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SPECIES ASSEMBLAGES OF PALM WEEVILS (*Rhynchophorus* SPP.) IN THREE DIFFERENT COCONUT PLANTATIONS IN WESTERN SARAWAK, MALAYSIA

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ABSTRACT

A study on the species assemblages of palm weevils was conducted in three different coconut plantations in Western Sarawak, Malaysia, which included Beliong, Kota Samarahan and Lundu districts, respectively, from December 2019 until February 2020. Pheromone traps and food-baited traps were deployed during this study. Total of nine individuals representing *Rhynchophorus vulneratus* (Red Stripe Weevil) were recorded while one individual was suspected to be *R. ferrugineus* (Red Palm Weevil). This study suggests that the differences in colour and markings on the elytra of *R. ferrugineus* captured may be influenced by environmental factors. The damages caused by *Rhynchophorus* species towards coconut trees in this study were also documented. Based on the Chi-Square analysis (X^2 (6, N = 10) = 12.59, p = 0.34), the preference of *Rhynchophorus* spp. toward the type of treatments is independent. Further studies or repetition should be conducted to consider longer trapping days and additional sampling areas.

Keywords: phytophagous insects, pheromone trap, *Rhynchophorus*, weevil

ABSTRAK

Satu kajian mengenai himpunan spesies kumbang tanduk palma telah dijalankan di tiga ladang kelapa yang berbeza di Sarawak Barat, Malaysia, iaitu di Beliong, Kota Samarahan, dan Lundu, dari Disember 2019 hingga Februari 2020. Perangkap feromon dan perangkap berumpan makanan telah digunakan dalam kajian ini. Sebanyak sembilan individu *Rhynchophorus vulneratus* (Kumbang Tanduk Berjalur Merah) telah direkodkan, manakala satu individu disyaki *R. ferrugineus* (Kumbang Tanduk Merah). Kajian ini mencadangkan bahawa perbezaan warna dan corak pada elytra *R. ferrugineus* yang ditangkap mungkin dipengaruhi oleh faktor persekitaran. Kerosakan yang disebabkan oleh spesies *Rhynchophorus* terhadap pokok kelapa dalam kajian ini turut didokumentasikan. Berdasarkan analisis Chi-Square (X^2 (6, N = 10) = 12.59, p = 0.34), ini menunjukkan bahawa kecenderungan *Rhynchophorus* spp. terhadap jenis rawatan adalah bebas. Kajian lanjut atau pengulangan kajian disarankan dengan tempoh perangkap yang lebih lama serta penambahan kawasan persampelan.

Kata kunci: serangga fitofaj, perangkap feromon, *Rhynchophorus*, kumbang tanduk

INTRODUCTION

The palm weevils of the genus *Rhynchophorus* (Herbst 1795) are significantly known as pests to a broad range of palm species (family Aracaceae) including coconut, sago, oil palm and dates worldwide (Hoddle & Hoddle 2016; Sukirno et al. 2018). Coconut plantation is one of the principal economic crops grown in Malaysia. Coconut also has become a unique source for various natural products, especially medicines and for development of industrial products (DebMandal & Mandal 2011). However, pest infestation of palm weevils on coconut plantations causes massive destruction to this crop and results in a low number of productions. Palm weevils infest coconut palms throughout their life cycle. As adults, they move to a new healthy palm after destroying the previous host(Azmi et al. 2013), despite various treatments like insecticide application (Azlina et al. 2024). However, infestations are often detected only when the palm is critically damaged or dead (Azmi et al. 2017). There is limited knowledge about the species assemblages of palm weevils in coconut plantations in Sarawak. A previous report by (Kueh Tai 2013) from the Department of Agriculture, Sarawak, recorded only *R. vulneratus*, the local indigenous species. This study aims to identify the palm weevil species infesting coconut plantations in Sarawak and determine the most effective trap for mass trapping. The findings will contribute to developing best management practices for controlling palm weevils.

MATERIALS AND METHODS

Sampling Sites

This study was conducted at three different coconut plantations in Western Sarawak, Malaysia namely Kampung Tambirat Beliong, Cocoa Research and Development Centre (CRDC) field centre owned by Malaysian Cocoa Board (MCB), Kota Samarahan and Cocoa Research Centre (CRC), Lundu Station owned by MCB in Lundu, Kuching.

