The Key Container of *Aedes aegypti* in Rural and Urban Malang, East Java, Indonesia

Zuhriyah L[a*], Habibie IY[b], Baskoro AD[c]

[a]*Department of Public Health, University of Brawijaya, Malang, East Java, Indonesia*
[b]*Department of Nutrition Sciences, University of Brawijaya, Malang, East Java, Indonesia*
[c] *Department of Parasitology, University of Brawijaya, Malang, East Java, Indonesia*

*Corresponding author email: lilikz.fk@ub.ac.id
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ABSTRACT: The incidences of Dengue Hemorrhagic Fever have been increasing in the last five years both in rural and urban areas. Identifying the key container is an important key to prevent more incidences. This study aims to determine whether key containers are different between rural and urban areas of Malang, East Java, Indonesia; as well as identify the type of mosquito larvae. The survey was conducted between November 2010 and June 2011. Data were analyzed by Chi Square test. The results show that main bathrooms, tanks for boiled water and dispenser were the main containers with larvae habitation. In rural areas, scatter discarded litters were the main source. The ownership of goods that have the potential for mosquito breeding sites in rural was fewer than in urban areas. Rural communities were more permissive towards the surveyor than urban communities. The type of larvae mostly found in urban and rural areas was *Aedes aegypti. Culex* and *Anopheles* were found in small percentages in urban areas, while in rural areas *Aedes albopictus*, and *Culex* were found in small percentages. The presence of larvae in the bathroom was associated significantly with the types of area (OR = 2.57, 95% CI: 1.83 to 3.62). Urban areas were at greatest risk for larvae finding than rural areas (OR = 1.92, 95% CI: 1.43 to 2.57). *Aedes aegypty* was believed to remain the main vector of dengue virus both in urban and rural areas.

Keywords: *Aedes aegypty*, key container, rural, urban

Introduction

Dengue Hemorrhagic Fever (DHF) disease is caused by four dengue viruses (Dengue-1, Dengue-2, Dengue-3, and Dengue-4) which have all been found in various regions in Indonesia. Dengue-3 is associated with severe dengue cases and is the most widespread serotype. It is followed by Dengue-2, Dengue-1 and Dengue-4 in Indonesia (Depkes, 2005). DHF is generally transmitted through the bite of *Aedes aegypti* although it can also be transmitted by *Aedes albopictus* that usually lives in the gardens. Mosquito-borne dengue fever is found in almost all areas of Indonesia, except in places with an altitude over 1000 meters above sea level (Depkes, 2005).

In the past 50 years, the incidence of dengue has increased 30-fold with a widespread geographic area well into the new state or from urban to rural (WHO, 2009). In Indonesia, according to Basic Health Research 2007, dengue cases that were diagnosed by health officers and the existence of symptoms stated by respondents showed the prevalence of 0.6% (range: 0.3 ‰ - 2.5%) within a period of 12 months (Depkes, 2008). In addition, the prevalence in East Java is only 0.24%, but monitoring is still needed, considering that East Java is one of the densely populated provinces in Indonesia (Badan Pusat Statistik, 2012).

According to the Basic Health Research (2007) of East Java Province, the prevalence of dengue and prevalence of the dengue fever symptoms in rural areas is smaller than in urban areas (0.23% vs. 0.27%). The prevalence of dengue in the city of Malang, the second most populous city in East Java, was also smaller than in Malang regency (0.23% vs. 0.27%). However, according to the diagnosis of health officers, dengue prevalence in urban areas is higher than that in rural areas (0.23 vs 0.15) (Depkes, 2007).

Habitat change, land use, and distribution of the vector are non-climatic factors related to dengue. Observations focused on the geographic area are important for surveillance (Frumkin *et al.*, 2008). Deforestation, water storage facilities, vegetation and soil type determine the vector species. Similarly, the agricultural activity will affect the availability of a breeding place for the different vector species leading to a local effect on vector borne disease (Sutherst, 2004). Urbanization has also resulted in increasing number of products that can hold water such as plastic containers and cans. Large drums open for household water storage

(Gubler, 1997) also contributed to increasing availability of breeding places *for Aedes*, especially in the city (Campbell, 2003).

