

One health approach for taeniasis/cysticercosis control measure in Bali, Indonesia: updated situations, implementations, and challenges



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ABSTRACT

Background: Taeniasis/cysticercosis (TC/CC), a group of infectious diseases caused by *Taenia solium*, is still a burden in Bali, particularly in the Kubu subdistrict. By utilizing Duku village as the representative location of TC/CC in the Kubu subdistrict as the continuation of earlier epidemiology studies in the same area, this study provides current situations and state-of-the-art risk factors of TC/CC along with an assessment of post-interventional indicators and their potential challenges in terms of One Health-based TC/CC control in Bali.

Methods: Community-based epidemiological surveys were conducted in the Kubu subdistrict in 2020 as a continuity of previous surveys held in 2011, 2013, 2014, 2015, 2016, and 2019, which have been published.

Results: In absolute counts, 14 out of 474 people were more seropositive than in 2019. Pig seroprevalence in Kubu was 2.92% (8/274) during the 2020 survey. A few related risk variables were investigated. Community-based interventions effectively elevated knowledge and behavior towards TC/CC in the Duku village society.

Conclusion: This study has significantly increased public knowledge, behavior, and awareness towards TC/CC as an early step in controlling the disease through the designated One Health framework. Despite some challenges in each stage of implementation, the One Health approach to TC/CC control measures in Bali is a worthwhile contribution to be made.

Keywords: One Health, Taeniasis, Cysticercosis, Bali, Community.

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INTRODUCTION

Taeniasis/cysticercosis (TC/CC), a group of infectious diseases caused by *Taenia solium*, has a variety of infectious forms, with Neurocysticercosis (NCC) being the most deliberating of all, frequently causes NCC-associated active epilepsy, which is being considered to induce high economic burden in some countries. TC/CC is considered to still be a burden in Bali, in contrast with the island's modernity and adaptability to globalization due to its status as an international tourist destination. In a study by Ito A et al., it was suggested that Kubu, an area located beneath the slope of Bali's highest volcano, Mt. Agung in Karangasem district, which

has been a great representative of TC/CC control in Bali, is still being endemic for TC/CC, even if some initiatives for control measures have already taken.¹ Being an endemic and neglected infectious disease, the Taeniasis control measure is considered to fit the aim of the One Health approach.²

One Health, a collaborative, multisectoral, and transdisciplinary approach to achieving optimal health outcomes recognizing the interconnection between people, animals, plants, and their shared environment, has proven to create a recognizable improvement in prevention control measures of various zoonotic diseases in many countries.³ Nevertheless, One Health practitioners are

facing persistent challenges in designing and implementing the initiatives. Thus, to propose One Health-based prevention and control measure for TC/CC, practitioners should carefully design a suitable framework consisting of problem identification, implementation of interdisciplinary programs, and plans for future actions by considering results from epidemiological studies.

Several community surveys have been taken in Duku village, a representative area for TC/CC in Kubu, since 2011, aimed at gaining insights into the prevalence and risk factors and implementing collaborative solutions to control TC/CC. As the continuation of previous surveys held in 2011-2016 and 2019, this study

has gained data on TC/CC prevalence among humans and pigs in Dukuh village, Kubu, in 2020 despite some limitations in conducting the surveys due to coronavirus disease-19 (COVID-19) pandemic.^{4,5} Along with the current situation of TC/CC, this study will also discuss the current state-of-the-art risk factors of TC/CC along with an assessment of post-interventional indicators and their potential challenges regarding One Health-based TC/CC control in Bali.

METHODS

Community and Hospital-based Clinical Studies

Community-based epidemiological surveys were conducted in the Kubu subdistrict in 2020 as a continuity of previous surveys held in 2011, 2013, 2014, 2015, 2016, and 2019, which have been published.^{1,6-9} The surveys were conducted using the published method to gain insights on the incidence of taenia infections among society, roaming pigs of study villages, and associated risk factors in the Kubu subdistrict.¹ Findings from hospital-based clinical studies that have identified cases of ocular cysticercosis and neurocysticercosis were published.¹⁰⁻¹²

One Health Interventional Approaches

One Health has manifested in various methods developed by the Department of Public Health and the Department of Psychology of Universitas Udayana. They consist of public health online-based education for youngsters, along with two approaches from the Department of Psychology: board games and self-manufactured comic books for primary school students in Dukuh village.¹³ Both departments used distinct approaches in implementing inclusion and exclusion criteria for their studies. The inclusion criteria for online-based education for youngsters are all residents of Dukuh village aged between 13-18 years at the period of study, who agreed to be respondents by signing an informed consent form and having access to social media platforms by using their private accounts. The respondents who did not complete any pre- or post-tests were excluded. On the other hand, the inclusion criteria for board game and comic book interventions are

all elementary school students in Dukuh village who got informed consent signed by parents. The exclusion criteria were the absence in more than 50% of activities. Total population sampling was used in this study.