Insect Sampling

Pheromone traps (Ferrolure +) and food-baited traps were used in this study, following (Azmi et al. 2014) with small modifications. The traps were designed by using 7-L polypropylene buckets with 3 cm diameter holes cut at 4 cm below the upper rim of the bucket. The pheromone was placed at the same height as the 3 cm diameter holes, with the function of the hole being to provide access for the weevils to enter. The outer surface of the bucket was covered using a sackcloth to provide friction for the weevils and prevent them from easily falling off. In addition, water and detergent were added inside the trap during the trap installation. Water was needed to maintain the moisture inside the trap and prevent weevils from escaping the bucket, while detergent was used to kill the weevils as it will break the surface tension of the water. Blue-coloured traps were used, as recommended by Al-Saoud (2013). Table 1 shows the type of treatments and the number of traps used in three different coconut plantations. Each treatment was deployed for 14 days in each location. A randomized block design (RCBD) was applied in the setup of the four treatments including control in each coconut plantation (Figure 1).

Table 1. Type of treatment and number of traps in each replicate

Treatments	Number of Traps In Each Replicate
(A) Pheromone (Ferrolure +)	2
(B) Pineapples	2
(C) Pheromone (Ferrolure +) + Pineapples	2
(D) Control	2

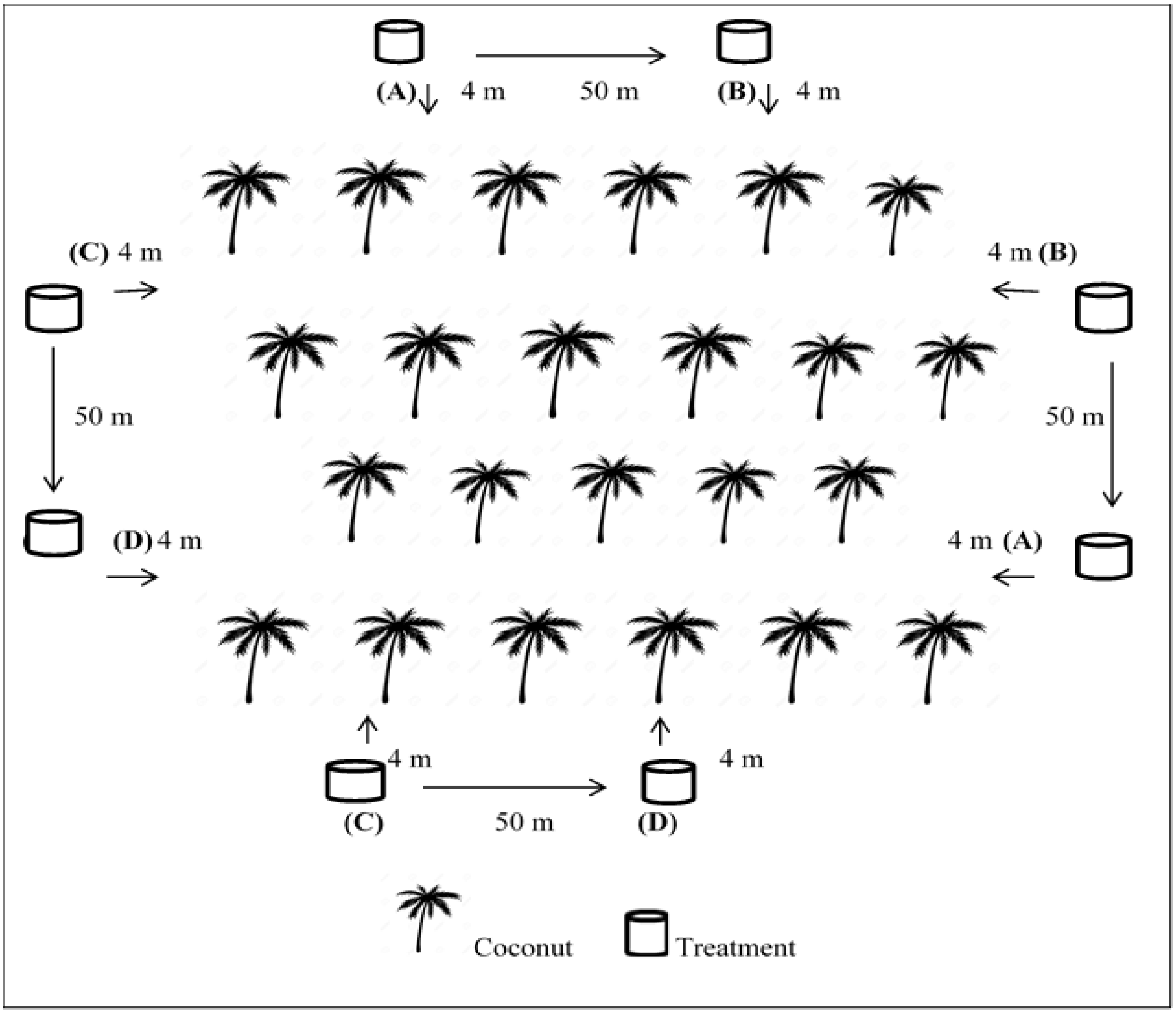

Figure 1. Randomized complete block design (RCBD) with four different treatments including control.

A total of 24 traps were deployed around each of the coconut plantations. Each treatment was deployed 4 m away from the coconut plantation while the distance between each trap was around 50 m. This may attract palm weevils away from the coconut plantation. Additionally, placing traps outside the plantation can help prevent them from entering and infesting the coconut trees.

