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Application of Mobile Sensing in Kader Surabaya Hebat (KSH) about Major Mosquito-Borne Disease in the Metropolitan City of Surabaya, Indonesia

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Abstract

Dengue fever is a viral infection transmitted through mosquitoes and endemic in most tropical countries, such as Surabaya. DHF cases is continued to be monitored, as well as the issue of social distancing, where Kader Surabaya Hebat (KSH) officers were not allowed to enter the house to conduct larvae examinations. In addition, mosquito eggs and first instars are rarely detected in this examination, making DHF endemicity remain high in Surabaya. Larvae were sampled in 115 houses and the accompanying 115 KSH officers were sampled randomly in 27 villages in Surabaya. Furthermore, the variable will be accommodated on the layer point map to evaluate the larvae in real-time by recording videos for five seconds and entering them in the mobile sensing application so that larvae movement and type would be detected. The results of larvae positively detected and identified were Aedes aegypti (100%) and Aedes albopictus (100%). In addition, based on the questionnaire to 115 KSH officers, it was found that they had the knowledge (89%), behavior (97%), and practice (86%) in controlling DHF vector mosquitoes. Considering the success of mobile sensing applications as part of effort to control DHF vectors requires community and KSH to support government programs regarding mosquito disease control, more efforts are necessary to facilitate KSH officers more in conducting home visits, thus potential for DHF transmission can be reported more routinely and accurately.

Keywords: *Mobile Sensing, KSH, Mosquito-Borne Disease, Surabaya, Good health and wellbeing*

INTRODUCTION

Mosquitoes have been responsible for the spread of several kinds of viruses among human populations for a long time. The role of mosquitoes as vectors of several diseases have been well recorded, including dengue fever, malaria, and Japanese Encephalitis Virus. Many of these diseases are transmitted by Culicidae, for example *Aedes (Ae) aegypti*, *Aedes (Ae) albopictus*, *Anopheles (An)* and *Culex (Cx),* resulting in widespread economic loss, health burden, and mortality in endemic countries [1]. Based on previous report, at least 500 to 700 million people were estimated to suffer from diseases transmitted by mosquitoes every year. On top of that, more than a million of death per year was reported as result. Thus it contributes to the global health risk in our current society [2].

Indonesia as an archipelago in tropical Southeast Asia is endemic area for two main vectors of dengue fever; *Ae. aegypti* and *Ae. albopictus* [3]. Dengue fever incidences in the second biggest city of Indonesia, Surabaya, showed an increase since 1968 up to 2012 [4]. The incident rate (IR) of dengue fever in East Java was 38.15/100.000 residents, while case fatality rate (CFR) was at 0.7%. This showed that dengue fever is still

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considered as health issue that should be managed in East Java. The surveillance of public health can be applied to know and monitor the status of public health, determine health priority, evaluate health program, and develop researches on health-related subjects [5].

According to [6], Integrated Vector Managemenet (IVM) is the rational decision to apply resources optimally for vector control. The application of IVM helps the program of local community in controlling vectors, finding and using more evidence, integrating appropriate intervention, and collaborating health with other sectors, for example academics, community household, and other community elements. Vector control is important component in preventing and controlling dengue fever transmission.

Kader Surabaya Hebat or Excellent Surabaya Front (KSH, used to be *Jumantik*) is local activists in Surabaya, Indonesia who monitor and evaluate mosquito vectors in the surrounding households in the mission to control dengue fever transmission [7]. They work once a week as a "larvae hunter" around their residence to monitor water container tanks in the house of their neighbors. As we know, many Indonesian stores clean water in a type container in their bathroom. So KSH activists monitor the presence of vector larvae in these tanks in each household of their area. However, during the COVID-19 pandemic, due to the enforcement of social distance measure which limit movement, KSH activists faced difficulty in visiting households to perform their routine larvae monitoring

This study applied mobile sensing system as new technology to be performed in local community. Activists of KSH were trained and assisted to detect *Ae. aegypti* and *Ae. albopictus* mosquito larvae as main vectors of dengue fever in water container tanks around Surabaya [8]. The mobile sensing system will assist KSH activists in detecting larvae that can't be seen with naked eyes easier due to small size of the larvae (1-2 mm) or in the case where houseowners did not give permission for activists to enter their house.

In effort to aim for a more efficient, cost-effective, and eco-friendly vector control, decision making should be based on local evidences, working to prevent the transmission of several diseases by applying existing system and local human resources. Local human resources have been directed in several provinces in Indonesia, especially in endemic area. However, in some area, members of community didn't give permission to KSH to inspect their bathrooms. In addition, knowledge about life cycle of mosquitoes and their behavior are still lacking in KSH activists, resulting in overlook of mosquito eggs during inspections.

KSH activists also help local health department to evaluate *Angka Bebas Jentik* (ABJ), an index that indicates the ratio of houses without larvae in an area and one of vector control indication, thus KSH activists are usually more focused to record larvae presence and overlook the eggs. In addition, traditional bathwater containers are usually made of clay, large in size and quite deep, which makes it difficult for KSH activists to monitor the presence of larvae. Other places with stagnant water are also often overlooked, for example watering hole for birds, water dispenser, and many holes found in the soil. By paying attention to the detection of dengue fever mosquito vectors in Surabaya, the implementation of *Ae. aegypti* and *Ae. albopictis* larvae survey and monitoring system is important to be carried out as an effort to eradicate the transmissible diseases.

