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EVALUATING THE ACCURACY OF THE AEDESTECH MOBILE APP (ATA): A MOBILE APPLICATION FOR ASSESSING POPULATION SURVEILLANCE OF *Aedes* TO AID IN COMBATTING DENGUE

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ABSTRACT

Ovitrap can be used for monitoring *Aedes* mosquitoes and some of them were built for controlling the *Aedes* population such as the AedesTech Mosquito Home (AMHS) trap which utilizes pyriproxyfen. While ovitraps play a crucial role in monitoring *Aedes* mosquito transmission, manual counting of mosquito eggs within these traps proves labour-intensive and error prone. To address this challenge, the AedesTech Mobile App (ATA) was developed and continues to iterate, aiming to calculate the precise number of eggs attached to OviTo linen, an oviposition strip in AMHS, where gravid mosquitoes lay eggs. This mobile application modernizes the process by capturing OviTo linen images and automatically counting *Aedes* mosquito eggs through image analysis, securely storing data in the cloud. The app further enhances efficiency by facilitating precise ovitrap location tracking via QR codes. Research focuses on evaluating ATA's precision based on 1358 pieces of OviTo linen in assessing mosquito populations in the multilevel Asoka Apartment in Penang. A comparison between ATA version v0.9.3 and manual counting methods reveals a consistent 3.53% accuracy across all collected OviTo linen. There was less observable improvement in ATA accuracy over three consecutive periods. The study underscores the necessity for enhancements in ATA version v0.9.3 to address limitations and achieve more accurate counts in mosquito population assessments.

Keywords: *Aedes,* dengue, mobile applications, population surveillance, mosquito control

ABSTRAK

Ovitrap boleh digunakan untuk pemantauan nyamuk *Aedes* dan ada sesetengah yang digunakan untuk mengawal populasi *Aedes* seperti perangkap AedesTech Mosquito Home (AMHS) yang menggunakan pyriproxyfen. Walaupun ovitrap memainkan peranan penting dalam pemantauan penularan nyamuk *Aedes*, pengiraan manual telur nyamuk daripada perangkap ini memerlukan banyak tenaga dan rentan kepada kesilapan. Bagi menangani cabaran ini, AedesTech Mobile App (ATA) telah dibangunkan dan masih dalam penambahbaikan. Ia dicipta bertujuan untuk mengira jumlah telur yang melekat pada OviTo linen dengan tepat. OviTo linen adalah kain tempat nyamuk bertelur di dalam AMHS. Aplikasi mudah alih ini memodenkan proses dengan menangkap imej OviTo linen dan secara automatik mengira telur nyamuk *Aedes* melalui analisis imej, menyimpan data secara selamat dalam awan. Aplikasi ini turut meningkatkan kecekapan dengan memudahkan penjejakan lokasi ovitrap yang tepat melalui kod QR. Kajian ini menumpukan kepada menilai ketepatan ATA berdasarkan 1358 keping OviTo linen dalam menilai populasi nyamuk di Asoka Apartment yang mempunyai beberapa aras di Penang. Perbandingan antara ATA v0.9.3 dan kaedah pengiraan manual mendedahkan ketepatan sebanyak 3.53% daripada kesemua OviTo linen yang dikumpul. Tiada peningkatan ketara dalam ketepatan ATA sepanjang tiga tempoh yang berturut-turut. Kajian ini menekankan keperluan penambahbaikan dalam versi ATA v0.9.3 untuk mengatasi kelemahan dan mencapai pengiraan yang lebih tepat dalam penilaian populasi nyamuk.

Kata Kunci: *Aedes*, denggi, aplikasi mudah alih, pengawasan populasi, kawalan nyamuk

INTRODUCTION

In the context of averting sudden dengue epidemics, it becomes vital to closely monitor the *Aedes* mosquito population (Djiappi-Tchamen et al. 2022). Among the array of methods available, one that stands out is the ovitrap approach (Hasnan et al. 2016). This method not only exhibits high sensitivity but also proves cheap and economical in detecting *Aedes* mosquitoes through the presence of mosquito eggs. The procedure involves deploying specialized traps to allure gravid mosquitoes to lay eggs, followed by meticulous manual counting of these eggs at their laying sites (Ishak et al. 2022).