Species Identification

The collected weevils were brought back to the Zoological Museum, FRST, UNIMAS for identification. The process followed the study by Sazali et al. (2018) which involved measuring the morphological characteristics of *Rhynchophorus* spp. using a stereo microscope and referencing works such as(Khoo et al. 1991; Musthafa et al. 2019; Yaakop e.t al. 2021). External characteristics were measured using a digital caliper (Mitutoyo TM) calibrated to 0.01 mm and recorded to two decimal points.

Data Analysis

Bait preferences of *Rhynchophorus* spp. towards four different treatments were analyzed using the Chi-Square Test of Independence to determine whether bait selection was independent of treatment type. The analysis was conducted using IBM SPSS Statistics v30 and Microsoft Excel 2010. We hypothesized that *Rhynchophorus* spp. bait preference is independent of the treatment type.

RESULTS

Occurrence of Palm Weevils (*Rhynchophorus* spp.) at Three Different Coconut Plantations

Table 2 shows the occurrence of palm weevils (*Rhynchophorus* spp.) during the sampling period at three different coconut plantations. The result shows a total of 10 individuals of *Rhynchophorus* spp. representing two species namely *R. ferrugineus* (Figure 2) and *R. vulneratus* (Figure 3). A total of three individuals of *R. vulneratus*, four individuals of *R. vulneratus* and two individuals of *R. vulneratus* with one individual of *R. ferrugineus* were captured in Beliong, Kota Samarahan and Lundu, respectively. Another weevil species collected in this study was *Macrochirus praetor* (Figure 4), which was captured in Kota Samarahan.

Table 2. Occurrence of palm weevils (*Rhynchophorus* spp.) in three different coconut plantations

Species/ Sampling Area	***R. vulneratus*** **(Adult)**		***R. ferruginues*** **(Adult)**	
	Male	**Female**	**Male**	**Female**
Beliong	1	2	0	0
CRDC, Kota Samarahan	1	3	0	0
CRC, Lundu	0	2	0	1