However, some adjustments were made due to the coronavirus pandemic during the study period. Due to COVID-19 regulations, it was impractical to use face-to-face interaction to do such interventions. Thus, using a social media platform was considered the best solution, as WhatsApp® was the most commonly used communication platform in Dukuh village due to its user-friendly interface.

Taeniasis online education for youngsters

The Department of Public Health of Universitas Udayana has planned to implement this intervention in 2020 to elevate the awareness of youngsters in Dukuh village (n=64) regarding taeniasis. Information was disseminated through a WhatsApp® group, and an active discussion between the educator (department staff) and the participants (youngsters) also took place. The sequential components of the method's implementation mechanism were the pre-intervention test, knowledge transfer from the educator, assignment, and post-intervention test.

The pre-intervention test was taken by giving ten statements (closed questions) made by the educator (department staff) to the concerned participants. All participants were assigned to make educational videos encompassing any learning topics. Each video was a responsibility for an individual or a group of two until five, up to 10 minutes, and can be in the form of drama, graphical presentation, animation, or other creative ideas in Indonesian or Balinese languages. Data from both tests were gained as knowledge scores and compared statistically.

Taeniasis online game (SiCapit) & comics for primary school students

These interventions utilizing educational games and comics were designed by the Department of Psychology, Universitas Udayana (Fig.1). Taeniasis's educational game is 'SiCapit,' an online game based on a snake and ladder board game. The

students were also provided with self-manufactured comic books to increase their knowledge of preventing taeniasis for primary school students in Dukuh village. The game and comic were delivered through a WhatsApp group that consisted of 63 students as participants. Validity testing was carried out qualitatively. The suitability of the items was checked with the topic, including the answer choices. Games were manually set up (according to Wulanyani NMS et al., 2019) and then converted into mobile game applications. Content validity through expert judgments was conducted qualitatively by the parasitologists. Knowledge scores were evaluated by using a validated questionnaire.

Data Analysis

Both interventions' knowledge and preventive behavior scores were analyzed using SPSS for Windows. Mann-Whitney test was employed to compare the knowledge scores before and after the online education program. This research has complied with the ethical consideration based on the Ethical Clearance document (2099/UN14.2.2.VII.14/LP/2019) issued by the Ethical Committee of Research of the Faculty of Medicine, Universitas Udayana. Written informed consent was obtained from all participants in the study.

RESULTS

Current Situations of TC/CC in Bali

Continuing previous community surveys held in 2011-2016 and 2019, this study gained data on TC/CC prevalence among humans and pigs in Dukuh village in 2020. All participants were diagnosed in the same manner, such as giving questions regarding possible signs, symptoms, and history of diseases related to TC/CC, followed by physical examinations. This study was conducted after some implementations of One Health-based methods in 2019; one has already been published.¹³

During the 2020 community survey, 474 individuals participated, and 202 provided fecal samples. The prevalence of *Taenia solium* taeniasis in the Kubu subdistrict of Karangasem has decreased from the previous study as only one individual had confirmed from conducting the interview.

Fourteen over 474 individuals were confirmed to be seropositive; thus, overall seroprevalence in humans was 0.03%, slightly more in absolute counts than in 2019. The seroprevalence of pigs in Kubu during the 2020 survey was 2.92% (8/274), compared with a serological examination in 2019, as no positive cases were found.¹

Three cases of NCC and one case of CC were reported in a hospital-based setting in Bali in 2020. The NCC cases consist of intraventricular, intraparenchymal, and spinal subtypes. A case of intramuscular cysticercosis on a patient with a chief complaint of a decrease in consciousness was detected.

Associated Risk Factors

Surveys conducted in 2020 were also focused on gathering in-depth information about water and waste management along with their behavior regarding environmental awareness of either society in general or the food handlers in Dukuh village, Kubu, as a complementary to the data of previous surveys to design a comprehensive framework of interventions and assessing future challenges. From this study, 93.1% of houses were considered seedy, and so did 40% of food handlers' stores.