The unavailability of vaccines and drugs for dengue would make vector control the right choice for the prevention of outbreaks (Scott *et al.,* 2010). Vector control is an adaptation measure to be considered in localized prevention and control. Important sources of health data for disease surveillance are data of diseases and observations focused on specific geographic areas (Frumkin *et al*., 2008).

Households and other facilities in which humans exist (such as schools, hospitals, and workplaces) are the main targets of activity to control mosquito larvae of *Ae. Aegypti*, *Ae. Albopictus* or other species if proven to be a local vector (WHO, 2009). One approach in the eradication of larvae is to focus on key breeding containers of primary vector. This approach is proven to reduce the proliferation of *Aedes aegypti* larvae (Tsuzuki *et al.,* 2009).

The House Index in the city of Malang from 2008 - 2010 was still more than 5% (P2PL 2008, 2009, 2011). This is similar in Malang regency for the years 2005 – 2009 (P2PL, 2010) indicating that efforts to eradicate mosquito breeding so far has not been able to reduce the House Index rate.

Therefore, this study aims to identify the key containers for the breeding of *Aedes aegypti* considering the type of area whether rural or urban as well as identify the types of mosquito larvae. A comparison of the two areas was made due to the differences in environments. Knowing the key containers for each of these areas, might result the dengue prevention efforts become more effective and efficient.

Methods

The survey was conducted in two sub districts in the region of Malang city and four sub districts in Malang regency from November 2010 to June 2011. Malang city is the second largest city in East Java. It is located in the midst of Malang regency which has 33 sub-districts. Population density of Malang city was 5646 people /km ^{2} in 2010. It is higher than the Malang district population density (693 people /km^2) (Badan Pusat Statistik, 2012).

Malang City is situated at an altitude between 440-667 meters above sea level and located 112.06° - 112.07° east longitude and 7.06° - 8.02° south latitude. The average air temperature during the year 2008 for the city of Malang ranged from 22.7°C-25.1°C. The maximum temperature reached 32.7°C and minimum temperature was recorded as 18.4°C. The average humidity ranges from 79% - 86%. The city has a maximum humidity of 99% and minimum of 40%. Relatively high rainfall occurred in February, November, and December. Rainfall is relatively lower in June and September (Dinas Komunikasi dan Informatika Pemerintahan Kota Malang, 2011).

Malang Regency is geographically located between 112°17'10.90" up to 122°57' 00.00" east longitude and 7°44 '55.11 "up to 8°26'35.45" latitude south with a height between 0-2000 m above sea level.

Malang Regency is a plateau topographically surrounded by several mountains and lowland or valley areas. The average air temperature ranged between 19.1ºC to 26.6ºC. The average humidity of Malang Regency ranges between 71ºC to 89ºC. The average rainfall ranges between 2 mm and 780 mm. The average rainfall is the lowest in June, and highest in December. Most of the land is forest (28.6%), dry land farming (23.8%); settlements (22.5%) and other land types with adequate water resources. With these conditions, Malang regency has adequate water resources (Pemerintah Kabupaten Malang, 2011).

The study locations were all buildings (houses, schools, places of worship, village offices) and the environment around the buildings in six sub-districts. Sub-district selection was conducted using purposive sampling based on the number of dengue cases and deaths over the past three years as reported by the local health officers. The selection also considered the diversity of demographic characteristics, climate, and geography.

In the region of Malang city, the survey was conducted in the sub-district Klojen situated 505m above sea level and sub-district Kedung Kandang 437m above sea level (Badan Meteorologi dan Geofisika, 2010). Klojen is the sub-district with the highest population density in the city of Malang, while Kedung Kandang is the sub-district with the lowest population density (Dinas Komunikasi dan Informatika Pemerintahan Kota Malang, 2011). In Malang Regency, the survey was conducted in the sub-districts of Poncokusumo with an altitude of 600m above sea level, Pujon with an altitude of 1200 m above sea level, Bantur with an altitude of 300m above sea level and Manjing Wetan with an altitude 550 m above sea level (Badan Meteorologi dan Geofisika, 2010).

Primary data collected included the House Index and the type of mosquito larvae found in the selected sub-districts. Data were analyzed using the Chi Square test with a significance level of 5%.