Figure 2. *Rhynchophorus ferrugineus* in dorsal view

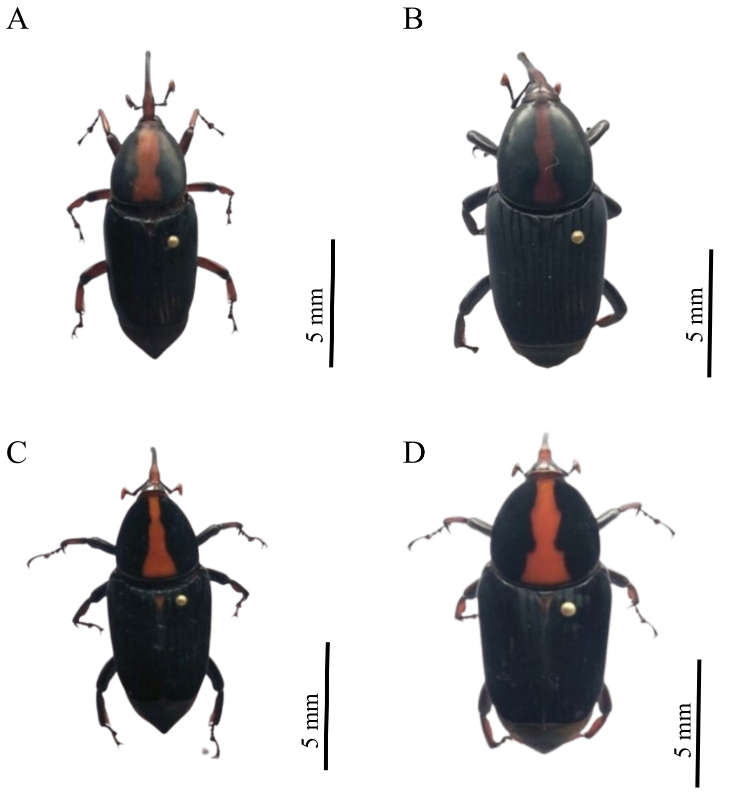

Figure 3. Various markings on the pronotum of *R. vulneratus* captured in this study

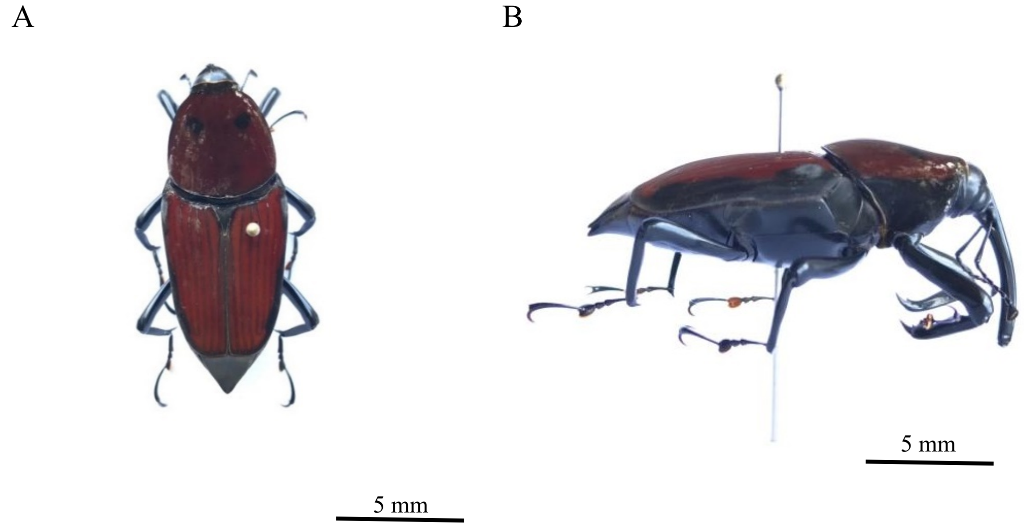

Figure 4. *Macrochirus praetor* captured in Kota Samarahan in (A) dorsal and (B) lateral view

Bait Preferences (Treatments) for *Rhynchophorus* spp.

Table 3 presents the bait preferences (treatments) for each individual of *Rhynchophorus* spp. It demonstrates that all *R. vulneratus* in this study were attracted to both Treatment A (pheromone only) and Treatment C (pheromone combined with pineapples). While *R. ferrugineus* was attracted to Treatment C (combination of pheromone and pineapples). Both Treatment B (pineapples only) and Treatment D (control) do not capture any *Rhynchophorus* spp. or any other weevil species.

Table 3. Bait preferences (treatments) of *Rhynchophorus* spp. towards four different types of treatment

Treatment/ Species	**(A) Pheromone (Ferrolure +)**	**(B) Pineapples**	**(C) Pheromone (Ferrolure +) + Pineapples**	**(D) Control**
R. vulneratus	4	0	5	0
R. ferrugineus	0	0	1	0
R. bilineatus	0	0	0	0

Table 4 shows that another weevil species, *M. praetor*, was captured in Treatment C, which consisted of a combination of pheromone and pineapple. *Macrochirus praetor*, belonging to the Dryophthoridae family, is known to resemble *Rhynchophorus* spp. in appearance (Royals & Gilligan 2017).

