EPIDEMIOLOGY OF MALARIA DETERMINANTS IN CHILDREN IN PURWOREJO REGENCY (CASE CONTROL STUDY OF MALARIA IN CHILDREN IN 2022-2023)

Rahayu N*, Martini M, Arie WM, Retno H, Setiawan SH and Sakundarno AM

Department of Public Health Science, Faculty of Public Health, Diponegoro University, Indonesia

rahayuningtyas014@gmail.com

Abstract: Since 2019, Annual Parasite Incidence of malaria in Indonesia has increased from 0,9/ 1.000 to 1,1/ 1.000 people until 2021. Purworejo is a regency in Central Java with the high malaria cases, reach 544 cases with 129 cases in children 0-18 years in 2022. This study aims to analyze the risk factors for malaria in children 0-18 years in Purworejo. It is an analytic observational study with case control design. Case and control groups were selected based on the results of blood microscopic test. Data were analyzed univariately and bivariately using the chi square test with 0,05 degree of significance and presented in a cross table. This study recruited 154 parents/ guardians. From the results of bivariate analysis, malaria cases in children related with the existence of breeding places (p = 0,010), the existence of resting place (p = 0,037), knowledge of parents/ guardians (p = 0,001), and prevention practices by parents/ guardians (p = 0,035). Attitude of parents/ guardians (p = 0,159) and the existence of cattle pens (p = 0,127) were not related to the incidence of malaria in children. Child's age (p = 0,007; OR = 0,341) is a protective factor for malaria in children. From the results of multivariate analysis, malaria in children caused by the existence of breeding place (p = 0,010; OR = 0,421; 95%CI = 0,218–0,814) and prevention practices of parents/ guardians (p = 0,036; OR = 2,028; 95%CI = 1,047–3,925) is a protective factor for malaria in children. Community education and vector control need to be improved considering malaria in children influenced by environmental and behavior of parents/guardians' factors.

Keywords: malaria, children, risk factors

Introduction

Malaria is a red blood cell infection disease caused by plasmodium parasites that inoculated into the human body through the bite of an infected female Anopheles mosquito.(World Health Organization, 2010) Plasmodium species that cause malaria are P. falciparum, P. vivax, P. malariae, P. ovale and P. knowlesi. Malaria infection caused by P. falciparum is the most dangerous type of infection because it can cause severity like cerebral malaria, even mortality if not treated immediately.(Recht et al., 2017) The clinical symptoms of malaria are headache, shiver, muscle ache, nausea/ vomiting, dizzy, fever, or combination of these symptoms. While the symptoms of severe malaria are convulsions,

*Corresponding Author's Email: rahayuningtyas014@gmail.com

respiratory disorder, acidosis, hypoglycemia, fluid and electrolyte disturbance, homeostatic disturbance, hyperparasitemia, anemia, coma, cerebral malaria, and death.(Maria Van Eijk et al., 2020) According to the Global Malaria Report (2021), nearly half of the world's population (87 countries) live in the high risk area of malaria transmission. Malaria is one of the important health problems in the world, especially in tropic and subtropic countries like Indonesia. Children are one of the groups most vulnerable to malaria in high transmission area. It is because children have not yet developed partial immunity to malaria. In 2020, there was 241 million malaria cases in the world with 627.000 deaths (mostly children in sub-Saharan Africa).(Centers for Disease Conrol and Prevention, 2022) According to the Global Malaria Report, there was 247 million malaria cases with 619.000 death in 2021. During the peak 2 years of the COVID-19 pandemic (2020–2021), there was an increase in cases and mortality caused by malaria (around 13 million more cases and 63.000 death). In 2021, toddler accounts for nearly 80% of death caused by malaria in the African region.(World Health Organization, 2022)

In 3 consecutive years, Annual Parasite Incidence in Indonesia increased from 0,9 per 1.000 people in 2019 and 2020 to 1,1 per 1.000 people in 2021.(Kementrian Kesehatan Republik Indonesia, 2022) The increase of API also occurred in Central Java Province, from 0,01 per 1.000 people in 2019 dan 2020 to 0,02 per 1.000 people in 2021.(Kementrian Kesehatan Republik Indonesia, 2022),(Badan Penelitian dan Pengembangan Kementrian Kesehatan Republik Indonesia, 2019) Purworejo is one regency in Central Java that has not been eliminated from malaria until 2022.(Dinas Kesehatan Provinsi Jawa Tengah, 2019) Malaria cases in Indonesia reached 304.607 cases in 2021.(Kementerian Kesehatan Republik Indonesia, 2022) Based on data from the Purworejo Regency Health Office, malaria cases in Purworejo during 2017-2020 has decreased significantly from 338 cases in 2017, to 194 cases in 2018, to 27 cases in 2019, and 7 cases in 2020. However, malaria cases in Purworejo again increased drastically in 2021 reach 538 cases. In 2022, malaria cases in Purworejo reached 523 cases that spread accros 5 malaria endemic district including Bener District, Kaligesing District, Loano District, Bagelen District, and Purworejo District. Most of the malaria cases that occurred in Purworejo Regency were indigenous cases with the type of parasite is Plasmodium falciparum.(Dinas Kesehatan Kabupaten Purworejo, 2022)