Recent advancements have propelled innovation in this domain, with the development of user-friendly apps designed to modernize egg counting. These advancements, demonstrated in the studies by Hamesse et al. (2023), Javed & López-denman (2023) and Yussof et al. (2018), which hold substantial potential for enhancing the precision and efficiency of monitoring and controlling the *Aedes* mosquito population.

Normally, in manual counting, tools like magnifying glasses and microscopes have been commonly utilized. Recent studies, exemplified by the implementation of stereoscopic microscopes in studies by Hamesse et al. (2023), Santos et al. (2020) and Yazan et al. (2020), aim to facilitate this process. However, manual counting remains a time-consuming and labour-intensive task, demanding substantial effort (Yussof et al. 2018). A study in Bukit Tinggi used a method of combining manual counting with a hand tally counter, offering an add-on approach to lessen the burdens (Ishak et al. 2022).

Numerous apps have been developed to ease the counting process, such as AedesTech Mobile App (ATA), ICount, MECVision, and Ovitrap Monitor (Gopalsamy et al. 2021; Hamesse et al. 2023; Javed & López-Denman 2023). The ATA was developed by Universiti Malaysia Terengganu, Universiti Sultan Zainal Abidin, and One Team Network Sdn. Bhd. (Gopalsamy et al. 2021; Man et al. 2020b).This mobile application is easy to handle compared to other apps that need other appliances, such as a scanner, to do counting (Dembo et al. 2014).

It is important to note that ATA is still in the process of development, as informed by One Team Network Sdn. Bhd. and its access are currently limited to a designated link discreetly provided by the company. The apps are currently not available for public access and cannot be downloaded online. The primary objective of developing the ATA was to provide an efficient method for automating the counting of *Aedes* eggs attached to the OviTo linen, an oviposition strip where gravid females lay their eggs in the AedesTech Mosquito Home System (AMHS) trap. This app aims to reduce the dependence on manual labour in the management of dengue disease (Man et al. 2020a). The AMHS trap utilized an autodissemination process to control the *Aedes* population with the use of pyriproxyfen (Yazan et al. 2020).

Currently, only one comprehensive study has been conducted at Universiti Putra Malaysia to test the effectiveness of ATA (Gopalsamy et al. 2021). Unfortunately, the findings revealed a significant deficiency in the accuracy of ATA's performance. Out of the 455 total counts analyzed, only four demonstrated consistency, underscoring an alarmingly low level of precision (Gopalsamy et al. 2021). Consequently, the calculated accuracy rate stood at a mere 0.88%. This result sharply contrasts with the remarkable precision levels of other contemporary applications, such as EggCountAI, ICount, MECVision, and Ovitrap Monitor. These competing applications showcased levels of precision that approached a nearly impeccable 99% threshold (Hamesse et al. 2023; Javed & López-denman 2023).

To ensure the precision and reliability of the ATA when it comes to counting *Aedes* mosquito eggs, the primary objective of this study is to comprehensively assess and scrutinize the accuracy of ATA's egg-counting capabilities. Through this study, we aim to contribute valuable insights and data that can aid in optimizing ATA's functionality for mosquito egg counting purposes.

MATERIALS AND METHODS

Location of the Study

This study was conducted at Asoka Apartment (5.30230, 100.25720), located in Bayan Lepas, Pulau Pinang, Malaysia (Figure 1). This location was chosen due to its classification as a dengue hotspot, as indicated by the idengue (2023) website. The small-scale study encompassed four levels of Asoka Apartment. Surrounding residential areas include Akasia Apartment, Mutiara Perdana, Orchard Ville Condominium, Meridien Residence, among others. Moreover, the building is situated near a lush tropical forest area, located less than one kilometre away.

Figure 1. The picture shows the location of the study site, Asoka Apartment, in Bayan Lepas, Pulau Pinang, Malaysia.