To fulfill their household needs, the villagers predominantly used either rainwater or bought water distributed by tank trucks. Similar proportions in each source were observed in a group of food handlers, where 20% utilized water gained from rainwater storage. The physical quality of drinking water in Dukuh village was turbid, colorless, tasteless, and odorless, and no foams were observed.

Data on hygiene aspects has been retrieved by considering household waste management, toilets, and handwashing habits. Household management among villagers in Dukuh village was considered poor. Most (79.2%) of them manage their household waste by burning it, and almost all of the general and food handlers' samples throw away their waste onto either the ground or rivers. No integrated waste management was reported. Despite nearly all of them having private-owned toilets, there was a small portion (6%) of people who still implement open defecation in their daily lives. Almost 20% of food stalls

in Dukuh village were without adequate handwashing facilities such as clean water, soaps, and tissues. All the food handlers in Dukuh wash their hands during processing and before serving food. Nevertheless, rather than using running water, most of them tend to use the water stored in pails.

In the village of Dukuh, eating "lawar" is a common practice. It is a typical dish comprised of vegetables, prawn paste, peppers, and herbs, in which pig's blood and raw meats are added for a variation called "lawar Barak" ("Barak" is the Balinese word for red color). In this village, lawar is usually served during special occasions and ceremonies related to culture and religion. The ceremonies are part of Balinese culture, which delighted in some time-specific events to commemorate essential stages during the life of every human being. In this case, the ceremonies were conducted in an atmosphere of festivity, with various foods as offerings to the religious states, in which pork and pig-related dishes are the main courses.

One Health Approach: Level of Knowledge after Interventions

Online education for Youngsters in Dukuh Village

Knowledge scores were assessed before and after the designated online program. Since every correct answer was worth one point and every false one was worth zero. Thus, the maximum score gained was 100. The knowledge scores increased significantly after the intervention (Fig. 2). The median (inter-quartile range) of the knowledge scores increased from 80 before the intervention to 100 at the end of the online education program ($Z=-6.29$; $p<0.0001$).

Psychology: Knowledge of primary students

Online games and comics increased primary school students' knowledge, whereas online games were more effective than comics. The statistical test results showed that students' learning was significantly higher after being given the intervention (Mean=14.476, SD=1.625) compared to the previous condition (Mean=14.064, SD=1.615) ($p = 0.044$). These results support the idea

that intervention (SiCapit and comics) increases students' knowledge of taeniasis.

The initial knowledge of the two groups was equivalent. After the intervention, the knowledge score in the group of students who played the SiCapit game (M=14,886) was significantly higher compared to the group of students who received education by comics (M= 13,964) $p = 0.018$.

DISCUSSION

The burden of TC/CC infection, especially in the central nervous system as NCC induces epilepsy and other chronic neurology problems, has been identified to be the pivotal reason for catastrophic effects on socio-economic aspects.¹⁴ *Taenia solium* has been identified in Bali for almost 100 years after its first appearance in the doctoral thesis of Le Coultre (1928) and is still a concern in the public health area despite the promising development of therapeutic approaches.² As the first step of designing a One Health framework for defeating Taeniasis, various epidemiological studies have identified the prevalence of TC/CC in Bali. It cannot be denied that sporadic cases in humans still exist. Thus, identifying risk factors is needed to understand the following plans comprehensively.

Hygiene aspects, including water and waste management, are critical factors in controlling TC/CC, based on studies assessing the significance of the environment towards transmission and infection control measures of Taeniasis.¹⁵⁻¹⁷ A systematic review by Jansen F et al. revealed a higher survival rate of *Taenia spp.* eggs favored by low temperature (0-20 °C), impaired quality of wastewater treatment system, and use of sludge from wastewater treatment plants to fertilize fields on which crops used for animal fodder and human foods. Those factors were observed in our study location and seem to be a strong reason why Kubu is still endemic for Taeniasis.

One Health has been recognized as an important game-changing approach in neglected and endemic tropical diseases, as it keeps removing obstacles connecting sectors such as science, health, and security, as well as crucially bridging gaps between natural and social fields of knowledge.¹⁸ To control endemic infectious diseases

in humans, this collaborative approach has a broader perspective beyond human health compared with Planetary Health, a newer collaborative method where humans are valued more than other animals or ecosystems.¹⁹ These advantages should be used as a strong advocacy to the government for a sustainable implementation of prevention and control measures of TC/CC (Fig. 3).

