0.195 | 0.003 | | 1.000 | 0.003 | |
| | Var 1 → Var 4 | 0.408 | 5.556 | <0.001 | 0.281 | 0.560 | 0.187 | | 1.076 | | |
| | Var 2 → Var 4 | 0.015 | 0.208 | 0.835$^{ns}$ | -0.122 | 0.172 | 0.000 | | 1.076 | | |
| | Var 3 → Var 4 | 0.027 | 0.287 | 0.774$^{ns}$ | -0.173 | 0.186 | 0.001 | | 1.005 | 0.172 | |
| | Var 1 → Var 5 | 0.218 | 2.449 | 0.015 | 0.076 | 0.419 | 0.075 | | 1.278 | | |
| | Var 2 → Var 5 | 0.112 | 1.673 | 0.095$^{ns}$ | -0.043 | 0.221 | 0.023 | | 1.076 | | |
| | Var 3 → Var 5 | 0.036 | 0.510 | 0.611$^{ns}$ | -0.144 | 0.150 | 0.003 | | 1.006 | | |
| | Var 4 → Var 5 | 0.556 | 7.215 | <0.001 | 0.385 | 0.691 | 0.515 | | 1.208 | 0.503 | 0.083 |
| Indirect effect | Var 1 → Var 2 → Var 4 | 0.006 | 0.237 | 0.813$^{ns}$ | -0.036 | 0.058 | | 0.020 | na | | |
| | Var 1 → Var 3 → Var 4 | 0.006 | 0.237 | 0.813$^{ns}$ | -0.036 | 0.058 | | 0.070 | na | | |
| | Var 1 → Var 4 → Var 5 | 0.261 | 5.060 | <0.001 | 0.171 | 0.365 | | 0.270 | na | | |
| | Var 2 → Var 4 → Var 5 | 0.008 | 0.213 | 0.831$^{ns}$ | -0.074 | 0.095 | | 0.010 | na | | |
| | Var 3 → Var 4 → Var 5 | 0.015 | 0.290 | 0.772$^{ns}$ | -0.092 | 0.108 | | 0.030 | na | | |

**Notes:** VIF = Variance Impact Factor, VAF = Variance Accounted for, Lo95 = Lower case of 95% CI, Hi95 = Higher case of 95% CI, ns = not significant, na = not applicable, Var 1 = Perceptions of the Benefits of Rabies Control, Var 2 = Perceptions of Rabies Risk, Var 3 = Perceptions of Obstacles to Rabies Control, Var 4 = Perceptions of the Need for Technology, Var 5 = Attitudes toward Rabies Control.

necessary. For effective education, attitude influences preventive and protective behavior.[15] The HBM defines factors influencing health behavior, such as perceptions of health susceptibility, disease severity, health program benefits, program constraints, and self-efficacy.[14,28,29]

This study found a modification of the HBM regarding attitudes toward rabies control. Model development used PLS-SEM, which could display in detail the factors that influence attitudes. During the COVID-19 pandemic, digital technology was needed to carry out rabies surveillance, and a structural model could demonstrate the community's attitude toward using digital technology. This study could also be a consideration for policymakers in controlling rabies using digital technology. The limitations of this study were the limited number and area of the participants; Denpasar City does not represent Bali Province. Participants were limited only to those with cell phones. However, this study demonstrated the role of factors influencing attitudes in controlling rabies.

## Conclusion

During the COVID-19 pandemic, innovation is needed to make efforts to control rabies. The perception of the benefits of rabies control and the need for technology affect the community's attitude toward rabies control. The use of technology during the COVID-19 pandemic is needed to provide education and surveillance. Most people prefer information sources through social media and the internet because they are easier to access.

**Abbreviations**

WHO: World Health Organization; COVID-19: coronavirus disease 2019; HBM: Health Belief Model; PLS-SEM: Partial Least Square-Structural Equation Modeling; AVE: Extracted Mean-Variance; VAF: Variance Accounted for; VIF: Variance Impact Factor.

**Ethics Approval and Consent to Participate**

This study has received ethical clearance from the Faculty of Medicine, Udayana University (2448.UN.14.2.2.VII/14/LT/2021). This study was carried out following the Declaration of Helsinki and the recommendations of those committees with written informed consent from all participants.

**Competing Interest**

The authors declared that there is no significant competing financial, professional, or personal interest that might have affected the performance or presentation of the work described in this manuscript.

**Availability of Data and Materials**

The generated dataset is available to share from the corresponding author upon a reasonable request.

**Authors' Contribution**

SGP participated in conceptualizing, designing, analyzing, and revising the manuscript. MS and AU participated in collecting the data, analyzing, and writing the manuscript. KA, IS participated in analyzing and writing the result in the manuscript. The authors discussed the results of the study. All authors read and approved the final manuscript.

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