Results

Urban areas

In urban areas, 22 villages were surveyed with a total of 398 buildings. Most of the buildings surveyed were homes (76.1%). This was followed by mosque/ mosque/ other prayer areas (13.1%), schools (6.3%), and public bathrooms (2.3%). While the remainder were markets/shops, meeting houses, orphanages, boarding schools, and clinics/ health facilities.

Level of education, assumed as an important demographic factor; was also collected in this survey. **Table 1** shows that residents in urban areas were mostly highly educated.

Table 1: Highest level of education in the family in two sub-districts in Malang City 2010

The highest level of education in the Family	Frequency	Percentage
Bachelor/ Diploma	63	15.9
Senior High School	129	32.5
Junior High School	43	10.8
Elementary School	54	13.6
Uneducated	13	3.3
Irrelevant (Public Space)	95	23.9
Total	**397**	**100.0**

It was found that among the 398 buildings surveyed, 152 (38.2%) of the buildings evidenced larvae habitation within various containers. This percentage reflects the high rate of House Index in Malang City. This finding is shown in Table 2. Some of the containers were not surveyed because house owners denied permission. The percentage of rejection for the survey in urban areas varied depending on the surveyed containers with a range from 0 to 1.76%. The highest rejection was in the refrigerator waste water. This is because most of the refrigerators were placed in difficult locations for the surveyor to access the waste water.

The rank of possession of container types from the highest to the lowest in the urban areas were namely main bathroom, tank for boiled water, refrigerator waste water, dispenser, extra bathroom, fish pond, pet drinking container, aquatic plant vase, scattered discarded litters, and prayer area. For urban areas, larvae were found respectively in the bathroom and tank for boiled water (**Table 2**). Larvae were found in a much smaller percentage within dispensers, refrigerator waste water, fish ponds/aquariums, scatter discarded litters, aquatic plant vases, and prayer areas.

Table 2: The presence of larvae in two sub-districts of Malang City

No	Type of Containers	Positive		Negative		Not Allowed		None/ Don't have		Total	
		n	%	n	%	n	%	n	%	n	%
1	Main bathroom	113	28.39	270	67.8	0	0	15	3.77	398	100
2	Extra bathroom	6.33	1.59	30.33	7.62	0	0	361.33	90.8	398	100
3	Dispenser	9	2.26	56	14.07	1	0.25	332	83.42	398	100
4	Effluent Waste Water	6	1.51	107	26.88	7	1.76	278	69.85	398	100
5	Aquatic Plant Vase	3	0.75	15	3.77	1	0.25	379	95.23	398	100
6	Fish Pond/ Aquarium	5	1.26	25	6.28	1	0.25	367	92.21	398	100
7	Tank for boiled water	27	6.78	108	27.14	2	0.50	261	65.58	398	100
8	Pet drinking container	0	0.00	21	5.28	2	0.50	375	94.22	398	100
9	Scattered Discarded litters	4	1.01	6	1.51	1	0.25	387	97.24	398	100
10	Prayer area*	1	0.25	2	0.50	0	0.00	395	99.25	398	100

**The area is to take water to clean some part of the body before praying for Muslim.*

From the total sample of 107 larvae examined, 103 (96.26%) were larvae *Aedes aegypty*. Three samples (2.8%) were *Culex* larvae and one sample (0.93%) was *Anopheles* larvae.

Rural areas

For the rural areas, the survey was conducted in 45 villages of four sub-districts with a total of 452 buildings surveyed. Most of the buildings were homes (78.8%) followed by the mosque/ prayer room (10.6%), schools (5.3%), and meeting houses (3.5%). Others include markets/shops, orphanages, public bathrooms, and Islamic boarding schools.

Most of the buildings surveyed were located in the vicinity of the mosque/prayer room (60.9%), schools (20.8%), meeting house (11.5%), health centers (0.9%), and the Islamic boarding school (2%).

Most of residents surveyed in rural areas have low education, **Table 3**. In contrast to the urban areas, rejections of the survey in rural areas were not evidenced. This is likely due to the fact that ownership of containers likely to become mosquito breeding grounds in the rural areas is lower than in urban areas.