The participants in health education programs in this study consisted of younger-age populations consisting of adolescents and children. It has been observed that adolescents and children make up a core target group for studies assessing health literacy. This is due to their ongoing fundamental processes of cognitive, emotional, and physical development, which is essential for maintaining personal health and well-being into adulthood. From the public health perspective, health literacy interventions targeting children and adolescents can effectively prevent future health risks and promote healthy behaviors.²⁰

Various studies have reported the efficacy of health education in infectious disease prevention and control for students. Health education has significantly improved knowledge of infectious diseases and alleviated preventive behaviors among primary, secondary, and high school students. Lack of family health guidance, minimum access to knowledge as described by their area of living, and low socioeconomic status contributed to lower scores on knowledge.²¹⁻²³ The relationship between education and health has been linked to various potential indicators, including but not limited to interrelationships between demographic and family background factors.²⁴ In this study, the knowledge levels of primary school students were not statistically different. Thus, a continuous intervention regarding the elevation of knowledge is needed.

At Dukuh village, pigs raised to have a tendency to roam around and consume human feces, let loose into the surrounding environment as they would discover their own food as no specialized pig farms were found. Some people cage them in the backyards, while others tether

them to trees. If we look into a broader spectrum, raising pigs in Bali is such an investment to every family, dedicated to upcoming traditional ceremonies. In general, pig farming activities in Bali are considered to be free-range instead of barn-hut. Due to the multidimensional nature of transmission, this may alter how people, animals, and the environment interact in Kubu, which is relevant to One Health. The TC/CC zoonoses may emerge or reappear as a result of these alterations.

Delivering education to various community groups is a crucial part of this TC/CC control approach. Along with education for primary school students and adults, regular social services, which included fecal sampling to identify the incidence of Taeniasis, have previously been held in the village of Kubu. It ensures the concept of sustainability in the prevention approach. As continuity is one of the important factors in addressing the One Health approach, education should be implemented by giving specified modules related to TC/CC and delivered in a regular manner. It should be important to remember that cultural forces among human societies define social relations and thus need to be considered in designing a comprehensive prevention control model of infectious disease, particularly TC/CC.²⁵⁻²⁹

Stakeholders, in this case, consisting of local and national-level government, are the next stage of One Health implementation after the community level. Samples were taken by a team of health centers in Kubu and an animal health center in Karangasem district so that it was carried out comprehensively, not only by multidisciplinary academics but also by stakeholders in the area. A systematic review by Dos (2019) has revealed that the most challenging factor in performing the One Health initiative framework is promoting collaboration at the stakeholder level, along with efforts to match the wide diversity of policies among them.³⁰⁻³² In particular, the collaborative activities mentioned in this paper can be utilized as a basis for advocacy, providing evidence that it will be simpler for the government to control the TC/CC beyond any potential future cost-effectiveness since the endemic and neglected infectious

diseases typically receive less funding than unpredictable emergent outbreaks.

This study has some limitations. First, the delivery of information by the team during the implementation of the program was only using social media rather than direct live interaction. The method was adjusted due to the COVID-19 pandemic situation, where social distancing is mandatory. Lack of communication signals owing to remote geographic location and the fact that not all residents of Dukuh village had smartphones were further limitations discovered during program implementation. Even if some adjustments were made, both interventions showed promising results. Second, we were only assessing some districts in Kubu as sample points. Third, the short time frame chosen for conducting both interventions in this study is likely to affect the impact of the interventions on the residents' knowledge and behavior toward TC/CC. Because of this, it is impossible to evaluate the intervention's long-term effects. A longer time frame has been suggested to ensure sustainability in the information process and transfers among residents. Fourth, this study did not use any control group during the implementation of education programs, so it was impossible to determine if the observed improvements in knowledge and behavior were due to interventions alone. Despite these limitations, this study still proves its significance in controlling TC/CC and provides references for disease conditions, risk factors, and plans for implementing One Health approaches. Future research is needed to continue the aim of this study by including a larger scope in endemic areas of the Kubu subdistrict-surrounding village other than Dukuh. The designed future efforts will impede the limits of the current study, acknowledging that the COVID-19 outbreak has ended.

CONCLUSION

Since TC/CC is still a problem in an endemic area of Kubu, Karangasem District of Bali, a comprehensive One Health approach is needed to maintain the sustainability of current progress. This study has provided remarkable success in increasing public knowledge, behavior, and awareness towards TC/CC as an early

step in controlling the disease through the designated One Health framework. Despite some challenges in each stage of implementation, the One Health approach to TC/CC control in Bali is a worthwhile contribution to be made.