(Source: Google Earth 2023)

The AedesTech Mosquito Home System (AMHS Trap)

The AedesTech Mosquito Home System (AMHS) trap, supplied by One Team Networks Sdn. Bhd., is designed as an autodissemination trap (Figure 2). It consists of a black polyethene opaque bucket with dimensions of 13.0 cm (height) × 11.0 cm (bottom width) × 14.8 cm (top width) and features a plum-coloured lid. The trap is lined with the OviTo linen around the bucket base, providing a substrate for mosquitoes to oviposit (Figure 3(a)). This design allows the trap to serve as a monitoring device for the *Aedes* population by counting the number of eggs attached to the OviTo linen. The dimensions of the OviTo linen are 7.5 cm in length and 17.5 cm in width (Figure 3(b)). A 500 ml bottle of Mosquito Home Aqua solution (MHAQ solution) containing 400 ppm pyriproxyfen is positioned in the middle of the bucket base (Figure 4). The flow of the MHAQ solution is facilitated by gravity, allowing it to fill the bottom of the bucket base.

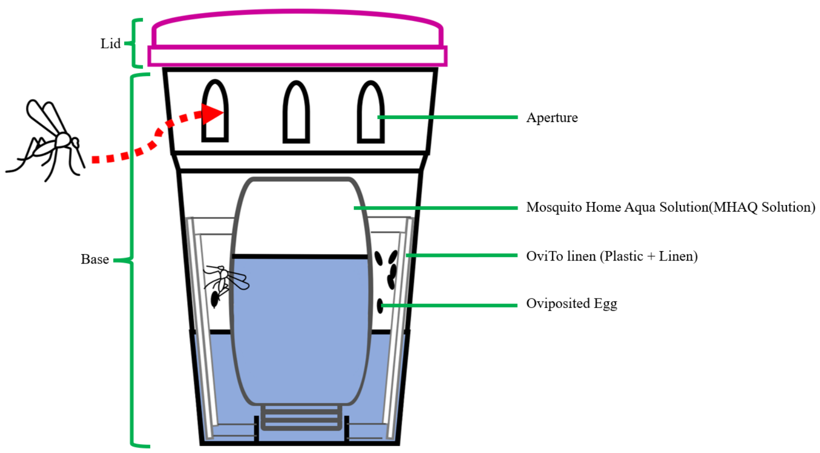

Figure 1. A concise visual representation showcasing the AedesTech Mosquito Home Trap equipped with OviTo Linen and MHAQ solution

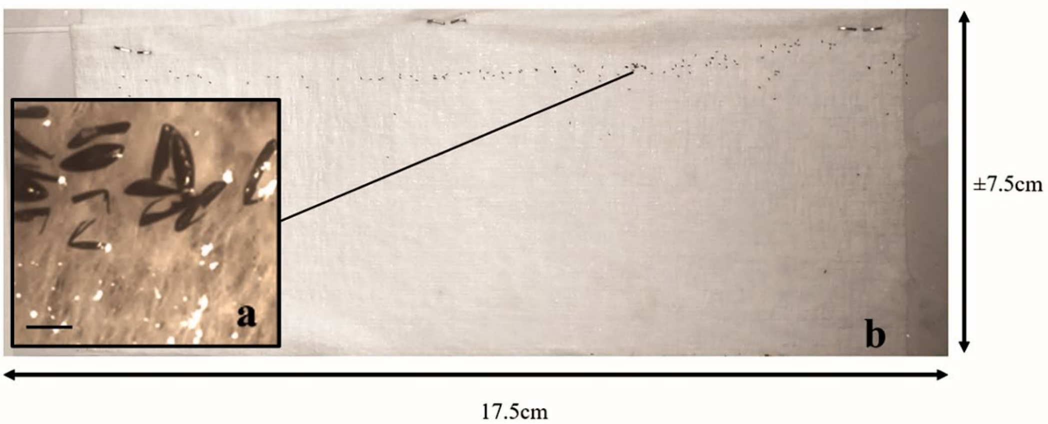

Figure 2. (a) The zoom-in picture is of the eggs under a dissecting microscope. Scale bar = 500 µm. (b) The size of OviTo linen (oviposition strip used in AedesTech Mosquito Home Trap)

Figure 4. An instruction to prepare the AedesTech Mosquito Home System (AMHS)

(Source: One Team Network Sdn. Bhd. 2021)

Study Design

The research was organized into three consecutive periods, as detailed in Table 1, to enhance clarity. AedesTech Mosquito Home System (AMHS) traps were deployed in the Asoka Apartment for this study, covering four levels of the multilevel building, with each trap placed 0.8m to 1.0m from the others. The AMHS traps were serviced every week, and the OviTo linen in the AMHS traps was collected and replaced. The number of OviTo linen collected for each period is shown in Table 1. The primary objective of this study was to assess potential enhancements of the AedesTech Mobile App (ATA) throughout these periods, considering the ongoing development of the application. Simultaneously, the investigation sought to draw comparisons with findings from a prior study conducted by Gopalsamy et al. (2021).

