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Controlling Factors that Potentially against Transmission of Dengue Hemorrhagic Fever at State Elementary Schools in Yogyakarta

Faktor Kontrol yang Berpotensi terhadap Penularan Demam Berdarah Dengue pada Sekolah Dasar Negeri di Yogyakarta

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Abstract
Elementary school is a place that can result in increase of dengue disease among children because of environmental factors, potential transmission, the absence of good environmental management system and some control efforts which are no longer effective. This study aimed to determine factors that potentially against transmission of dengue hemorrhagic fever in state elementary school, so the early warning system can be enforced. Type of study was analytic with cross-sectional design. The study was conducted in 91 state elementary schools in Yogyakarta City in 2014. Variables in the observation are virus serotype DEN, insecticide resistance, the density of vector and physical condition of schools. Data analysis used descriptive and correlation-regression (α = 5%). Results showed that there were eight schools with dengue virus serotype 2 and 3 mosquitoes declared to have mild and moderate resistance to organophosphate, the school environment was susceptible to transmission of dengue hemorrhagic fever based on the container index, house index, breteau index and ovitrap index, temperature and humidity inside and outside were potential to the high density of eggs, wire netting was not installed on ventilation and the very close distance between the buildings could lead to transmission.
Keywords: Dengue hemorrhagic fever, elementary school, transmission

Abstract
Sekolah dasar merupakan tempat yang dapat mengakibatkan peningkatan penyakit dengue pada anak karena faktor lingkungan, adanya potensi penularan, belum adanya system manajemen lingkungan yang baik dan beberapa upaya pengendalian yang tidak lagi efektif. Penelitian ini bertujuan untuk mengetahui faktor yang berpotensi terhadap penularan demam berdarah dengue bagi anak, sehingga sistem kewaspadaan dini dapat ditegakkan. Jenis penelitian ini adalah analitik dengan rancangan potong lintang. Penelitian dilaksanakan pada 91 sekolah dasar negeri di Kota Yogyakarta. Variabel yang diobservasi adalah serotype virus DEN, resistensi insektisida, kepadatan vektor,dan kondisi fisik sekolah. Analisis data menggunakan analisis deskriptif dan korelasi-regresi (α = 0.05). Hasil menunjukkan bahwa terdapat delapan sekolah dengan virus dengue serotip 2 and 3, terjadi resistensi insektisida organofosfat tingkat ringan dan sedang, lingkungan sekolah telah rentan terhadap penularan demam berdarah berdasarkan *container index, house index, breteau index* dan *ovitrap index*, suhu dan kelembaban di dalam dan luar ruangan berpotensi terhadap tingginya kepadatan telur, ventilasi tidak terpasang kawat kasa, dan jarak antara bangunan sangat dekat dapat menyebabkan penularan menjadi sangat cepat.
Kata kunci: Demam berdarah dengue, sekolah dasar, penularan

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Introduction

Dengue virus is a flavivirus genus (Arbovirus group B) one of the familia genus *Flaviviridae* which consists of four serotypes of the virus that are DENV-1, DENV-2, DENV-3 and DENV-4.[1] Transmission of dengue virus in humans is through the bite of mosquitoes infected with the virus when mosquitoes suck the blood of humans which have been infected. After the incubation period for 10 days, the infected female mosquitoes can transmit the dengue virus to other people during the rest of her life when blood sucking. Mosquitoes can also transmit the dengue virus in the offspring with vertical transmission (transovarial) or through eggs.[2]

Prospective cohort study showed no correlation between the density of *Aedes aegypti* with a prevalence of dengue infections because the density of mosquitoes vector associated with a tendency to blood sucking of humans, therefore increase the contact between humans and mosquitoes or the occurrence of dengue virus transmission, highly efficient, so the density should be as low as possible.[3] Study in six districts and one city in Central Java found transovarial transmission with a frequency of 0.48% - 8.77%, the rate of free larva below a standard 95% with the lowest and highest value of 46.51% - 90.0%.[4]

Study showed that mosquito habitat around human habitation housing conditions and inadequate sanitation are *Aedes aegypti* mosquito, *Aedes albopictus* and *Culex quinguefasciatus.*[5] The density of mosquitoes is influenced by the existence of a potential mosquito breeding sites, mosquito resting place and places for mosquitoes in search of food. The preferred places as a breeding ground are water reservoirs to daily purposes, not for daily use, and natural water reservoirs.[6]