According to the Indonesian Minister of Health Regulations, Children are someone who is less than equal to 18 years. Thus, malaria in children is a red blood cell infection by plasmodium parasites in someone aged ≤ 18 years. Malaria in children in Indonesia relatively high. According to the Riskesdas 2018, the incidence of malaria from result of blood microscopy reached 0,4%, where 0,78% of them were occur in children (age 0-14 years) with the highest type of parasite that attacks the gorup of children is P. falciparum as muh as 0,73%.(Badan Penelitian dan Pengembangan Kementrian Kesehatan Republik Indonesia, 2019) Purworejo Regency Health Office data shows that there was an

increase in cases of malaria in children (0-18 years) in Purworejo Regency, from 56 cases in 2018, to 1 cases in 2019, 0 cases in 2020, 145 cases in 2021, and 129 cases in 2022.(Dinas Kesehatan Kabupaten Purworejo, 2022) Based on these data, authors intend to conduct research entitled "Epidemiology of Malaria Determinants in Children in Purworejo Regency (Case Control Study of Malaria in Children in 2022-2023)" with the aim of studying the risk factors that influence the incidence malaria in children (age 0-18 years) in 3 districts in Purworejo Regency, there are Bener District, Purworejo District, and Kaligesing District.

Methods

This research was conducted from February-June 2023 in 3 endemic district with highest malaria cases during 2022 in Purworejo Regency, including Bener District, Purworejo District, and Kaligesing District. This research classified as analytic observational research with a case-control study design. Population in this study are parents/ guardians of children aged 0-18 years in Bener District, Purworejo District, and Kaligesing District during 2022 as much as 12.792 people. Sample in this study consist of case group sample as much as 77 respondent taken by total sampling technique and control group sample as much as 77 respondent taken by purposive sampling technique. Dependent variable in this study are child's age, environmental factors (involve : the existence of cattle pens, the existence of breeding place, the existence of resting place), and behavioral factors of parents/ guardians (involve : knowledge, attitude, and malaria prevention practices). While, independent variable is malaria status in children aged 0-18 years. Data were collected through interviews to collect data on the behavioral factors of parents/ guardians using a questionnaire sheet and through observations to collect data on environmental factors using an observations sheet. Data were processed using Ms. Excel through stages are editing, scoring, coding, entry, cleaning, and tabulating. Data were analyzed using SPSS software univariately and bivariately. Univariate analysis was performed to analyze all variable descriptively in the form of a frequency distribution table. Meanwhile, bivariate analysis was performed to know whether there is relationship between dependent variable with independent variable using a Chi Square statistical test ($\chi 2$) with meaning limit (α) = 0,05 and ConfidenceeInterval (CI) = 95%. The results of Chi Square test presented in cross tabular form to count the value of OddsnRatio (OR).

Results

Below are the results of the interview on 154 respondents consist 77 respondent in case group and 77 respondent in control group in Purworejo Regency, specifically in Bener District, Kaligesing District, dan Purworejo District.