Because of that, we designed an automatic larvae detection system which was able to accurately detect the larvae of *Ae. aegypti* and *Ae. albopictus* from low-resolution photo taken using portable device without the need to collect larvae sample. The designed system was based on artificial intelligence (AI) to detect larvae without supervision from expert and have high accuracy comparable to laboratory inspection [9]. This detection allows rapid implementation and appropriate control actions. This study aimed to apply the mobile sensing method practically in the local community of Surabaya to automatically detect *Aedes* larvae based on larvae movement recorded using portable video device, like smartphone or digital camera.

MATERIALS AND METHODS

Theoretical Framework

There are many studies regarding vector control system developed using recent technology by utilizing videos taken by standard cameras, integrating it with artificial intelligence to detect larvae without expert supervision

but resulting in high accuracy comparable to laboratory examinations [9]. In this analysis, we use construction that has been proposed in previous study to be tested in real time in the field regarding to the behavior of KSH officers in vector control and relevant predictors, given the high risk of the environment because Surabaya is still categorized as endemic area of dengue fever. Therefore, by using this mobile sensing system, we try to understand whether the perception of risk, knowledge, and source of information is a key factor related to the acceptance of intervention. Supervision and training of KSH officers in using mobile phones when performing *Pemberantasan Sarang Nyamuk* (PSN) or monitoring larvae habitat is due to government's role in implementing vector control strategies. Further details about how we apply mobile sensing methods in the field previously can be found in the prior study [9]

Study Area/Design

This study was a cross-sectional observational and descriptive study using survey method. Survey was conducted using a structured questionnaire to be answered by respondents. This questionnaire was given to 115 KSH officers randomly selected in 27 sub-districts of Surabaya, East Java from July to October 2023. The respondents were active KSH officers in Surabaya. The questionnaire is prepared in Bahasa Indonesia, if needed, according to adaptation [10]. After filling out the questionnaire, KSH officers were trained to use mobile sensing application (using Bahasa Indonesia) to search for *Ae. aegypti* and *Ae. albopictus* larvae in their breeding location of each house. Data collected from the application was stored and sent through GPS devices, presented larvae movements in real time. Details information on the residential demographic of respondents were also collected, including age, area of residence, education level, and occupation, adapting from previous study [9] as presented in Figure 1.

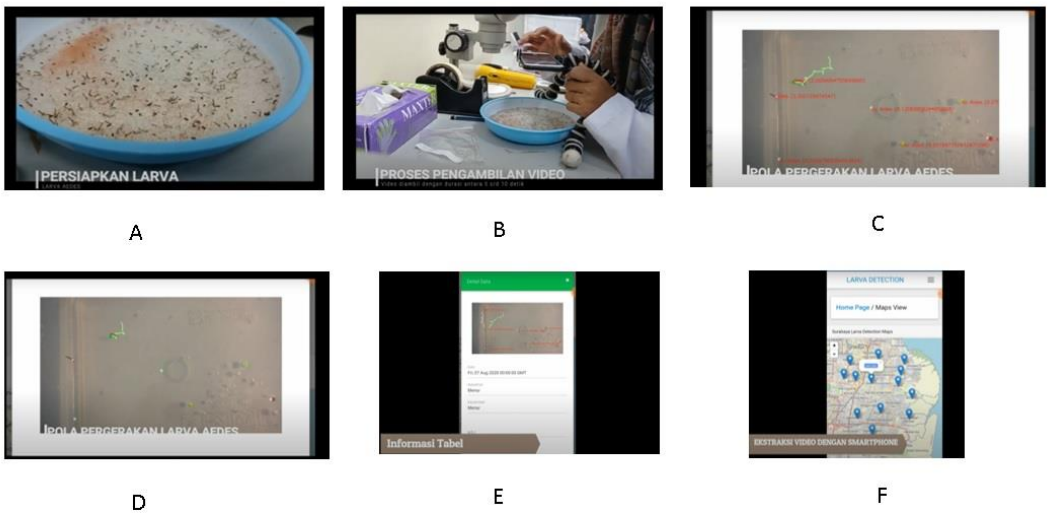

Figure 1. Trial of larvae examination in a laboratory using mobile sensing system carried out by Yuana, et al, 2020 in the Entomology laboratory, Institute of Tropical Disease, Universitas Airlangga. Description in the image listed version of Indonesian language: A: Larvae preparation; B: Video-taking process, C-D: Entering video in the mobile sensing system and examining larvae movement pattern; E: Data Labeling data; F. Data of identified larvae distribution will appear in real-time in the application based on sampling location (the data has been entered and can be tracked in real-time on Google Maps to locate dengue vector larvae). Indoensian version (A; Persiapan larva, B; Proses pengambilan video, C; Pola pergerakan larva *Aedes*, D; Pola pergerakan larva *Aedes,* E; Informasi tabel, F; Ekstraksi video dengan *smarthphone*).

Ethical Clearance: The research protocol has been approved by Surabaya National Unity and Politics Agency and Surabaya City One-door Office in collaboration with Surabaya City Health Office based on permit number of 072/26944/436.7.2/2022. The research objectives were explained to community leaders and local government officials before the permit was granted. Complete oral explanation of this research was given to

selected household members and approval was obtained before being registered as respondent. Respondents were given the right to refuse to participate in the study and was able to resign at any time during the interview. Privacy and confidentiality are maintained throughout the study.

DATA ANALYSIS:

The data were entered into a Microsoft Excel Worksheet and analyzed, descriptive analysis on Survey Knowledge, Attitude, and Practice (KAP) to measure relative frequencies, percentages, averages, and relative frequencies of the variables using SPSS version 21.

Based on the survey responded by KSH regarding their knowledge on the use of smartphones, mobile sensing system could support KSH officers in monitoring larvae more effectively and efficiently for preventing dengue fever. Figure 2 shows the design of Mobile Sensing KSH application system managed by Larvae Hunter, monitored by the Surabaya City Health Office, and can also be used by the community in general to see the results of ABJ in certain area (ABJ Report).