CONFLICT OF INTEREST

All authors have declared that no conflicts of interest were taken during the process of making this manuscript.

ETHICAL CONSIDERATION

This research has complied with the ethical consideration based on the Ethical Clearance document (2099/UN14.2.2.VII.14/LP/2019) issued by the Ethical Committee of Research of the Faculty of Medicine, Universitas Udayana. Written informed consent was obtained from all participants in the study.

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AUTHOR CONTRIBUTIONS

A.A. Raka Sudewi: conceptualization, supervision, writing-review and editing, funding; Kadek Swastika: Data curation, methodology, formal analysis; I Made Sudarmaja: data curation, methodology, formal analysis; Ni Made Swasti Wulanyani: data curation, methodology, formal analysis, investigation; Nyoman Sadra Dharmawan: validation, methodology, writing-review and editing; I Made Ady Wirawan: data curation, formal analysis, investigation; A.A. Ngurah Anom Kumbara: writing-review and editing, methodology; Tjokorda Istri Pramitasuri: writing-original draft, formal analysis; A.A. Ayu Suryapraba Indradewi Karang: data curation, methodology; Ni Made Susilawathi: conceptualization, investigation, data curation, project administration, writing-review and editing.

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REFERENCES

- Ito A, Yoshida T, Wandra T, Sudewi AAR, Susilawathi NM, Swastika K, et al. Implementation of *Taenia solium* control measures in Bali, Indonesia: Survey findings and a historical overview. *Acta Trop.* 2022;227:106297.
- Okello AL, Thomas LF. Human taeniasis: current insights into prevention and management strategies in endemic countries. *Risk Manag Healthc Policy.* 2017;10:107-16.
- Mackenzie JS, Jeggo M. The One Health Approach-Why Is It So Important? *Trop Med Infect Dis.* 2019;4(2):88.
- Mwacalimba KK, Green J. 'One health' and development priorities in resource-constrained countries: policy lessons from avian and pandemic influenza preparedness in Zambia. *Health Policy Plan.* 2015;30(2):215-222.
- Nyatanyi T, Wilkes M, McDermott H, Nzietchueng S, Gafarasi I, Mudakikwa A, et al. Implementing One Health as an integrated approach to health in Rwanda. *BMJ Glob Health.* 2017;2(1):e000121.
- Sutisna P, Kapti IN, Wandra T, Dharmawan NS, Swastika K, Raka Sudewi AA, et al. Towards a cysticercosis-free tropical resort island: A historical overview of taeniasis/cysticercosis in Bali. *Acta Trop.* 2019;190:273-283.
- Swastika K, Wandra T, Dharmawan NS, Sudarmaja IM, Saragih JM, Diarthini LPE, et al. Taeniasis caused by *Taenia saginata* in Gianyar town and *Taenia solium* in Karangasem villages of Bali, Indonesia, 2011-2016: How to detect tapeworm carriers, anamnesis or microscopy? *Acta Trop.* 2017;174:19-23.
- Wandra T, Ito A, Swastika K, Dharmawan NS, Sako Y, Okamoto M. Taeniasis and cysticercosis in Indonesia: past and present situations. *Parasitology.* 2013;140(13):1608-16.
- Wandra T, Swastika K, Dharmawan NS, Purba IE, Sudarmaja IM, Yoshida T, et al. The present situation and towards the prevention and control of neurocysticercosis on the tropical island, Bali, Indonesia. *Parasit Vectors.* 2015;8:148.
- Soejitno A, Niryana IW, Sriwidayanti NP, Susilawathi NM, Witari NP, Sudewi AAR. Neurocysticercosis presented as a solitary cystic parenchymal lesion mimicking primary brain tumor: A case report. *IDCases.* 2020;22:e01004.
- Susilawathi NM, Suryapraba AA, Soejitno A, Asih MW, Swastika K, Wandra T, et al.