Several attempts were made to control the spread of dengue, through virological surveillance on vectors which can be used as an early warning to predict outbreaks. The use of reverse transcription polymerase chain reaction (RT-PCR) to detect the presence of dengue virus in mosquitoes can be a method of monitoring serotypes/ virology in endemic areas of dengue virus infection, so as to prevent the occurrence of extraordinary events.[7] Characteristics of dengue virus serotypes in a region is very important to be observed because each serotype provides a different clinical picture. Mapping of dengue virus circulating in an area, the severity or degree of dengue hemorrhagic fever can be quickly identified. This epidemiological analysis can help reduce the impact that occurs when outbreaks.[8]

Mosquito control with chemicals such as malathion as an insecticide in the implementation of the selective fogging has been carried out since 1990, but study in Salatiga, Central Java on household insecticides circulating in the community showed that all household insecticide active ingredient included in the group synthetic pyrethroid have been resistant.[9] The results of biological testing found that all *Aedes aegypti* strains in Cuba, Venezuela, Costa Rica, and Jamaica declared susceptibility to malathion.[10] Similarly in Indonesia, study in Samarinda showed that *Aedes aegypti* mosquitoes were resistant of the insecticide *Malathion, Permethrin, Lambdasihalothrin* and *Bendiocarb*.[11]

Transmission of dengue fever among children aged 5-14 years mostly occurs on school age.[2,12] This is in line with results of study by Krianto,[13] that 30% of dengue hemorrhagic fever (DHF) patients in Depok are school-age children. The risk of contracting dengue virus is not only in school, but a study showed that the school has many mosquito-breeding places of *Aedes sp* because Figures Free Larva in the School District of Umbulharjo only reached 59.7%, very away from the national standard of 95%, as well as the existence of water containers in school potentially against the transmission.[4,14,15] These conditions need to be controlled through environmental surveys, entomology status of insecticide resistance and type of the virus throughout the state elementary schools in Yogyakarta. The results of this study can improve the early warning system, so the potential transmission to children in school can be controlled.

Method

Type of this study was analytic with cross-sectional design, in which places and samples come from all state elementary schools in Yogyakarta City as many as 91 schools through the technique of totality sampling. The study variables included factors, such as the physical environment, indoor air temperature, air humidity of the room, the physical condition of schools (floors, walls, ceilings, doors, window, ventilation, guttering, distance of buildings, drainage), the density of vector-based house index (HI), container index (CI), breteu index (BI) and ovitrap index (OI), status of insecticide resistance, and virus serotype.

Instrument used in this study were vector density measuring instrument with a method single larvae standard use of the Ministry of Health 2008; measurement of physical condition of school environments with the tools Thermo Hygrometer and Lux Meter has been calibrated in *Laboratorium Penelitian dan Pengujian Terpadu Universitas Gadjah Mada* (LPPT UGM) and measurements were taken three times; examination of serotype DEN virus in mosquito *Aedes aegypti* using imunositokimia, Nested-RT-PCR; testing of insecticide resistance with method microplate.[16] This method was applied to determine the increase in the activity of non-specific esterase enzymes in the body of the mosquito adults/larvae. The criteria used to interpret the results of lethal concentration (LC 50) or LC 100 were the mortality of 99 -

100% including vulnerable/sensitive, the mortality of 80 - 98% were tolerant, mortality less than 80% including resistance.[17] Data analysis used descriptive analysis and analytic correlation-regression with a p value = 0.05.

Results

Serotype Virus Dengue

Serotypes of dengue virus was done by collecting (pool) samples of mosquitoes captured from the field and adapted to the amount collected in each region of ± 20 tails, then grouped into one pool. Based on RT-PCR method was found one positive pool DEN-3 and DEN-2, this situation was shown by the emergence of the tape electrophoresis 290bp (DENV-3) and 119bp (DENV-2), as in Figure 1.

Examination results of DENV virus on *Aedes sp* in Pool 1, 2, 3 at state elementary schools was found DENV serotypes of DENV 2 and 3 in Pool 3. These results illustrate the high risk of DHF and potential outbreaks in schools.