Table 1. Univariate Analysis of Research Respondent Characteristics

Respondent Characteristic	Case		Control		Total	
	n = 77	%	n = 77	%	n = 154	%
PARENTS/ GUARDIANS						
Age						
< 65 years	75	97,4	72	93,5	147	95,5
≥ 65 years	2	2,6	5	6,5	7	4,5
Sex						
Man	30	39,0	19	24,7	49	31,8
Woman	47	61,0	58	75,3	105	68,2
Status of the Child						
Parent	71	92,2	63	81,8	134	87,0
Guardian	6	7,8	14	18,2	20	13,0
Education						
Uneducated	1	1,3	3	3,9	4	2,6
Elementary School	37	47,4	30	39,5	67	43,5
Junior High School	30	38,5	34	44,7	64	41,6
Senior High School	9	11,5	9	11,8	18	11,7
College	1	1,3	0	0,00	1	0,6
Occupation						
Government employees	0	0,0	0	0,0	0	0,00
Army/ Police	0	0,0	0	0,0	0	0,00
Farmer	48	62,3	48	62,3	96	62,3
Trader	1	1,3	6	7,8	7	4,5
Laborer	22	28,6	19	24,7	41	26,6
Others	6	7,8	4	5,2	10	6,5
Income						
≤ Rp. 1.000.000	31	40,3	24	31,2	55	35,7
Rp. 1.100.000 - Rp. 2.000.000	42	54,5	51	66,2	93	60,4
Rp. 2.100.000 - Rp. 3.000.000	4	5,2	2	2,6	6	3,9
Rp. 3.100.000 - Rp. 4.000.000	0	0,0	0	0,0	0	0,0
> Rp. 4.000.000	0	0,0	0	0,0	0	0,0
CHILDREN						
Sex						
Male	52	67,5	52	67,5	104	67,5
Female	25	32,5	25	32,5	50	32,5
Education						
Not yet in school/ Early Cildhood Education/ Kindergarden	23	29,9	31	40,3	54	35,0
Elementary School	20	26,0	27	35,1	47	30,5
(Junior &Senior) High School	34	44,2	19	24,7	53	34,4
Graduate from High School/ College	0	0,0	0	0,0	0	0,0

Based on table 1, it is known that respondents in this study dominated by adult society (< 65 tahun) as much as 147 people (95,5%), where the youngest age is 20 years and the oldest age is 75 years. Respondents also dominated by women, as much as 105 people (68,2%). Based on their status with child, the majority of respondents are parents, as much as 134 people (87,0%). Most of the respondent still have low education, like no school, primary school graduate, and junior high school graduate as

much as 135 people (87,7%). Most of the work of the respondents are farmers as much as 96 people (62,3%), with average income per month is Rp. 1.100.000 - Rp. 2.000.000 as much as 93 people (60,4%).

Table 2. Bivariate Analysis between Dependent Variable and Independent Variable

Variable	Case	Control	Total	p-value	OR (95% CI)
	n (%)	n (%)	n (%)		
Child's Age					
Toddler	22 (28,6%)	26 (33,8%)	48 (31,2)	0,059	0,470 (0,214 – 0,314)
Childhood	19 (24,7%)	31 (40,3%)	50 (32,5)	0,007	0,341 (0,154- 0,751)
Teenager	36 (46,8%)	20 (26,0%)	56 (36,4)	comparison	
The Existence of Cattle Pens					
Yes	31 (40,3)	22 (28,6)	53 (34,4)	0,127	1,685 (0,860 – 3,300)
No	46 (59,7)	55 (71,4)	101 (65,6)		
The Existence of Breeding Place					
Yes	43 (55,8)	27 (35,1)	70 (45,5)	0,010	2,342 (1,224 – 4,483)
No	34 (44,2)	50 (64,9)	84 (54,5)		
The Existence of Resting Place					
Yes	59 (76,6)	47 (61,0)	106 (68,8)	0,037	2,092 (1,040 – 4,208)
No	18 (23,4)	30 (39,0)	48 (31,2)		
Knowledge of Parents/ Guardians					
Less	47 (61,0)	27 (35,1)	74 (48,1)	0,001	2,901 (1,507 – 5,585)
Good	30 (39,0)	50 (64,9)	80 (51,9)		
Attitude of Parents/ Guardians					
Less	27 (35,1)	19 (24,7)	46 (29,9)	0,159	1,648 (0,820 – 3,314)
Good	50 (64,9)	58 (75,3)	108 (70,1)		
Prevention Practices of Parents/ Guardians					
Less	41 (53,2)	28 (36,4)	69 (44,8)	0,035	1,993 (1,046 - 3,799)
Good	36 (46,8)	49 (63,6)	85 (55,2)		

From the results of bivariate analysis in table 2, it is known that the variables that have a significant relationship (p ≤ 0,05) with incidence of malaria in children aged 0-18 years are the existence of breeding place (p = 0,010; OR = 2,342; 95% CI = 1,224 – 4,483), the existence of resting place (p = 0,037; OR = 2,092; 95% CI = 1,040 – 4,208), knowledge of parents/ guardians (p = 0,001; OR = 2,901; 95% CI = 1,507 – 5,585), and prevention practices of parents/ guardians (p = 0,035; OR = 1,993; 95% CI = 1,046 – 3,799). Variables that were not related (p > 0,05) with incidence of malaria in children aged 0-18 years are the existence of cattle pens (p = 0,127) and attitude of parents/ guardians (p = 0,159). Child's age has a negative relationship with the incidence of malaria in children aged 0-18 years.