Table 1. Number of OviTo linen collected from the AMHS traps for three consecutive periods at Asoka Apartment in Penang

Period	**Number of OviTo Linen Collected**	**Duration***
1	160	6 weeks
2	958	12 weeks
3	240	6 weeks
Total	1358	24 weeks

*5 days is considered as 1 week.

AedesTech Mobile App (ATA)

The AedesTech Mobile App (ATA) used in this study is version v0.9.3 (Figure 5). This mobile app was built by a group of researchers from Universiti Malaysia Terengganu, Universiti Sultan Zainal Abidin, and One Team Network Sdn. Bhd. (Man et al. 2020a). This application is designed to assist in automated egg counting by capturing pictures of the OviTo linen data. The data obtained from the images was then analyzed, and results were stored in the cloud for further access (Gopalsamy et al. 2021; Man et al. 2020a).

The OviTo linen attached with *Aedes* eggs collected from the AedesTech Mosquito Home System (AMHS) during the study were calculated using ATA and manual counting. The AMHS were deployed in Asoka Apartment involving four level of the multilevel building, and the trap's location was tagged in the ATA with an internet connection. After a week, the OviTo linen was collected and brought back to the laboratory. The process preceded with scanning the QR code attached to each OviTo linen using a mobile phone, which allows the corresponding AMHS trap data to be accessed. A picture is captured using the same mobile phone. Subsequently, the application analyzes the data by allowing the user to manually crop the image (Gopalsamy et al. 2021). Following this, the application runs recognition to identify the eggs, conducts a counting process, and stores the data in the cloud (Figure 6). The recorded information is linked to the respective trap locations, which can be conveniently accessed through the QR codes attached to both the OviTo linen and the AMHS traps.