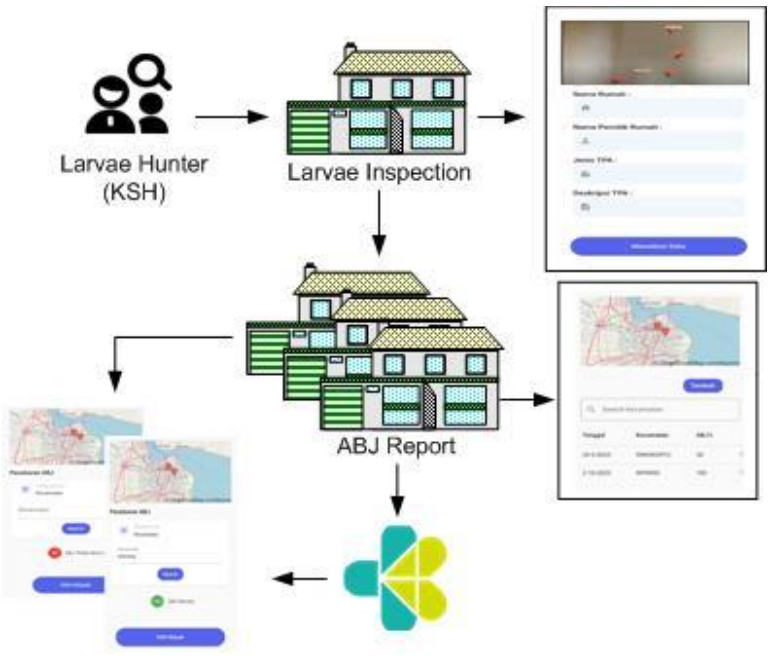

Figure 2. System design for larva inspection mobile application

Figure 2 shows that KSH officers inspect the house to check larvae by using mobile-based larvae detection application, this system http://sivemo.online is self-made and the result of their own work as presented in detail in as presented in detail in Figure 3. The mobile-based larvae detection application can be used to check larvae more accurately, send inspection reports more quickly and efficiently, as well as being monitored at any time easily by the Surabaya City Health Office. In addition, the community can also contribute to reporting larvae presence in their house when homeowners object to be checked by KSH. Larvae checking using this mobile application can be done by installing the mobile sensing application in the smartphone, then turn on the larvae detection function. Users then check by directing the camera to the water container object that would be checked for 5 seconds. Then the larvae checker can start filling in demographic data consisting of valid examination location in accordance to the current KSH; examination date; detailed home address where examination is performed; name of examined houseowner; waer container type; and description of water container. After larvae checking is automatically carried out and demographic data has been filled, the inspection data is uploaded by clicking data entry button.

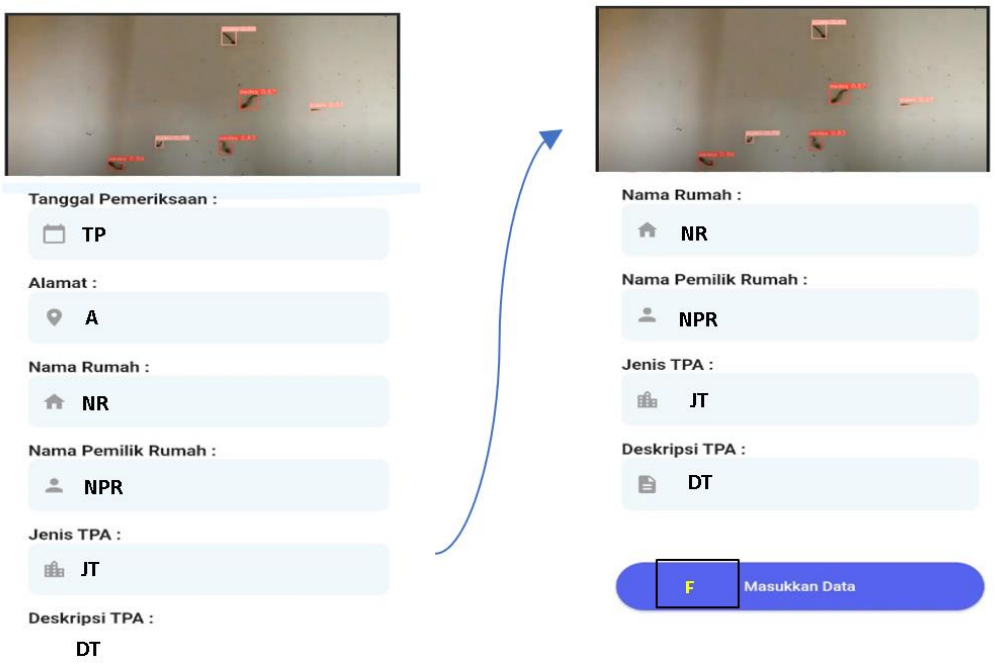

Figure 3. Automatic *Aedes* Larva Detection Feature

During aedes larvae examination activities carried out periodically by KSH, report can be obtained by calculating ABJ obtained from larvae examinations in several houses in one area. This application can also calculate ABJ automatically in the area based on several houses that were examined at that time. Inside the layer there is a description (Indonesian version); Tanggal Pemeriksaan (TP); Alamat (A); Nama Rumah (NR); Nama Pemilik Rumah (NPR); Jenis Tempat Penampungan Air (JT); Deskripsi Tempat Penampungan Air (DT); Masukkan data (E). Description (English version) including; inspection Location (TP); home address (A); the name house (number of house) (NR); homeowner's name (NPR); type of breeding site (JT); Common outdoor/indoor breeding sites (DT); data is entered (F) (Figure 3).