Table 3: Highest level of education in the family in four sub-districts in Malang Regency 2010

The highest level of education in the Family	Frequency	Percentage
Bachelor/ Diploma	50	11.1
Senior High School	100	22.2
Junior High School	84	18.6
Elementary School	115	25.5
Uneducated	8	1.7
Irrelevant (Public Space)	94	20.8
Total	**451**	**100.0**

Among the 452 buildings, 110 (24.3%) of the buildings were found to have larvae in various containers. This percentage is reflective of the high rate of House Index in Malang Regency. In the rural areas, the container ownerships varied. Container ownership ranking from the highest to lowest were main bathroom, tank for boiled water, refrigerator waste water, dispensers, scattered discarded litters, pet drinking containers, fish ponds/aquariums, aquatic plant vases, and prayer areas.

The larvae were mostly found in the bathroom and tank for boiled water as illustrated in **Table 4**. A much smaller percentage of larvae were found in scattered discarded litters, extra bathroom, dispensers, fish ponds/ aquariums, refrigerator waste water, pet drinking containers, and prayer areas. From total larvae from 93 samples examined, 86 (92.47%) were *Aedes aegypty* larvae, 4 (4.3%) were *Aedes albopictus*, and 3 (3.22%) were *Culex* larvae.

Table 4: The presence of larvae in four sub-districts in Malang Regency

No	Type of Containers	Positive		Negative		Not Allowed		None/ Don't have		Total	
		n	%	n	%	n	%	n	%	n	%
1	Main bathroom	58	12.83	365	80.75	0	0	29	6.42	452	100
2	Extra bathroom	4	0.88	28	6.19	0	0	420	92.92	452	100
3	Dispenser	2	0.44	42	9.29	0	0	408	90.27	452	100
4	Refrigerator Waste Water	1	0.22	59	13.05	0	0	392	86.73	452	100
5	Aquatic Plant Vase	0	0.00	9	1.99	0	0	443	98.01	452	100
6	Fish Pond/ Aquarium	2	0.44	16	3.54	0	0	434	96.02	452	100
7	Tank for boiled water	36	7.96	191	42.26	0	0	225	49.78	452	100
8	Pet drinking container	1	0.22	22	4.87	0	0	429	94.91	452	100
9	Scattered Discarded litters	17	3.76	16	3.54	0	0	419	92.70	452	100
10	Prayer area*	1	0.22	2	0.44	0	0	449	99.34	452	100

**The area is to take water to clean some part of the body before praying for moslem.*

Mosquito Breeding Opportunities Difference in the Urban and Rural Area.

Urban and rural areas differed in terms of mosquito breeding opportunities. Urban areas had a nearly 2-fold odds (OR=1,915; 95%CI: 1,426-2,573) for larvae than rural areas (**Table 5**).

The different larvae habitation of rural and urban areas (**Table 6)** indicated the presence of larvae in each container differed not only in the bathroom which suggesting, all containers should be monitored as a breeding place for mosquitoes. The main bathroom in urban areas are 2.57 times (OR=2.57; 95%CI: 1, 83-3, 62) more likely to have larvae compared to rural areas.

Table 5: A comparison of larvae presence by area

Area	Positive		Negative		Total	
	n	%	n	%	n	%
Urban	152	38,2	246	61,8	398	100
Rural	110	24,2	341	75,6	451	100
Total	262	30,9	587	69,1	849	100

P=0,00; Chi Square = 18,231 OR=1,915 (95%CI:1,426-2,573)