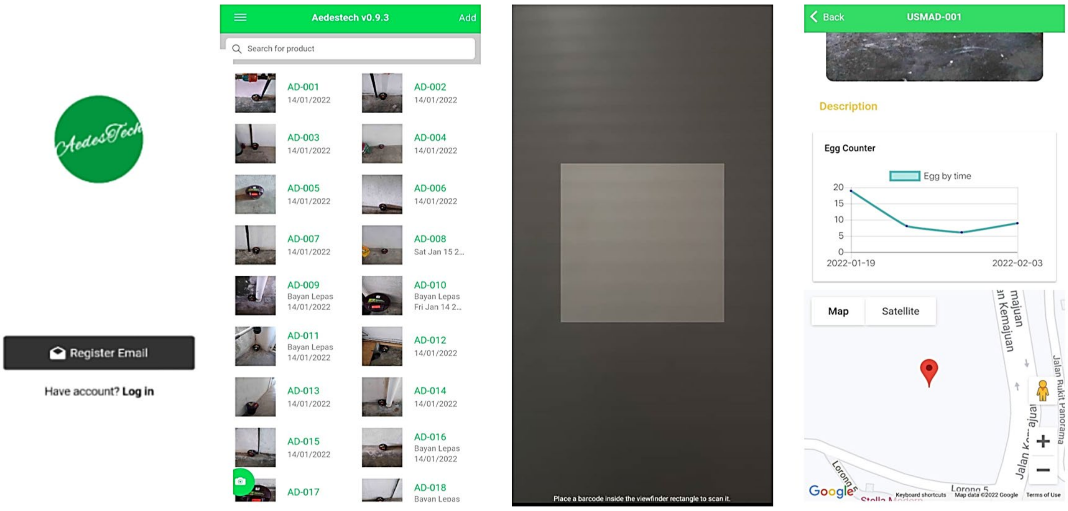

Figure 5. Snapshots of AedesTech Mobile App v0.9.3 interfaces

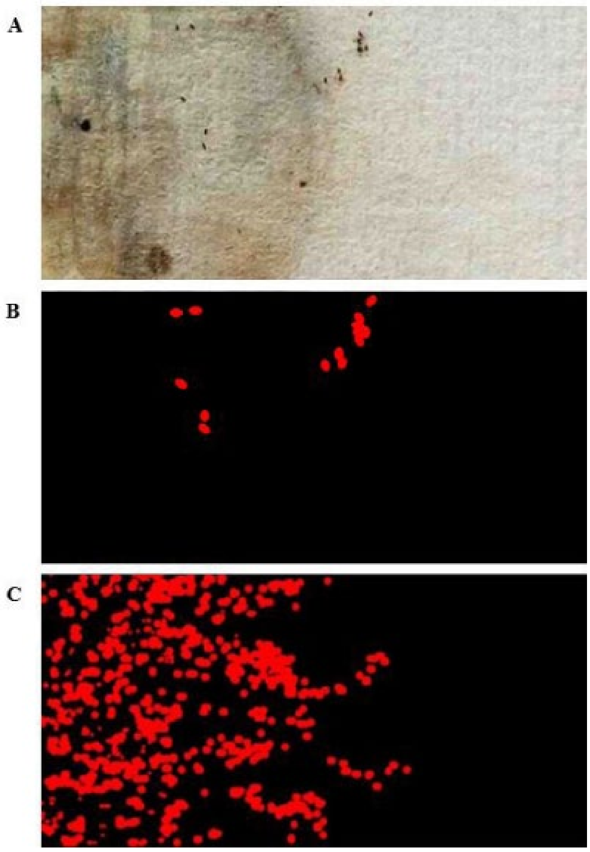

Figure 6. Image breakdown using ATA Version 5.9. (a) Eggs attached to OviTo linen (b)Expected image (c) Actual image counted by the app

(Source: Gopalsamy et al. 2021)

Manual Counting

In order to evaluate the precision of the counting app, a comparison was made using a manual counting technique. In the manual counting process, a magnifying glass and tally counter was utilized to count the number of *Aedes* eggs through grids. However, in instances where the mosquito eggs were clustered together, which required a closer examination, a light microscope was employed, following the approach outlined in the research conducted by Yazan et al. (2020). To validate manual counts, three repetitions were conducted independently by two individuals, resulting in a total of six counts. The average count was then calculated.

Statistical Analysis

The Wilcoxon Signed-Rank Test was utilized to compare the counting results obtained from ATA counting and manual counting. This test helped assess the occurrence of tied counts and determine the accuracy of the apps in relation to manual counting. Besides, the data for each consecutive period was analyzed using Kruskal-Wallis to compare the successful ties data.

RESULTS

A comprehensive analysis was conducted on a total of 1358 OviTo linen pieces collected from the deployment of AMHS traps. The variance between manual counting and counting through the AedesTech Mobile App (ATA) was examined using Wilcoxon's signed-rank test. Out of all the samples examined (Figure 7), only 48 instances, approximately 3.53%, resulted in ties of the counting by ATA and manual. ATA reported a higher count than the manual count of 832 cases (61.27%). While 478 cases with 35.20% showed, ATA had a lower count compared to the manual count. Wilcoxon Signed-Rank Test showed a significant difference between ATA and manual count ($Z=-1.963$, $P=0.050$).

Referring to Table 2**,** the highest recorded percentage of success (%) based on weekly observations was 10.00%, which was recorded during Period 3 on weeks 1, 2, and 6. Notably, this outcome signified the occurrence of four tied samples between ATA and manual counting in AMHS traps out of 40 samples in each respective week.

Conversely, the most substantial overall percentage of success was observed in Period 2. Remarkably, this study segment attained a rate of 33.75%, drawing from an extensive sample of 958 samples. This outcome underscores that approximately 323 out of the 958 samples subjected to the study exhibited tied results. However, upon conducting a Kruskal-Wallis analysis, it was apparent that there was no significant difference in the percentage of success (%) during the three consecutive periods ($H= 2.46$, $df=2$, $P=0.292$). This suggests that no discernible improvement in accuracy was observed throughout the entire duration of this study.