Figure 4 is ABJ data report obtained based on the inspection of several houses in each location with different inspection date. This ABJ data can be viewed in real time by Surabaya City Health Office and can also be known by the community as early warning of dengue fever spreading in their respective area. In the ABJ feature report in inspection Location as shown in Figure 4, the application shows examination date, the sub-district of examination location, and the percentage of ABJ obtained from the number of houses examined. ABJ is one of the entomological indexes used to determine the risk of dengue fever transmission in an area based on Density Figure (DF) categories of low, medium and high [11].

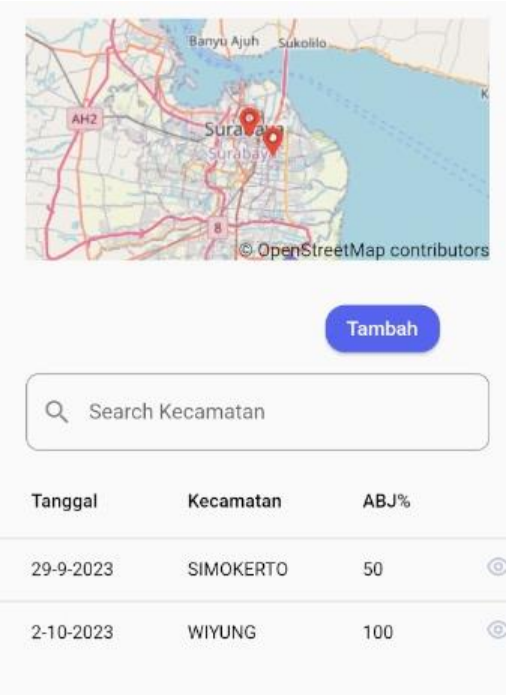

Figure 4. Report Angka Bebas Jentik (ABJ) Data in Inspection Location.

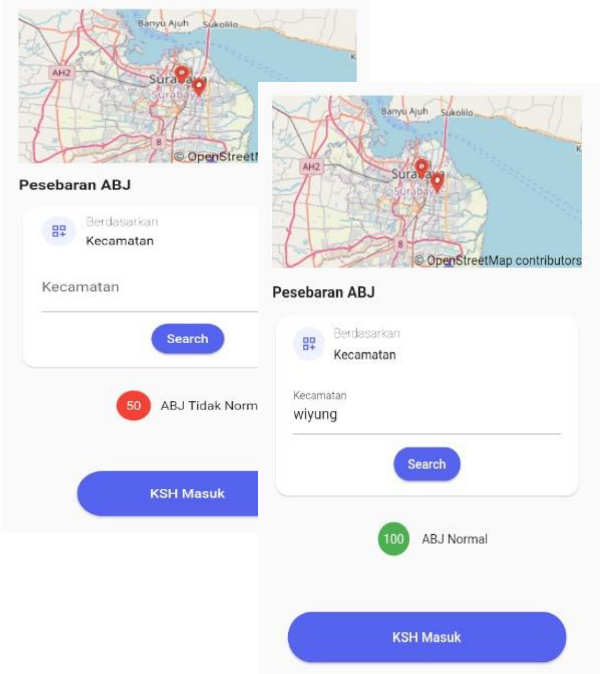

Figure 5. ABJ Information Detail

Based on requirements of the Quality Standard of Environmental Health and Vector and Animal Disease Carriers and Its Control, Indonesian Ministry of Health sets the quality standard value of *Ae. aegypti* and/or *Ae.*

albopictus control is ≥ 95% as normal ABJ and <95% as abnormal ABJ. This standard has been applied in the mobile sensing application to control dengue fever vectors as shown in Figure 5.

RESULTS AND DISCUSSION

Strength and limitation

The strength of this study is to assess public knowledge and preventive behavior regarding dengue fever in rural communities in Surabaya, where the disease is more common. This finding serves as a guide for health service planners for strategic planning to control dengue fever transmission better real time. In addition, this study applied a tight sampling approach and various respondents to represent the comprehensive perspective of residents in large cities like Surabaya. Another strength of this study is a face-to-face interview approach. This research certainly had its limitations. First, the cross-sectional design limits the identification of causal relationships between variables. Second, the study can only capture information in small-scale from participants and therefore cannot be generalized to other groups. The results possibly different from time to time. Third, convenience sampling is used to choose the study area and respondents in this study, which might result in bias of respondent representations. Finally, although this survey was anonymous, responses to the questionnaire may not reflect true beliefs and practices because respondents might try to provide socially acceptable responses.

The results showed that the participants had a moderate level of knowledge about dengue fever and *Aedes* mosquito bionomics, transmission methods, signs and symptoms, and prevention strategies. Although respondents had a higher perception on the severity and obstacles in the prevention of dengue fever, their perception of vulnerability to dengue fever was low. Interestingly, respondents were convinced that they had high self-efficacy to control the transmission of dengue fever vectors. On the other hand, participants were involved in about half of the entire practice of dengue fever prevention. The majority of participants showed a relatively high level of awareness to several aspects of the practice of dengue fever prevention, such as eradicating mosquito breeding sites, preventive measures to avoid mosquito bites, and cues to act, but the overall score of dengue prevention practices was not satisfactory. Practical, family-oriented, and community-based health education campaigns must be adjusted to increase knowledge about dengue fever, prevent negative beliefs of the community, and encourage the practice of preventing dengue fever in urban communities in Surabaya.