Table 3. Multivariate Analysis between Dependent Variable and Independent Variable

Variable	p-value	Exp(b)	95% CI
The existence of breeding place	0,036	1,047	1,623-3,925
Prevention practices of parents/ guardians	0,010	0,421	0,218-0,814

Table 3. presents a multivariate analysis of the variables that have relationship with malaria in children based on the results of bivariate analysis. From the results of multivariate analysis, its known that the most dominant variable as a risk factor of malaria in children is the existance of breeding place with p = 0,036 and OR = 1,047. While prevention practices of parents/ guardians is a protective factor for malaria in children aged 0-18 years with p = 0,010 and OR = 0,421.

Discussion

Child's age is negatively related to the incidence of malaria in children. This results are similar with the previous research (Yusuf Haji *et al.*, 2016) which showed an increase malaria incidence in teenager (10-15 years) higher than children aged < 2 years (OR = 2,19), while childhood decrease the risk of risiko malaria infeksi.(Haji et al., 2016) Ira Indriaty Paskalita B. S. and Yona Patanduk (2015) in their research found that the most seriuos cases of malaria occurred in toddlers.(Sopi & Patanduk, 2015) Children aged 6-11 years is a protective factors for malaria incidence in children aged 0-18 years. It is estimated due to behavioral difference factor from each child's age. In teenager, they already have some activity outside the house at night that are at risk of causing contact with malaria vector.(Patiran & Patiran, 2019) Toodlers are also more at risk of being infected with malaria because toodlers immune response to malaria is formed more slowly than older children.(Sopi & Patanduk, 2015)

Knowledge of parents/ guardians is a risk factor of malaria incidence in children aged 0-18 years in Purworejo Regency. It is appropriate with the research of Ruben Wadu Willa and Ni Waya Dewi A, which states there is a significance relationship between knowledge of parents/ adults of toodler with malaria.(Willa & Adnnyana, 2011) But, this research is not appropriate with the research of Nor Asila et al. (2022) which found there is no relationship between knowledge of parents with malaria in children aged 5-15 years.(Asila et al., 2022) Soekidjo Notoatmodjo (2011) in his book said that knowledge is the most important domain to establish someone's action/ behavior.(Notoatmodjo, 2011) It means that good or bad knowledge of parents/ guardians very determines the formation of risky or not risky action malaria incidence in children aged 0-18 years. Therefore, children of ill-informed parents/ guardians tend to be more likely to get malaria (61%) than children of knowledgeable parents/ guardians about malaria and its prevention (35,1%).

Malaria prevention practices of parents/ guardians is a risk factor of malaria incidence in children aged 0-18 years in Purworejo Regency. Itis coresponding with the research of Ruben Wadu Willa and Ni Waya Dewi A, which states there is a significance relationship between prevention action of parents/ adults of toodler with malaria.(Willa & Adnnyana, 2011) But, this research is not coresponding with the research of Agung Richardo M. et al. (2014), which found no relationship between family behavior factors with malaria incidence in children.(Mirontoneng et al., 2014) Soekidjo Notoatmodjo (2011) from his book said that attitude has not automatically formed into an action/ behavior cause the most important domain to formed someone's action/ behavior is knowledge.(Notoatmodjo, 2011) That statement is in accordance with the result of this research. In case group, malaria prevention practices by parents/ guardians is more poorly (53,2%) though attitude of parents/ guardians about malaria prevention is already good (64,9%). It is caused by knowledge level of parents/ guardians about malaria is still low (61,0%).

The existence of Anopheles mosquito breeding places around the house is a risk factor for malaria in children aged 0-18 years in Purworejo Regency. It is in line with research by Ira Indriaty Paskalita B. S. and Yona Patanduk (2015), which found that the presence of stagnant water are potentially to become breeding places for Anopheles mosquitoes which is at risk of transmitting malaria to toddler.(Sopi & Patanduk, 2015) But, this research is not appropriate with the research of Chantal Nyirakanani et al. (2018) which found no relationship between the existence of Anopheles mosquito breeding places around the house with malaria incidence in children.(Nyirakanani et al., 2018) This relationship between the existence of Anopheles mosquito breeding places and malaria in children aged 0-18 years can be caused by the compatibility between the types of breeding places found during the study and the Anopheles mosquito breeding habitats in Purworejo Regency (such as : An. balabacensis, An. maculatus, An. barbirostris, An. vagus, An. aconitus and An. kochi). In addition, seasonal factors also affects this relationship because an increase malaria cases in children occurs during the dry season (when this study took place in April-October), where the presence of stagnant waters which has the potential to become a breeding place of Anopheles mosquito are increases in that season.(S et al., 2018) The enhancment of breeding places during the dry season is due to the fact that the research area passed through a large river flow, so that when the river recedes, many water basins will appear between the rocks on the river banks.