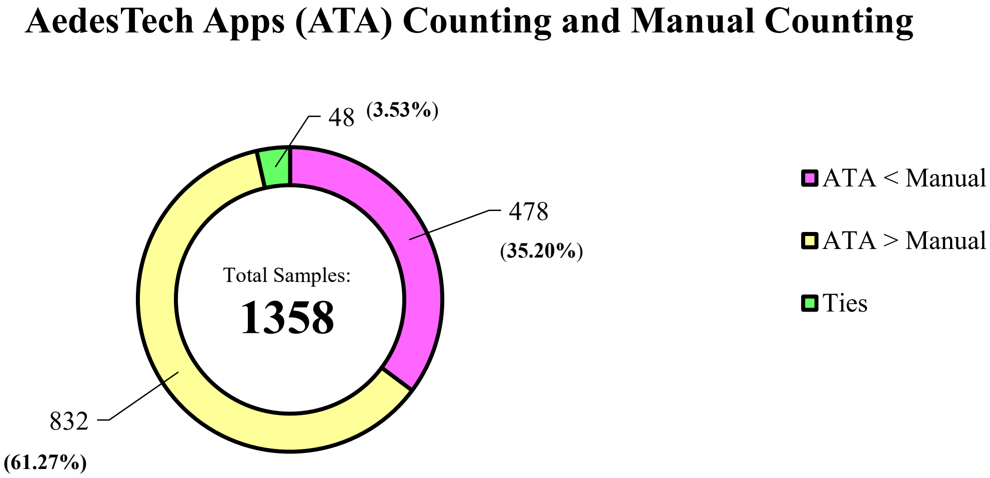

Figure 7. Pie chart illustrates the data for the counting between the AedesTech Mobile App and manual counting

Table 2. Comparison of the percentage of successful ties counts (%) between manual counting and AedesTech Mobile App (ATA) counting over time

Week	**Percentage Successful (%)**		
	Period 1	**Period 2**	**Period 3**
1	5.00	2.50	10.00
2	0.00	6.25	10.00
3	7.50	2.50	2.50
4	5.00	3.75	0.00
5	5.00	2.50	0.00
6	5.00	2.50	10.00
7		3.75	
8		2.50	
9		2.50	
10		2.50	
11		1.25	
12		1.25	
Total (%)	27.50	33.75	32.50
Mean per Week (%)	4.58	2.81	5.42

**Please note that both Period 1 and Period 2 were conducted over a duration of only six weeks.

DISCUSSION

Our results revealed that the successful ties of counting between ATA and manual were at 3.53% from the overall collected OviTo linen with *Aedes* eggs. Although the ATA only achieved a 3.53% match with the actual number of eggs when compared to manual counting, it still surpasses the results (0.88%) from a previous study conducted at Universiti Putra

Malaysia using an older version of ATA, Version 5.9, by about 2.65%. (Gopalsamy et al. 2021). This indicates a slight improvement in the accuracy of the AedesTech Mobile App (ATA).

ATA apps which utilized the MATLAB AutoCountMe system are designed for locating the AedesTech Mosquito Home System (AMHS) and counting mosquito eggs on OviTo linen (Man et al. 2020a). ATA also incorporates a graph indicating the total eggs collected based on the collection date per trap. The user interface is moderately user-friendly, facilitating convenient trap searches via the QR codes affixed to each AMHS trap. The apps are compatible with iOS and Android but offer limited customization options and restrict ovitrap data to user-designated study sites. ATA is currently undergoing further development by the developer. The app is available for free and can be used offline to upload OviTo linen pictures, although initial tagging necessitates internet access.

Even upon reviewing each period, the highest percentage of ties between the AedesTech Mobile App and manual counting stood at just 33.75%, derived from 958 samples within Period 2, indicating relatively low accuracy. Furthermore, even when examining the ties data for each week, the success percentage demonstrated consistent lows, with the lowest recorded at 0.00% and the highest at a mere 10.00% among the collected OviTo linen. These findings collectively highlight the AedesTech Mobile App has a limited success rate in achieving accurate outcomes.