If the implementation of mobile sensing application in Surabaya is carried out well, it is expected to be able to reduce the incidence of dengue fever. Therefore, this research needs to update technology as a real time vector data collection conducted by KSH, Puskesmas, and Surabaya City Office.

Characteristics of Study Population Socio-Demographic:

Socio-demographic characteristics of respondents 115 questionnaires distributed, all 115 were responded to and returned. As much as 45.74% of respondents were aged 21-30 years, 4.27% was less than 20 years old, and 38.09% was aged between 31-40 years, representing workforce population, and 13.44% at the age of 41-50 years, while 10.55% of respondents represent retirees and elderly at 50 years and over. The number of households ranges from two people (27.34%) to five people and over (35.02%). Most of the respondents were married (70.36%) followed by single (13.82%), and widows or widowers (7.51%). Occupation of respondents varied, from traders, businessmen, civil servants to housewives with percentage ranging from 13.24% to 60.29%. As much as 39.71% of respondents were Muslim, while Christianity and Buddhism were 20, 00% respectively. As many as 78.80% of respondents have had formal education, ranging from elementary level education to university, while 21.20% were uneducated formally. As many as 77.60% of respondents' populations lived in urban settlements while 60.44% of respondents lived in the suburbs (20.44%). As much as 58.60% respondents were from Javanese tribe, 17.30% Madura, while Chinese or migrants 4.10%.

Knowledge of mosquito disease types, cause, transmission, and sign/symptoms among residents:

Respondents were questioned about their knowledge in "diseases transmitted by mosquitoes and mosquito types". As many as 81.04% of respondents knew about mosquitoes and diseases they caused, 27.96% did not

know. As many as 68.96% respondents knew about various types of mosquitoes (*Culex, Anopheles, Aedes*), while 20.02% of respondents did not know. As many as 78.59% of respondents knew about dengue fever, 11.51% about malaria fever; 3.83% and 2.07% knew about Chikungunya and filariasis fever respectively. In terms of transmission and diseases commonly found in the community, the majority knew about mosquito bites (68.80%) followed by transmission due to direct contact (11.58%). In relation of signs and symptoms, 70.42% of respondents realized when they had mosquito-transmitted diseases, while 29.58% did not know. About 44.47% respondents identified languish as the most common symptoms of mosquito disease, followed by loss of appetite (7.06%), colds/shivering (13.96%), nausea-vomiting (13.44%), and dizziness (11.07%). As many as 67.84% and 63.39% of respondents knew the risk and mortality because of mosquitoes, while 32.16% and 36.615% of respondents did not know.

Practice towards prevention and control measures of mosquito-borne diseases among Residents:

The results of attitudes towards treatment of mosquito diseases. Regarding duration of fever as felt in the body, 38.37% respondents responded 2-3 days, followed by 1 day (20.68%), 4-5 days (17.58%), 6-7 days (11.58%) and 7 days (11.48%) respectively. In treatment considerations, 49.53% supports that the body's condition is the determining factor in treating fever, followed by duration of illness (19.34%), and treatment cost (19.03%). Several respondents also stated that they would consider distance from the nearest health service center. Regarding the treatment of mosquito-transmitted disease, when questioned what would their first action be if they detect fever symptom caused by mosquito, 69.64% of respondents reported that they would immediately go to the hospital after the symptoms appeared. As many as 23.88% of respondents would go to pharmacies/drug stores, 13.34% would seek treatment to anyone, and 10.13% of respondents wanted to treat it by themselves.

Regarding their knowledge about the habitat for breeding and mosquito behavior, 64.54% respondents acknowledged that inundated water was the most preferred habitat for mosquitoes to lay eggs, followed by bath water container that was common in Indonesian households (45.14%), gutters (11.69%), and ponds (10.24%). Regarding hiding place of mosquitoes, 48.50% responded in dark places, 37.71% responded in dirty place, 12.31% responded toilets and latrines, while 11.48% responded grass/shrubs as mosquito hiding places. Most respondents stated that mosquitoes usually bite in the morning (76.11%), while the rest responded that mosquitoes usually bite during the day (10.03%), evening (7.50%), and anytime (6.31%). Regarding mosquito population boom, 52.85% of respondents stated the lack of cleanliness in the surroundings cause mosquito number to rise. Other responded that population rise was caused by lack of drainage (24.30%), cleaning bushes (20.06%), and throwing unused empty containers around (11.79%).

In Surabaya, this is the first study conducted to provide basic information about the system developed in mobile phones to be used to detect the movement of larvae in a water reservoir. In addition, this study also evaluated the status of community knowledge in Surabaya regarding the disease transmitted by mosquitoes. The chosen study area, Lidah Kulon Village which have Kulon Puskesmas (local health center), covers 15.57% and 2.02% of people from the total population. From all 115 KSH activists, 71.15% consisted of women, while 28.65% men. This population distribution is caused by complex social and environmental dynamics such as migration between countries for settlements, trade, and climate change, making the places chosen to be the center of anthropogenic activities lead to the emergence of different habitat for various mosquitoes [12]. In line with the increase of human population, urbanization and environmental changes due to land expansion results in the rapid emergence of mosquito breeding habitats, so leading to increase of malaria and other mosquito-transmitted diseases, such as those occurs in Africa [13].