Status of Insecticide Resistance

Most mosquitoes that were found in state elementary schools were still vulnerable to the type of *organophosphate* insecticides (Table 1). Examination results of dengue vector mosquito resistance showed that mortality of mosquitoes to insecticide exposure types of organophosphates was still relatively high at 36.3%, but there had been low resistance of 23.1% to moderate resistance of 18.7%.

Vector Density

Larval survey results conducted in 91 elementary schools with 693 containers, found 55 schools with 79 containers positive larvae. The density of larvae at elementary schools in Yogyakarta City was still relatively high by the value of HI 60.4%, CI 11.4% and amounted to 86.8% BI. The survey resulted trap eggs done in 91 elementary schools with 693 containers, *Aedes* mosquito eggs were mostly found in the room of 100% compared to the outdoors of 67%.

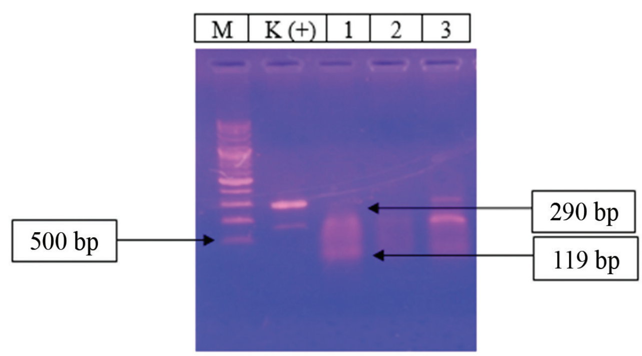
Physical Conditions of the School Environment

The physical condition of school environments can affect egg density invention. The results can be seen in Table 3.

The survey results of this study showed the average air temperature in the school rooms ranged between 27.79°C and outdoors at 30.98°C, but statistically the temperature did not affect the density of larvae. Different results were shown in the variable temperature in the room to the density of mosquito eggs, in which it was statistically significant. Any decrease in air temperature 0.152°C of average temperatures 27.79°C can increase the number of mosquito eggs produced up to ± 9 grain.

Air humidity is also one of the environmental conditions that can affect the development of mosquito larvae *Aedes aegypti*. The average results of measurements of indoor air humidity was 53.35% and outdoor 55.73% in which the value did not affect the density of larvae, but different results were found in the variable air humidity outdoors to the density of mosquito eggs, in which it was statistically significant. Only this study noted that every increase in air humidity in the room for 0.028% of the average humidity of 53.35% results in an increase in the number of eggs to ± 9 grain. Then any increase in air humidity outdoors amounted to 0.080% of the average humidity of 55.73% results in an increase ± 7 grain.

Table 5 below presents the results of observations of the physical environment in state primary schools. All schools had plastered floor, a wall of material that is wa-



Notes:
M = Marker 100bp DNA; K(+) = Positive Control; Pool 1, 2, and 3 are samples of mosquitoes

Figure 1. Results of Electrophoresis of RT-PCR for Detection of Dengue Virus Serotypes

Table 1. Description of Insecticide Resistance Status Type *Organophosphate*

Variables	Frequency	Precentage
Susceptible	33	36.3
Low resistance	21	23.1
Moderate resistance	17	18.7
High resistance	7	7.7
No larvae to test resistance	13	14.3
Total	**91**	**100.0**

Table 2. Description of Temperature and Humidity Inside and Outside School Environment

Statistical Measures	Indoor Temperature	Outdoor Temperature	Outdoor Humidity	Indoor Humidity
Mean	27.79	30.98	53.35	55.74
Std. deviation	1.59	1.94	8.84	5.91

Table 3. Description of Container Index Based on Temperature and Humidity in the School Environment

Variable		Description of Dengue Larvae Density		
		R	p Value	R^2
Temperature	Indoor	-0.037	0.730	0.008
	Outdoor	-0.002	0.986	
Humidity	Indoor	-0.036	0.732	
	Outdoor	-0.003	0.975	

Note:
R = Correlation

Table 4. Description of Egg Density Based on Temperature and Humidity in School Environment

Variable	Description of Egg Density Dengue Vector in the Room		
	R	p Value	Regression Equation
Indoor temperature	-0.212	0.045	density of eggs: 9.300+ (0.152)* temperature
Outdoor humidity	0.212	0.044	density of eggs: 9.300+0.028* humidity
Indoor humidity	0.366	0.000	density of eggs: 6.818+ 0.080* humidity