The ATA app utilizes the customized MATLAB AutoCountMe system, which is designed to identify *Aedes* mosquito eggs through captured images. However, the presence of dust or other foreign objects may result in inaccurate readings, as the app may have difficulty distinguishing between the black color of the mosquito egg and similar objects (Gopalsamy et al. 2021). Based on our observation, the AedesTech Mobile App also counted thin metal staples due to the black colour of rusting. The AedesTech Mobile App has missed counting the eggs near the metal staples, which has caused inaccuracies in detection. Furthermore, ATA allowed users to crop the image in a rectangular shape only. Thus making, the ATA cannot freely exclude the staple's area. However, as the AedesTech Mosquito Home System has a lid, it has decreased the probability of being exposed to more dirt or any external foreign objects (Hamesse et al. 2023; Iyaloo et al. 2021).

It is worth noting that this study had a higher number of tied samples compared to the previous study by Gopalsamy et al. (2021). This may be due to the OviTo linen being left in the AMHS trap for only five days, which causes less infection by any fungi. Meanwhile, unlike the previous study, traps were left for six to eight weeks before servicing (Gopalsamy et al. 2021). This caused the fungi to colonize the OviTo linen and caused more inaccuracies in ATA counting. Remarkably, in a separate research endeavour using different types of ovitrap, it was concluded that maintaining the ovitrap deployment period within two weeks resulted in a significant decrease in fungi buildup (Montgomery et al. 2017). The existence of black fungi may worsen the counting process due to colour detection used in the ATA. In brief, these results underscore the importance of the duration of ovitrap placement in effectively managing the buildup of contaminants and the growth of fungi.

In this context, it is crucial to continuously refine the techniques and functionalities of the app to ensure accurate readings and reduce reliance on laborious manual counting. (Hamesse et al. 2023). Automatic egg counting tools offer several advantages, such as faster processing, increased image capacity, and reduced human error. These tools expedite counting, enabling the analysis of larger datasets in less time. Furthermore, they ensure standardized and consistent counting, minimizing errors due to human factors (Javed & López-Denman 2023).

CONCLUSION

In conclusion, our study highlights a consistently low accuracy rate of just 3.53% across all 1358 results. Moreover, upon examining various studies, there was no discernible improvement in the accuracy of the AedesTech Mobile App (ATA) accuracy over time. To address this limitation future iterations of the app should prioritize improving accuracy by introducing a new algorithm capable of differentiating *Aedes* eggs based on their shape and size rather than relying solely on image recognition by colour. Moreover, this enhanced algorithm should provide offline access during the initial location tagging, acknowledging that some deployment areas lack internet connectivity. These improvements have the potential to greatly enhance the egg counting process, enabling more efficient mosquito population monitoring and control measures while also expanding ATA's utility in the pest management sector.

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AUTHORS DECLARATIONS

Conflict of Interest
All authors confirm the absence of conflicts of interest influencing the reported findings in this paper.

Ethics Declarations
No ethic is required for this study.

Data Availability Statement
This manuscript is a part of a Master Project titled Efficacy and Autodissemination of AedesTech Mosquito Home System (AMHS) on *Aedes* mosquitoes in laboratory and small-scale study.

Authors' Contributions
Fatin Nabila executed experiments, analyzed data, and writing the original manuscript. Wan Fatma Zuharah provided overall guidance contributed to data analysis, writing, and manuscript enhancement. Lim Chee Hwa funded and supervised the research, particularly in the AMHS application. Mustafa Man guided the use of the AedesTech Mobile App (ATA), while Ahmad Mohiddin Mohd Ngesom provided direction on research design.

REFERENCES

Dembo, E., Ogboi, J., Abay, S., Lupidi, G., Dahiya, N., Habluetzel, A. & Lucantoni, L. 2014. A user-friendly method to assess *Anopheles stephensi* (Diptera: Culicidae) vector fitness: fecundity. *Journal of Medical Entomology* 51(4): 831–836.

Djiappi-Tchamen, B., Nana-Ndjangwo, M.S., Nchoutpouen, E., Makoudjou, I., Ngangue-Siewe, I.N., Talipouo, A., Mayi, M.P.A., Awono-Ambene, P., Wondji, C., Tchuinkam, T. & Antonio-Nkondjio, C. 2022. *Aedes* mosquito surveillance using ovitraps, sweep nets, and biogent traps in the city of Yaoundé, Cameroon. *Insects* 13(9): 1–11.