The results in the study of mobile sensing application as vector control that detect the movement of larvae showed that KSH officers had adequate and correct knowledge about the prevention of mosquito diseases commonly applied in the study area. This can be associated with the effectiveness of training or counseling for dengue fever and other mosquito-transmitted disease prevention launched by the government (1 House 1 *Jumantik* movement) or as we call GIRIJ which is held once a week in Surabaya. In line with this statement, [14] who had examined the prevalence of dengue fever in Thailand, associated this awareness with cluster detection

method and highlighted its potential in increasing supervision of dengue fever. This information can help public health institutions in endemic areas such as in Indonesia as well. In support with this study too, [15], reported the behavior of a small number of models or methods for evaluation of disease mapping when different conditions are present in the data. During examination of one collection of data, to make the results more thorough, simulation study can be carried out to examine various relative risk patterns (from simple risk gradients to more complex risk structures, including spatial correlation).

Results of further study showed that most respondents have knowledge of mosquito diseases, types of mosquitoes, risks, and deaths they cause. This is consistent with research conducted in India which found that most respondents knew mosquitoes as disease vectors [16]. In addition, the high number of KSH respondents in this study area with formal education contributed largely, reflecting to the ineffectiveness of public education regarding the dangers and prevention of disease. The main source of information about mosquitoes is health workers. This in line with result of survey that 39.78% of respondents received information from health workers, indicating that they had the proper knowledge about mosquitoes and the transmitted diseases. This is also relatively influenced by the community and formal education in the area. These results are in accordance with the previous study about the knowledge of *Ae. aegypti* found in bathtub in the house, at larvae density of 87% especially in the houses in Lidah kulon area, Surabaya. Most respondents were aware of the disease. This awareness was found to be related with education level of the community [17].

Regarding the disease commonly found in the community, 87.59% of respondents believed that the disease is related to dengue fever. This is possibly because the study area is located in the center of dengue fever endemic area, where dengue fever infection is found every year. Both *Ae. aegypti* and *Ae. albopictus* have also been found in the area. In addition, mosquitoes have high adaptability to their breeding habitat results in their endemic nature in the area. This is also supported [16] who stipulated that mosquito species adapt well to ecological conditions of the area (endemicity in large cities, such as Surabaya, Indonesia), and require consistent aggressive intervention for effective control. In line, [17] stated that urban areas are more preferred by mosquito for breeding due to anthropogenic activity that causes water to pool in both natural and artificial containers. Other common mosquito diseases mentioned by respondents included filaria fever, yellow fever, and malaria which either quite common or rare, so it is less significant for respondents.

This study involved larvae monitoring community (*Juru Pemantau jentik* or *Jumantik*) which is one of the functions and extension of KSH formed by the Surabaya City Government as one of the efforts to provide services to the community since 2022. Community empowerment efforts in eradicating dengue fever vector mosquitoes, *Ae. aegypti* and *Ae. albopictus* need to be improved through both local health center (*Puskesmas*) and active community participation through counseling and training on monitoring and inspecting larvae in water containers. The community referred to here is KSH who becomes *jumantik* through mobile sensing system application using their personal smartphone.

With KSH as respondents in the survey about dengue fever vector knowledge and its life cycle as well as the disease transmitted by mosquitoes, this intervention did not really affect or decreased the number of dengue fever cases. This community service program we explain several solutions to the problem. Counseling and training of KSH officers to be role model in the community to increase ABJ and influence the community to increase their awareness about the life cycle of mosquitoes. Developing mobile sensing technology in detecting *Aedes* mosquito larvae while checking water reservoir in the house as presented in Figure 1.

Regarding model of transmissions, most respondents identified *Aedes aegypti* mosquito bites, which is in line with previous study which reports that monitoring of virus circulation in mosquitoes allowed us to predict the risk of dengue fever, and contributed to identifying location which requires precautions and control measures [8]. This high response is an indication that they have the right knowledge about mosquitoes that cause diseases, especially dengue fever which are especially endemic in the study area. However, they did not always have a good understanding of other transmission methods. Lack of response from respondents regarding other transmission methods might be caused by limited knowledge and the information given previously to respondents that the disease transmission occurs through the bites of other mosquitoes rather than *Aedes* in their respective regions.

Signs and symptoms are very important regarding seeking medical assistance on the right time and preventing morbidity and mortality. Almost all respondents were able to notice and identify the most common signs and symptoms of mosquito-borne diseases, including fatigue, loss of appetite, runny nose, vomiting, and dizziness. This was an important result because these were initial symptoms experienced by individuals infected with mosquito-borne disease. This is similar to observations from most of previous studies [18]; [20]. This also follows the findings of other study in endemic areas [19]. According to (18), this might reflect to the accessibility and quality of health care facilities in the region.

Adequate knowledge regarding the signs and symptoms of mosquito-borne diseases shown by most respondents and their attitude regarding appropriate treatments and cares in the right time (1-3 days) and body conditions (49.53%) was an encouraging result. This shows a good understanding of the risk and consequences of diseases to personal health. This is in line with previous study which reported that public awareness has a big impact on the application of dengue fever prevention practices, in addition that information about dengue fever must be disseminated to the public to increase perception of susceptibility to this disease [20]. However, this is contrary to other study which stated that 89.3% of respondents seeking mosquito disease treatment, especially malaria, within 24 hours reflected their knowledge and access to health facilities [21]. The most preferred place for the treatment of mosquito-borne diseases was the hospital. Several of previous studies were in line with this [18]; [22], however others also reported differently, that respondents preferred home-based treatment and/or traditional treatment [23]; [24]. Regardless of patients visiting pharmacies/drug stores, looking for help from other individuals and treating themselves were indicated as the next choice by respondents. However, when their choices were seen closer, it seemed that these respondents would take these choices to treat any mosquito-borne diseases that they know. This indeed can potentially worsen the situation and in some cases might even cause mortality. Therefore, counseling and training in the community regarding self-treatment and visiting drug stores for treatment are necessary in these areas to avoid the dangers of malpractices. According to [20], knowledge, perception of threats, and self-efficacy are significant predictors of adequate practice in preventing dengue fever. Prevention and control strategies must focus on increasing awareness about the risk of transmission of dengue fever using various available media. Health messages must be designed to improve individual self-efficacy.