Note:
R = Correlation

Table 5. Description of Physical Condition in School Environment

Variable	Frequency	Percentage (%)
The entire floor had been in plaster/tile /ceramic	91	100.0
The entire wall of water - resistant material/plaster	91	100.0
The entire room had ceiling	91	100.0
The entire room was attached the door	91	100.0
Ventilation did not have installed wire netting	89	2.2
The entire room had a window	91	100.0
The entire guttering had no puddles	91	100.0
The distance between building:		
Far (> 10.5 meter)	5	5.5
Moderate (5.5 meter - 10 meter)	8	8.8
Close (2.5 meter - 5 meter)	27	29.7
Very close (0 - 2 meter)	51	56.0
Enclosed drainage conditions (no drains and flowing smoothly/not flooded	91	100.0

terproof/plastered had a ceiling, a door in each main room, and enclosed drainage conditions. However, there were still several physical parts of the schools at risk against the entry of dengue vector mosquitoes to rest, biting and breeding, such as the existence of open windows 97.8% of schools had ventilation with no wire netting attached and 56% of distance between the school buildings were very close approximately 0-2 m.

Discussion

Serotype Virus Dengue

DENV 3 most often leads to outbreaks in many areas and be associated with the severity of disease followed by DENV-2.[18] Study in India in 2006 concludes that reappearance of DENV-3 replaces the DENV-2 circulating a sign of outbreak.[19] This is reinforced from study by Prasetyowati and Astuti,[20] that the predominant serotype of dengue virus found in highly endemic areas are DEN 3 then followed DEN 2. Other data from various studies in several countries describe a unique, in which each serotype of dengue virus will trigger an outbreak based on geographical conditions and different time periods, for example serotype circulating in Bangkok is always different in each period.[21]

The results found that the school environment had higher potential transmission of dengue in children because dengue virus serotypes circulate and continue to be maintained, as submitted by Harun,[22] that infection with one serotype will cause antibodies to serotypes. Someone living in dengue endemic areas can be infected by 3 or 4 serotypes during his/her lifetime. This considered to cause a high incidence of dengue in endemic areas of high and moderate.[21]

These results need to be on alert, considering that the age of child is the age to the immune system that have not been as strong as an adult, and a potential time for mosquitoes to bite is a time when children moderate in school activities, namely at 08.00 a.m - 12.00 a.m, with the identification in this study proved that school environments had a density and a high risk of transmission because HI value reached 60.4%.[21]

Status of Insecticide Resistance

Organophosphate insecticide resistance test results in elementary schools had been in low to moderate resistance. The criteria that are used to interpret the results of lethal concentration (LC 50) or LC 100 are the mortality of 99% - 100% as vulnerable/sensitive, the mortality of 80% - 98% as tolerant, mortality less than 80% as resistant.[17] This suggests that some vector mosquitoes had been able to adapt to these insecticides, whereas organophosphates always used in dengue control national program in Indonesia. The condition occurred because of the nature of resistance can be passed down from generation to generation, the use of low dose (under dose) or a non-lethal dose and frequency of use of insecticides in urban areas thought to trigger resistance because apart from being used in the settlement being used on plant and agricultural land.[23]

Vector Density

Values larvae density in elementary schools based on WHO density figure exist on scale of 4 to CI values, scale 8 for HI values, scale 7 for the value of BI and the number of mosquito eggs were found in all schools.[21] This indicates that the current schools in Yogyakarta have a very high vector distribution and declared vulnerable to dengue infection. This condition was seen from the discovery of larvae in a few places that had the potential to vector breeding both of which can be controlled like flower pot with saucer, fountains, toilet and bath tub, and places that cannot be controlled such as oil drums, tin cans and plastic containers.

The high density of the vector due to the absence of the parties is responsible for cleaning up the water reservoirs. There is no active participation and optimal from the local health center to larva observer and school administrators in proper control of potential mosquito-breeding transmitters. Strategies to achieve value of BI < 5% and HI < 10% is to reduce vector breeding places. The same finding was stated by Nidar and Alvira,[14] and Sujariyakul *et al*,[24] that larvae were found in containers at the school because no one was responsible for cleaning up the water reservoirs. The emergence of dengue cases due to less effective controls, uncontrolled population mobilization, less of health infrastructure, and the use of different indicators larvae as in elementary school environment in Yogyakarta.[25] Risk of transmission of dengue virus is not only in school, but this study finds the school has many *Aedes aegypti* mosquito breeding habitat, therefore the behavior of school community towards vector control and control efforts contributing in the implementation of dengue prevention program for children.