Table 6: The differences larvae existence by type of containers and area

No	Type of Container	Area	Positive	Negative	Total	P value	OR
1	Bathroom	Urban	122	262	384	0,00	2,57
		Rural	65	359	424		(95%CI: 1,83-3,62)
2	Dispenser	Urban	9	56	65	0,194	3,05
		Rural	2	42	44		(95%CI: 0,69-16,44)
3	Refrigerator Waste Water	Urban	6	107	113	0,424	3,3
		Rural	1	59	60		(95%CI: 0,39-28,14)
4	Aquatic Plant Vase	Urban	3	15	18	0,529	0,83
		Rural	0	9	9		(95%CI: 0,67-1,01)
5	Fish Pond/ Aquarium	Urban	5	25	30	0,696	1,6
		Rural	2	16	18		(95%CI: 0,28-9,2)
6	Tank for boiled water	Urban	27	108	135	0,389	1,33
		Rural	36	191	227		(95%CI: 0,76-2,3)
7	Pet drinking container	Urban	0	21	21	1	1,05
		Rural	1	22	23		(95%CI: 0,96-1,14)
8	Scattered Discarded litters	Urban	4	6	10	0,721	0,62
		Rural	17	16	33		(95%CI: 0,15-2,64)
9	Prayer area	Urban	1	2	3	1	1
		Rural	1	2	3		(95%CI: 0,03-29,81)

Discussion

Educational level in urban is generally higher and may lead to an increase of awareness of the residents to prevent mosquito breeding. However, the facts show otherwise.

The presence of larvae monitoring, which does not exist in the district should also be able to reduce the number of larvae. However, our findings indicate otherwise. Rejection of a survey participation conducted by the local larvae monitoring observer (in the past) and the research team occurred in the urban areas.

Main bathroom and tank for boiled water were the most widely owned facilities in which larvae were found both in urban and rural areas. From observations, improper closure of the tank for boiled water is likely the cause or larvae habitation. Homes owned in urban areas evidenced more containers associated with both electronic and non-electronic goods. The third habitation of larvae was in dispensers in urban areas and scattered discarded litters in rural areas.

The results of this study are similar to those found in the densely populated city of Nha Trang (Vietnam). Buildings with certain container such as outdoor discarded containers, wells, large plastic buckets, jars, and toilet concrete basins were significantly associated with a repeated infestation of larvae in the building in two surveys conducted in different seasons (Tsuzuki *et al.*, 2009).

With a similar population density to the district of Malang, results of a research conducted in the city of Nova Iguaçu (Brazil) with 1,413.8 inhabitants/ km^2 showed that 90.2% larvae and 88.9 % pupae were found in containers used for water supply (water tanks, barrels) and waste containers (tires, cans, cups that cannot be recycled (non-returnable cups), and others). While in containers that are ornamental such as water plant pots, dishes, sewer, and water flow, few larvae and pupa were found (Medronho *et al*., 2009). However, both studies were not designed to target on electronic equipments such as dispensers and refrigerators that are generally owned by urban residents.

Aedes aegypti seems continue to be the dominant vector of dengue virus spread both in urban and rural areas of Malang. However, the discovery of *Aedes albopictus* larvae in rural area shows that it is a potential vector of dengue, especially in rural Malang. The high likelihood of larvae finding in urban areas shows that the urban population is of higher risk of dengue than the rural population. High vigilance against the presence of larvae needs to be applied primarily to the bathroom in urban areas. Vector control activities would be more efficient by giving high priority to the container with the highest percentage of larvae/pupae (Medronho *et al*., 2009). However containers other than bathroom and tank for boiled water also need to be monitored in urban and rural areas considering their potential as breeding sites of *Aedes aegypti* (Tsuzuki *et al.,* 2009).

The bathroom in urban areas mostly uses tap water, as compared to well water in rural areas. The use of tap water should reduce the chances of the larvae, but the fact is otherwise. Another factor that needs attention is the number of family members ≥ 6 people (Tsuzuki *et al.*, 2009). Studies that link demographic factors-especially population density, type of water, the role of dengue prevention programme, and the main vector of dengue virus requires further study as dengue is a disease that involves eco-bio-socio-cultural factors (Bazzani *et al.*, 2011).

This study has a few limitations. Pupae growth of *Aedes aegypti* and the original containers were not observed in this study. The risk of *Aedes aegypti* larvae is relatively low in man-made containers. Also, seasonal factor could be a confounding factor in this research.

Conclusion

Main bathroom and tank for boiled water are containers owned by residents in urban and rural areas of Malang. Household electronic equipments that cloud potentially hold water were more commonly found in urban areas than rural areas. Urban areas were most likely to contain larvae than rural areas. However, the same precautions should be aimed at all containers in urban and rural areas, especially in the bathroom.

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