Knowledge regarding habitat and behavior of mosquito breeding is important for the development of effective control and prevention of mosquito bites which is the transmission method of many mosquito-borne diseases (22). Respondents of this study identified stagnant water, gutters, rivers, and ponds had the potential to be mosquito breeding sites. Dark places, flooded place, container of fresh water, toilets, and tall grasses or shrubbery were also identified as resting places for mosquitos. This opinion might be partly caused by the fact that respondents observed high rate of mosquito disturbance near the breeding sites as mentioned earlier. The majority of respondents (76.11%) had experience mosquito bites at night. The time frame mentioned by most respondents was in accordance with their knowledge and ideas that mosquitoes bite in the morning and evening. Regardless, other timeframes as mentioned by different respondents might be resulted from additional information regarding timeframes of mosquito bites. Adequate knowledge regarding the habitat, breeding, and eating habit of mosquitos as reflected in this study can help in the prevention of mosquito-borne diseases and the development of mosquito control programs. In line with this, [25] reported that health education through community involvement produced good participation in the transmission intervention of dengue fever and other mosquito-borne diseases, as well as the increase of public knowledge and awareness.

Lack of good environmental sanitation, for example cleaning around the house, (43.85%), cutting surrounding bushes (20.06%), drying the gutters (24.30%), and did not throw waste inappropriately (17.79%), could result in the emergence of many breeding sites. Therefore, adequate knowledge with common practices in the area is needed to improve environmental and individual health. This affirmation supported the report that the biggest challenge caused by mosquitoes is their ability to breed in any pool of water. These results are contrary to the study of [26] which reported that prevention practices recorded in their research in India were more directed to personal protection rather than environmental control of the vector. Similar to the results of this study, 23.78% of respondents associated this with laziness, lack of responsibility by the authorities (respondents who

live in elite or luxury homes), and the indifference of neighborhood as a reason for this behavior. A total of 68.87% and 76.53% agreed with the use of AC and mosquito repellent creams as other actions to prevent and control mosquito-borne diseases.

From the findings of this study, it can be concluded that with the success of counseling and training of KSH officers launched by the City Health Office and knowledge as respondents in detecting *Ae. aegypti* and *Ae. albopictus* larvae movements in water tank, in addition to understanding eradication and control of mosquito-borne disease transmission, most people and KSH officers in the investigated area understood the use of mobile sensing application installed in the smartphones and the dangers caused by mosquitoes regarding dengue fever transmission. However, greater effort is necessary to perform routine visits to residents of community and increase the use of mobile sensing application gradually. This was the first role model carried out in Surabaya to detect larvae movement and distinguish *Ae. aegypti* and *Ae. albopictus* using mobile sensing application in real time.

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The authors declare that this research is an original work. It has not been published elsewhere. The authors have read and approved the manuscript. All authors have no conflicts of interest concerning this study, authorship, and publication.

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REFERENCES

Fagbohun IK., Idowu ET., Onafuwa AO., Adeneye AK., Adeogun AO., Adetoro OO. (2021). Knowledge, attitudes and perception of communities on mosquitoes and its control practices in Lagos State, Nigeria. Pan Afr Med J. 38:44. doi:11604/pamj.2021.38.44.22572. PMID: 33854673; PMCID: PMC8017369

Makanda, M., Kemunto, G., Wamuyu, L., Bargul, J., Muema, J., & Mutunga, J. (2019). Diversity and molecular characterization of mosquitoes (Diptera: Culicidae) in selected ecological regions in Kenya. F1000Research, 8.

Zumaroh. (2015). Evaluation of surveillance of dengue fever cases in the public health centre of Putat Jaya based on attribute surveillance. Jurnal Berkala Epidemiologi, Vol. 3, No. 1: 82–94.

Kraemer MU, Sinka ME, Duda KA, Mylne AQ, Shearer FM, Barker CM, Moore CG, Carvalho RG, Coelho GE, Van Bortel W. (2015). The global distribution of the arbovirus vectors Aedes aegypti and Ae. albopictus. Elife. 4: e08347. doi: 10.7554/eLife.08347.

Indonesian Health Ministry, (2022). Laporan tahunan Demam Berdarah Dengue 2022. Membuka Lembaran Baru. Jakarta: PusatData dan Surveilans Epidemiologi Kementerian Kesehatan RI, Indonesia.

[World Health Organization (WHO). (2011). Comprehensive Guidelines for Prevention and Control of Dengue and Dengue Haemorrhagic Fever. Geneva: WHO Regional Publication SEARO. p. 1-195.

Surabaya City Government. 2022. Gerakkan petugas puskesmas dan KSH, cara wali kota Eri Cahyadi cegah DBD di Surabaya. 2022. https://www.surabaya.go.id/id/berita/69845/gerakkan-petugas-puskesmas-dan-ksh-cara-wali-kota-eri-cahyadi-cegah-dbd-di-surabaya.

Mulyatno, K. C., Kotaki, T., Yotopranoto, S., Rohmah, E. A, Churotin, S., Sucipto, T.H., Amarullah, I. H., Wardhani, P., Soegijanto, S., and Kameoka, M. (2018). Detection and Serotyping of Dengue Viruses in Aedes aegypti and Aedes albopictus (Diptera: Culicidae) Collected in Surabaya, Indonesia from 2008 to 2015. Jpn. J. Infect. Dis., 71, 58–61, J-STAGE Advance Publication. DOI: 10.7883yoken.