Table 4. Bait preference of other weevils' species

Treatment/ Species	**(A) Pheromone (Ferrolure +)**	**(B) Pineapples**	**(C) Pheromone (Ferrolure +) + Pineapples**	**(D) Control**
Macrochirus praetor	0	0	1	0

Statistical Analysis of the Baits Preference of *Rhynchophorus* spp. Towards the Treatment

Table 5 shows the result for the preference of *Rhynchophorus* spp. towards the four different types of treatment. The data showed no significant difference (Chi-square value = 0.341, df = 6, Critical value = 12.592), indicating the preference of *Rhynchophorus* spp. towards the type of treatment is independent.

Table 5. Statistical analysis of Chi-square obtained for baits preferences by *Rhynchophorus* spp.

Hypothesis Testing	**Significance Value**
H_1: Preference of *Rhynchophorus* spp. towards the type of treatment are independent	$P = 0.341 > \alpha = 0.05$*

Chi-square test $\alpha = 0.05$; * = not significantly different

Condition of Coconut Tree at Three Different Sampling Areas

Figure 5 shows the condition of the young coconut trees observed at the coconut plantation in Kampung Tambirat, Beliong. These trees exhibit the lowest level of infestation, as no visible symptoms are present.

Figure 5. Conditions of the young coconut trees at Kampung Tambirat, Beliong (Photo: Sahira Gapor)

As represented in Figure 6, several symptoms caused by the chewing activities of Rhynchophorus spp. were observed at the coconut plantation in the Malaysian Cocoa Board (Cocoa Research and Development Centre), Kota Samarahan. These symptoms resulted in the drooping and yellowing of tree leaves.

Figure 6. Drooping and yellowing of leaves of coconut trees at the Malaysian Cocoa Board (Cocoa Research and Development Centre), Kota Samarahan

As shown in Figure 7, the fronds exhibited shapes resembling the number “7” and “>,” which were a result of the chewing activities of *R. ferrugineus*. Additionally, holes were observed on the petioles and the trunk, accompanied by reddish-brown fluid.

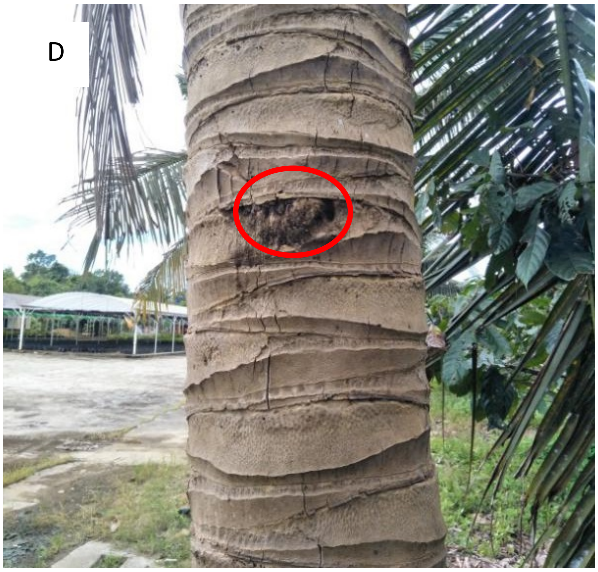

Figure 7. Condition of coconut trees at Malaysian Cocoa Board (Cocoa Research Centre) Lundu Station, Lundu and symptoms of *Rhyncophorus ferrugineus* infestation: (A) figure of number "7" on the fronds, (B) ">" shape cause by the chewing activities (C) holes on the petioles, and (D) holes with reddish brown fluid

DISCUSSION

A total of 10 individuals of *Rhynchophorus* spp. were collected from three different sampling sites which are Beliong, Kota Samarahan and Lundu. An additional weevil species known as the giant Malayan weevil, *M. praetor* was captured in the coconut plantation at Kota Samarahan. In this study, nine individuals of *R. vulneratus* were collected. *Rhynchophorus vulneratus* is a native species of Sarawak (Kueh Tai 2013) and has been identified as one of the major pests in palm plantations. The red palm weevil, *R. ferrugineus* is recorded in the list of quarantine species in Sarawak (Kueh Tai 2013). Based on the findings from this study, the only sample that was captured could be the first record of the red palm weevil species in Sarawak. The most possible reason might involve human activities (i.e. transporting any young or infected palms to the uninfected site as well as planting the new oil palm trees around the existing coconut plantation). This is supported by the findings of Kalidas & Subbanna (2022) and Kalidas et al. (2006), which noted that oil palm shares some pests with established crops such as coconut, areca nut, and palmyra trees, although the extent of damage varies with the intercrops. However, there has been no report or record of dead oil palm tree due to *R. ferrugineus* infestation (Idris et al. 2014) which is probably due to the use of pesticides in this large-scale agricultural industries.