Physical Conditions of the School Environment

The measurement results showed that the average temperature and humidity inside and outside school were not potential for larvae breeding because the temperature and humidity levels were less than the optimum levels (27°C and 81.5 - 89.5% respectively).[16,26] However, the temperature in the room, humidity outside and indoor declared affect the density of mosquito eggs because generally, mosquitoes will put their eggs at temperature of about 20-30ºC. Development of mosquito eggs seemed to have undergone a complete embrionization within 72 hours at the temperature, and result eggs hatch in a long time up to three months, resulting in the increase of mosquito egg density.[27-28]

Several previous study results used ecological analysis to determine the dynamics of dengue incidence in relation to the patterns of climate variability such as rainfall, temperature, humidity, and light intensity through the density of vector although not many link it with mosquito egg stage. Study by Sintorini,[29] stated that those climatic factors, such as rainfall, temperature and humidity of the most influential in the high cases of dengue fever in Jakarta. Climate which includes a variety of weather factors highly affect the lives of vector, such as rainfall, temperature, humidity, and CO_2 which impact the greenhouse effect in the urban environment. There are some connecting factors, so the climate can lead high vector densities. The first factor is breeding places because when rainfall is high then the breeding place will be quickly filled with water. The second factor is the ambient temperature affecting the extrinsic incubation period of mosquitoes. The incubation period is influenced by environmental temperature, humidity, level of viremia in humans, and strain.[30] Increasing temperatures will shorten the incubation period and increasing transmission. Higher temperatures can affect the temperature of the water in the breeding place which further affects the egg hatching into larvae more quickly, as seen in the results of this study.[31]

These results made clear in the study by Chan, *et al*,[32] and Sehgal,[33] that certain environmental temperature and humidity can determine the speed of development and activity of mosquitoes among others, namely duration of pre-adult stage, length geotropic cycle period, extrinsic incubation period or speed replication of the virus in the body of the mosquito. The results of this study can be used as an early model of Early Warning Dengue Hemorrhagic Fever in an effort to eliminate or reduce the mosquito eggs which can decrease the risk of transmission of dengue cases in children during school.

The results of observations of the physical environment of the school in Yogyakarta which could affect the density of dengue had been fairly well, but the absence of wire netting on ventilation was risky entry of mosquito vector of dengue to rest, bite and breed. The very close distance between the school buildings approximately 0 - 2 meter led to transmission in the community.[34] Crowded housing conditions made it easier for mosquitoes to transmit the dengue disease because of the habit of mosquitoes that did multi bites and the distance of flying only that was 50 - 100 meter.[35] The results were in line with the results of the study in Iquitos, Peru which indicated that the collection of adult *Aedes* mosquitoes were more common in dense settlements compared to a house within 30 meter.[36]

Conclusion

Early warning system needs to be enforced at state elementary schools in Yogyakarta City because the results of the study reveal that children in the area are vulnerable to dengue transmission based on the very high density larvae and eggs. Organophosphate insecticides used for dengue control have been on moderate resistance. Physical environmental conditions like school temperature, humidity, ventilation with no wire netting installed and the very close distance between the building are risky for breeding, resting and transmission by *Aedes sp.* Temperature and humidity can affect the density of mosquito eggs, so these results can be a model in the implementation of early warning system that is developed for the anticipation and prevention of *Aedes* sp vector breeding at state elementary schools in Yogyakarta City.

Recommendation

This condition requires the attention of all health centers in Yogyakarta City to improve health education about the dangers of dengue to the school management and improve the environmental management of schools with the involvement of larva-monitoring cadres and all school parties both teachers and students through periodic inspection larva regular. Ministry of Health as technical implementation unit area needs to review the use of insecticides that have been there through evaluation of its use and the impact of the results. Control model of dengue disease transmission during childhood in school by entering the components in this study can be used to support a good surveillance systems, epidemiological modeling and information technology that raise hopes for the formulation of early warning systems.

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