Yuana, D. B. M., Sesulihatien, W.T., Basuki, A., Harsono, T., Alimudin, A., Rohmah, E. A. Mobile sensing in Aedes aegypti larva detection with biological feature extraction. (2020). Bulletin of Electrical Engineering and Informatics (BEEI) ISSN: 2089-3191, e-ISSN: 2302-9285. DOI: https://doi.org/10.11591/eei.v9i4.1993] Du, Y., Wang, X., Brombal, D., Moriggi, A.,

Sharpley, A., & Pang, S. (2018). Changes in Environmental Awareness and Its Connection to Local Environmental Management in Water Conservation Zones: The Case of Beijing, China. Sustainability, 10(6), 2087.

Gómez-Vargas W, Ríos-Tapias PA, Marin-Velásquez K, Giraldo-Gallo E, Segura-Cardona A, Arboleda M. (2024). Density of Aedes aegypti and dengue virus transmission risk in two municipalities of Northwestern Antioquia, Colombia. PLoS One. 19(1): e0295317. doi: 10.1371/journal.pone.0295317. PMID: 38271346; PMCID: PMC10810462.

Caminade, C., Kovats S., Rocklov J., Tompkins, A.M., Morse, A.P., Colón-González, F.J., Stenlund H., Martens P., and Lloyd, Simon J. (2014). Impact of climate change on global malaria distribution. Proc Natl Acad Sci U S A. 111(9): 3286–3291. doi: 10.1073/pnas.1302089111.

] Mouchet, J., Manguin, S., Sircoulon, J., Laventure, S., Faye, O., Onapa A.W., Carnevale P., Julvez J., Fontenille D. (1998). Evolution of malaria in Africa for the past 40 years: impact of climatic and human factors. J Am Mosq Control Assoc; 14(2):121-30.

] Rotejanaprasert, C., Chinpong, K., Lawson, A.B., Chienwichai, P., and Maude, R.J. (2024). Evaluation and comparison of spatial cluster detection methods for improved decision making of disease surveillance: a case study of national dengue surveillance in Thailand. BMC Med Res Methodol 24, 14. https://doi.org/10.1186/s12874-023-02135-92014.

] Rodeiro, V.C.L., Lawson A.B. (2005). An evaluation of the edge effects in disease map modelling. Computational Statistics & Data Analysis, 49, Issue 1, Pages 45-62, ISSN 0167-9473. https://doi.org/10.1016/j.csda.2004.05.012.

Srinivasa S., Harish, S., Shruthi P., Devaranavadagi, R., Bhavya G. Anjum, S.K. (2018). Knowledge, attitude, and practice regarding dengue infection among parents of children hospitalized for dengue fever. International Journal of Contemporary Pediatrics. 5(3):893. DOI: 10.18203/2349-3291.ijcp20181509.

] Manawadu, U., Deepananda, K., & Wegiriya, H. (2005). Comparative study on the diversity and abundance of mosquito fauna to anthropogenic activities and environmental factors in selected sites of Matara area. Proceedings of the Academic Sessions, 3(5), 121-126.

] Singh, R., Musa, J., Singh, S., & Ebere, U. V. (2014). Knowledge, attitude, and practices on malaria among the rural communities in Aliero, Northern Nigeria. Journal of Family Medicine and Primary Care, 3(1), 39.

] Olayemi, I. K., Ukubuiwe, A. C and Oyibo-Usman, K. A. (2014). Mosquito Species Occurrence and Diversity in Conventional Larval Breeding Sites in Minna metropolis, Nigeria. International Journal of Innovation and Scientific Research. 9(1):86-93.

Abate, A., Degarege, A., & Erko, B. (2013). Community knowledge, attitude, and practice about malaria in a low endemic setting of Shewa Robit Town, northeastern Ethiopia. BMC Public Health, 13(1), 312.1] Manana, P. N., Kuonza, L., Musekiwa, A., Mpangane, H. D., & Koekemoer, L. L. (2018). Knowledge, attitudes, and practices on malaria transmission in Mamfene, KwaZulu-Natal Province, South Africa 2015. BMC Public Health, 18(1), 41.] Taranum R.S., Saima, G, Safia B., Waquaruddin A., and Shaimuna F.S. (2016). Use of the Health Belief Model for the Assessment of Public Knowledge and Household Preventive Practices in Karachi, Pakistan, a Dengue-Endemic City. PLoS Negl Trop Dis. 10(11): e0005129. doi: 10.1371/journal.pntd.0005129

Dida, N., Darega, B., & Abebe, A. (2015). Treatment-seeking behavior and associated factors among malaria suspected patients in Bale Zone, Southeast Ethiopia: an institution-based cross-sectional study. J Fam Med, 2(1), 5.

] Deressa, W., Ali, A., & Enquoselassie, F. (2003). Knowledge, attitude, and practice about malaria, the mosquito, and antimalarial drugs in a rural community. Ethiopian Journal of Health Development, 17(2), 99-104.

] Xu, J.-W., Xu, Q.-Z., Liu, H., & Zeng, Y.-R. (2012). Malaria treatment-seeking behaviour and related factors of Wa ethnic minority in Myanmar: a cross-sectional study. Malaria Journal 2 11:417 http://www.malariajournal.com/content/11/1/417.

Getachew D, Tekie H, Gebre-Michael T, Balkew M, Mesfin A. (2015). Breeding sites of Aedes aegypti: Potential dengue vectors in dire Dawa, East Ethiopia. Interdiscip Perspect Infect Dis. 706276. https://doi.org/10.1155/2015/706276 PMid:26435712.