Google Earth. 2023. https://earth.google.com/web/ [20 August 2023].

Gopalsamy, B., Yazan, L.S., Abdul Razak, N.N. & Man, M. 2021. Association of temperature and rainfall with *Aedes* mosquito population in 17th college of Universiti Putra Malaysia. *Malaysian Journal of Medicine and Health Sciences* 17(2): 78–84.

Hamesse, C., Andreo, V., Rodriguez Gonzalez, C., Beumier, C., Rubio, J., Porcasi, X., Lopez, L., Guzman, C., Haelterman, R., Shimoni, M. & Scavuzzo, C.M. 2023. Ovitrap monitor - online application for counting mosquito eggs and visualisation toolbox in support of health services. *Ecological Informatics* 75(October 2022): 102105

Hasnan, A., Dom, N.C., Rosly, H. & Tiong, C.S. 2016. Quantifying the distribution and abundance of *Aedes* mosquitoes in dengue risk areas in Shah Alam, Selangor. *Procedia - Social and Behavioral Sciences* 234: 154–163.

idengue. 2023. https://idengue.mysa.gov.my/ [30 September 2023].

Ishak, M.H., Shafie, F.A., Rajan, S. & Hasan, H.A. 2022. Distribution and abundance of *Aedes* mosquito breeding sites at schools in Bukit Tinggi, Klang. *Malaysian Journal of Medicine and Health Sciences* 18(8): 8–15.

Iyaloo, D.P., Elahee, K.B., Munglee, N.R., Latchooman, N., Ramprosand, S., Puryag, S., Ramdonee-Mosawa, V. & Bheecarry, A. 2021. Field evaluation of Aedes Tech Mosquito Home System ovitraps in Mauritius. *Vector Biology and Control Division, Ministry of Health and Wellness*: 1–15.

Javed, N. & López-denman, A.J. 2023. EggCountAI : A convolutional neural network based software for counting of *Aedes aegypti* mosquito eggs: 1–20.

Man, M., Bakar, W.A.W.A., Hwa, L.C. & Yusoff, W.N.J.W.M. 2020a. Dengue innovation: A sustainability integrated approach for preventing and controlling of dengue diseases outbreaks via IR4.0 technology. *International Journal of Emerging Trends in Engineering Research* 8(6): 2612–2616.

Man, M., Bakar, W.A.W.A., Hwa, L.C., Yusoff, W.N.J.W.M., Afenddi Mat Nor, M. & Mohd. Noor, M.I.H. 2020b. Dengue Innovation: A Sustainability approach for preventing and controlling of dengue diseases outbreaks via IoT technology. *IOP Conference Series:*

Materials Science and Engineering 769(012012): 1–9.

Montgomery, B.L., Shivas, M.A., Hall-Mendelin, S., Edwards, J., Hamilton, N.A., Jansen, C.C., McMahon, J.L., Warrilow, D. & van den Hurk, A.F. 2017. Rapid surveillance for vector presence (RSVP): Development of a novel system for detecting *Aedes aegypti* and *Aedes albopictus*. *PLoS Neglected Tropical Diseases* 11(3): 1–15.

One Team Network Sdn. Bhd. 2021. http://www.onedream.com.my/index.php?ws=showproducts&products_id=1010579&cat=Mosquito-Trap#openproducts [15 April 2023]

Santos, I.C. da S., Braga, C., de Souza, W.V., de Oliveira, A.L.S. & Regis, L.N. 2020. The influence of meteorological variables on the oviposition dynamics of *Aedes aegypti* (Diptera: Culicidae) in four environmentally distinct areas in Northeast Brazil. *Memorias do Instituto Oswaldo Cruz* 115(6): 1–10.

Yazan, L.S., Paskaran, K., Gopalsamy, B. & Majid, R.A. 2020. Aedestech mosquito home system prevents the hatch of *Aedes* mosquito eggs and reduces its population. *Pertanika Journal of Science and Technology* 28(1): 263–278.

Yussof, W.N., Man, M., Hitam, M.S., Hamid, A.A., Awalludin, E.A. & Bakar, W. 2018. Wavelet-based auto-counting tool of *Aedes* eggs. *Proceedings of the 2018 International Conference on Sensors, Signal and Image Processing,* pp. 56–59.