- Neurocysticercosis cases identified at Sanglah Hospital, Bali, Indonesia from 2014 to 2018. *Acta Trop.* 2020;201:105208.
- Swastika K, Dewiyani CI, Yanagida T, Sako Y, Sudarmaja M, Sutisna P, et al. An ocular cysticercosis in Bali, Indonesia caused by *Taenia solium* Asian genotype. *Parasitol Int.* 2012;61(2):378-380.
- Wulanyani NMS, Pratama YS, Swastika K, Sudarmaja IM, Wandra T, Yoshida T, et al. A preliminary study to assess the use of a "Snakes and Ladders" board game in improving the knowledge of elementary school children about taeniasis. *Acta Trop.* 2019;199:105117.
- Segala FV, De Vita E, Amone J, Ongaro D, Nassali R, Oceng B, et al. Neurocysticercosis in Low- and Middle-Income Countries, a Diagnostic Challenge from Oyam District, Uganda. *Infect Dis Rep.* 2022;14(4):505-508.
- Jansen F, Dorny P, Gabriel S, Dermauw V, Johansen MV, Trevisan C. The survival and dispersal of *Taenia* eggs in the environment: what are the implications for transmission? A systematic review. *Parasit Vectors.* 2021;14(1):88.
- Sanchez Thevenet P, Alvarez HM, Basualdo JA. Survival, physical and physiological changes of *Taenia hydatigena* eggs under different conditions of water stress. *Exp Parasitol.* 2017;177:47-56.
- Wardrop NA, Thomas LF, Atkinson PM, de Glanville WA, Cook EA, Wamae CN, et al. The Influence of Socio-economic, Behavioural and Environmental Factors on *Taenia* spp. Transmission in Western Kenya: Evidence from a Cross-Sectional Survey in Humans and Pigs. *PLoS Negl Trop Dis.* 2015;9(12):e0004223.
- Saylor K, Wolkong DJ, Hagan E, Martinez S, Francisco L, Euren J, et al. Socializing One Health: an innovative strategy to investigate social and behavioral risks of emerging viral threats. *One Health Outlook.* 2021;3(1):11.
- Lerner H, Berg C. A Comparison of Three Holistic Approaches to Health: One Health, EcoHealth, and Planetary Health. *Front Vet Sci.* 2017;4:163.
- Borzekowski DL. Considering children and health literacy: a theoretical approach. *Pediatrics.* 2009;124 Suppl 3:S282-8.
- Wang M, Han X, Fang H, Xu C, Lin X, Xia S, et al. Impact of Health Education on Knowledge and Behaviors toward Infectious Diseases among Students in Gansu Province, China. *Biomed Res Int.* 2018;2018:6397340.
- Carabin H, Traore AA. *Taenia solium* taeniasis and cysticercosis control and elimination through community-based interventions. *Curr Trop Med Rep.* 2014;1(4):181-193.
- Sarti E, Flisser A, Schantz PM, Gleizer M, Loya M, Plancarte A, et al. Development and evaluation of a health education intervention against *Taenia solium* in a rural community in Mexico. *Am J Trop Med Hyg.* 1997;56(2):127-132.
- Raghupathi V, Raghupathi W. The influence of education on health: an empirical assessment of OECD countries for the period 1995-2015. *Arch Public Health.* 2020;78:20.

25. Dos SRC, van de Burgwal LHM, Regeer BJ. Overcoming challenges for designing and implementing the One Health approach: A systematic review of the literature. *One Health*. 2019;7:100085.
26. Bhatia R. Implementation framework for One Health approach. *Indian J Med Res*. 2019;149(3):329-331.
27. Wedari NLPH, Sukrama IDM, Budayanti NNS, Sindhughosa DA, Prabawa IPY, Manuaba IBAP. One Health concept and role of animal reservoir in avian influenza: a literature review. *Bali Medical Journal*. 2021;10(2):515-520.
28. Buckee C, Noor A, Sattenspiel L. Thinking clearly about social aspects of infectious disease transmission. *Nature*. 2021;595(7866):205-213.
29. Bayeh R, Yampolsky MA, Ryder AG. The Social Lives of Infectious Diseases: Why Culture Matters to COVID-19. *Front Psychol*. 2021;12(1):648086.
30. Oka IBM, Dwinata IM, Dharmawan INS, Damriyasa IM, Astawa NM. Profiles of IgM, IgG, and IgE immune responses of mice against p14, p31, and p71 proteins following immunization with the crude cystic fluid of *Cysticercus bovis*. *Bali Medical Journal*. 2019;8(3):719-727.
31. Widodo A, Prabandari YS, Sudiyanto A, Rahmat I. Increasing the quality of life of post-shackling patients through multilevel Health promotion of shackling prevention. *Bali Medical Journal*. 2019;8(2):678-688.
32. Negara KSP, Sari Y, Wijayanti L, Haryati S, Anjani AH, Azzahra AZ et al. One health strategy in prevention and control of parasitic zoonosis globally and Indonesia- from theory to practice: a mini-review. *Bali Medical Journal*. 2022;11(3):1537-1542.



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