The comparative result on bait preferences of each *Rhynchophorus* spp. towards four different treatments indicates that Treatment C was the most effective. A total of five *R. vulneratus* individuals, one *R. ferrugineus* individual, and one *M. praetor* individual were captured. Treatment C is a combination of pheromone and pineapple that have also been suggested by (Azmi et al. 2013) to be the most effective bait for the weevil's species. Another treatment that has been recorded to capture the weevils' species in this study was Treatment A, which captured four individuals of *R. vulneratus*. All the data were further analyzed using the Chi-Square Test of Independence to assess the preference of *Rhynchophorus* spp. for the four types of treatments. The results indicate that the preferences of each *Rhynchophorus* spp.

towards the treatments are independent. Preferences for the bait may vary if more specimens are collected in future studies.

Study by Azmi et al. (2014) found that pheromone traps recorded the highest number of palm weevils during the hot and sunny day. In the present study, as sampling was conducted in December 2019 for the sampling site at Beliong, January 2020 for sampling site in Kota Samarahan and February 2020 for the sampling site at Lundu, the weather conditions for these months were mainly affected by the Northeast Monsoon. Overall, during the sampling period, the weather was rainy and windy, with occasional thunderstorms. The amount of sunlight and heavy rainfall will also cause the slow release of the pheromones and the food baits compound to the surrounding, which is believed to lure the weevils. This may suggest the reason for the low number of captured weevils during the sampling session. In addition, heavy rainfall will also affect the mobility of the palm weevils.

Figures 6, 7 and 8 show the different levels of infestation by *Rhynchophorus* spp.. For the coconut plantation at Beliong, most of the coconut trees were still young and suitable for the infestation of *Rhynchophorus* spp. as the palm stems are still moist, fresh and easy for the species to bore into it (Azmi et al. 2017). The level of infestation in this area was still at the lowest since the coconut trees did not exhibit any visual symptoms. Based on Figure 7, most of the coconut trees at the CRD, Kota Samarahan show similar symptoms. The fronds (leaves) of the coconut trees at the plantation were yellowing and drooping, which was caused by *Rhynchophorus* spp. (Azmi et al. 2013; Kueh Tai 2013). Critical level of infestation by *Rhynchophorus* spp. especially by the *R. ferrugineus* can be seen in Figure 8. The fronds display the figure of number "7" and ">" shape that are caused by the chewing activities of the *R. ferrugineus.* The similar damage symptoms were also observed in studies by Hrnčić and Radonjić (2017). There were holes on petioles that can be seen and also the holes with reddish brown fluid on the trunk, which could be caused by the tunnelling activities of *Rhynchophorus* spp. or co-attack by *Oryctes rhinoceros* as the holes' characteristics have been reported to be similar.

CONCLUSION

Conclusively, this study found that coconut plantations harbour at least two species of palm weevils. The most captured species was *R. vulneratus*, a local species in Sarawak. The suspected *R. ferrugineus* exhibited colour and marking variations on the elytra, which may be influenced by environmental factors. Genetic analysis should be conducted for this species, as there is ongoing debate regarding species identification, with reliance solely on morphological characteristics being potentially confusing. As part of integrated pest management, pheromone mass trapping could be useful for trapping and monitoring these species.

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AUTHORS DECLARATION

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Conflict of Interest
The authors declare that they have no conflict of interest.

Ethics Declarations
No ethical issue is required for this research

Authors' Contributions
Nurul Hafizah Yusuf (NHY) contributed to data collection, investigation, formal analysis, and writing. Wan Nurainie Wan Ismail (WNWI) was responsible for resources, writing the original draft, visualization, investigation, supervision, reviewing and editing the final manuscript. Ratnawati Hazali (RH) contributed to conceptualization, supervision and editing. Siti Nurlydia Sazali (SNS) assisted with data analysis and reviewing. All authors reviewed and approved the final manuscript.

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