The existence of Anopheles mosquito resting places around the house is a risk factor of malaria in children aged 0-18 years in Purworejo Regency. It is coresponding with the research of Ira Indriaty Paskalita B. S. and Yona Patanduk (2015), which found the presence of dense vegetation around the house is risk of transmitting malaria in toddler.(Sopi & Patanduk, 2015) But, it is not coresponding with the research of Ruben Wadu Willa and Ni Waya Dewi A, which found no effect of the existence of vegetation as a place to perch or rest for Anopheles mosquitoes around the respondent's house who

suffered malaria in toddler.(Nababan & Umniyati, 2018) Relationship between the presence of Anopheles mosquito resting places and malaria in children is related with the behavior of Anopheles mosquito species in Purworejo Regency (An. balabacensis, An. maculatus, An. barbirostris, An. vagus, An. aconitus, and An. kochi) that having exophilic habits or prefer perch/ rest in outdoor.(S et al., 2018) It is in line with the results of this study which found that the presence of potential places to become Anopheles mosquito resting places (such as unkempt gardens/ yards not maintained, forests, shrubs, and bamboo groves) around the respondent's house can increase the risk of malaria transmission in children aged 0-18 years.

The existence of cattle pens around the house is not risk factor for malaria in children aged 0-18 years in Purworejo Regency. Its can be caused species of Anopheles mosquitoes found in Purworejo Regency (such as : An. leucosphyrus, An. maculatus, An.vagus, An.indefinitus, An.barbirostris, An.kochi, and An.balabacensis) tend to be exophagic (prefer suck blood in the outdoor) and zoophilic (prefer animal blood than human blood).(Widjajanti & Kinansi, 2019) Anopheles mosquitoes which are zoophilic allow the existence of cattle pens to act as cattle barrier or bait for mosquitoes, because the exists of cattle can reduce Anopheles mosquitoes bite in human.(Zebua et al., n.d.) Thus, the existence of cattle pens around the respondent's house can decrease the risk of malaria transmission in children aged 0-18 years. The results of this study is analogous with the research of Taye Bayode and Alexander Siegmund (2022), which stated that there was no significant effect between the existence of cattle pens around the house and malaria incidence in toddler.(Bayode & Siegmund, 2022) However, this research is not in accordance with the research of Tirsa Feronika Natbais (2019) which prove that there was significant relationship between the existence of cattle pens and malaria incidence in teenager.(Tirsa Feronika Natbais, 2019)

Attitude of parents/ guardians is not a risk factors for malaria incidence in children aged 0-18 years in Purworejo Regency. It is because attitude is not a real action or activity that can prevent malaria incidence in children, but only a closed-response which does not necessarily encourage positive behavior. Soekidjo Notoatmodjo (2011) in his book said that knowledge plays an important role in developing a complete attitude because a good attitude shows compatibility between a person's closed-response and the received stimulus such as knowledge/ information.(Notoatmodjo, 2011) Parents/ guardians who have a good attitude towards malaria prevention because they already a good knowledge about malaria and its prevention. It is in accordance with the results of this study, where respondents with good knowledge (51,9%) are more than respondents with lack knowledge (48,1%). The results of this research are in line with the research of Santy et al.(2014) which found that there was no significant relationship between respondents' attitude about malaria prevention and malaria incidence, where most of the respondents in that research already had a good attitude towards malaria prevention.(Santy et al., 2014) However, this research is not coresponding with the research of Ruben

Wadu Willa and Ni Waya Dewi A, which found that there was a significant effect between attitudes of parents/ adults of toddler and malaria incidence in toddler.(Willa & Adnnyana, 2011)

Conclusions

This study proves that the existence of breeding places, the existence of resting places, the knowledge of parents/ guardians, and the prevention practices of parents/ guardians are potential risk factors for malaria in children. Where, the existence of breeding place is the most dominant risk factor and prevention practices of parents/ guardians is a protective factor for malaria in children aged 0-18 years in Purworejo Regency. The existence of cattle pens and the attitude of parents/ guardians are not risk factors for malaria in children aged 0-18 years in Purworejo Regency. Environment-based vector control and community education need to be improved in the research area.

Acknowledgements

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