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HEALTH SCOPE²⁰²³

The Official Research Book of
Faculty of Health Sciences
Universiti Teknologi MARA

Healthscope

The Official Research Book of Faculty of Health Sciences

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Preface

Healthscope (e-ISSN: 2735-0649) is a peer-reviewed and evidence-based scientific research book published by Faculty of Health Sciences, Universiti Teknologi MARA, Puncak Alam Campus, Malaysia. The research book's mission is to promote excellence in health sciences and a range of disciplines and specialties of allied health professions. It welcomes submissions from academic and health professionals' community. The research book publishes evidence-based articles with solid and sound methodology, clinical application, description of best clinical practices, and discussion of relevant professional issues or perspectives. Articles can be submitted in the form of research articles, reviews, case reports, and letters to the editor or short communications. The research book's priorities are papers in the fields of Physiotherapy, Occupational Therapy, Optometry, Medical Laboratory Technology, Environmental Health & Safety, Nursing, Nutrition & Dietetics, Medical Imaging and Basic Sciences. Relevant articles from other disciplines of allied health professions may be considered for publication.

Dr. Siti Nor Ismalina Isa
Chief Editor
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RESEARCH ARTICLE

The relationship between breakfast habits, physical activity status and academic achievement among undergraduates in UiTM Puncak Alam Campus.

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Abstract:

A regular breakfast consumption and physical activity were among the important health practices in order to live a healthy life. However, breakfast is the most common skipped meal and physical activity has been neglected by many university students. Therefore, the present study aimed to examine the relationship between breakfast habits, physical activity and academic achievement among university students. The main objective of this study is to assess students' breakfast habit, physical activity status and their level of academic achievement. This is a cross-sectional study involving a total of 376 undergraduate students randomly selected from eight faculties in UiTM Puncak Alam Campus. A self-administered questionnaire on breakfast habits, physical activity and academic achievement was given. There were 49.5% of the respondents classified as breakfast eaters while the other 50.5% of them were breakfast skippers. Majority of the respondents claimed to be engaged in vigorous and moderate physical activity within 1-2 days/week and they only spent 1-2 hours/day in minimal activity. Most of the respondents have moderate CGPA which ranged from 3.00-3.49. The associations of breakfast habit, physical activity and CGPA was determined by using Pearson's Chi-square test and the results obtained showed that there are no significant associations among those variables. In conclusion, the study did not find any relationship between breakfast habits, physical activity status and academic achievement.

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Keywords: Academic achievement, Breakfast habit, Physical activity, Undergraduate

1. INTRODUCTION

The significance of breakfast consumption among adults cannot be overstated, as it plays a pivotal role in promoting physical health and enhancing mental well-being (Pengpid & Peltzer, 2020). A growing body of empirical evidence underscores the profoundly constructive impact of breakfast consumption on various aspects of adult life. Indeed, breakfast consumption has been scientifically demonstrated to exert a positive influence on key parameters such as body mass index (BMI), daily caloric intake, and the adoption of a healthy dietary regimen (Kavi & Walvekar, 2022). Moreover, it has been associated with the cultivation of favorable sleep patterns and the cultivation of robust mental well-being (Nusrat Aziz, 2020).

The merits of breakfast extend beyond the realms of physical health and psychological well-being, as breakfast consumption has been unequivocally linked to heightened physical activity levels throughout the day in adults (Masoomi et al., 2020). This enhanced physical activity, in turn, underscores a salient correlation with cognitive function and academic achievement (Masoomi et al., 2020). Consequently,

it is evident that breakfast consumption engenders a multitude of advantageous outcomes for adults.

Regrettably, the consumption of breakfast has been steadily declining among adults over the past decade (Lazzeri et al., 2016; O'Donovan et al., 2020; Terry et al., 2020) attributed in part to the effects of urbanization and modernization, which have led to increasingly sedentary lifestyles (Park & Ko, 2022; Sincovich et al., 2022).

While the deleterious consequences of breakfast skipping may be subject to debate, a substantial body of research has unequivocally demonstrated its adverse repercussions among adults. These repercussions encompass being underweight (Fagnant et al., 2022), anemia (Anandaraj et al., 2019), dysmenorrhea (Fujiwara et al., 2020), diminished cognitive functions (Dutta & Nayak, 2022), heightened risk of type 2 diabetes mellitus due to postprandial hyperglycemia (Mirghani, 2021), and elevated BMI (Longo-Silva et al., 2022). Notably, these deleterious effects have been observed in studies focusing on adult populations, thereby emphasizing the gravity of this issue among those who constitute the backbone of a nation's workforce.

Considering that the future of any nation is inherently intertwined with the health and well-being of its adult population, the persistence or exacerbation of the trend of breakfast skipping poses a grave concern for the prospects of future generations. Consequently, the primary objective of this study is to elucidate the intricate relationship between breakfast consumption, physical activity, and academic achievement within the context of adolescents at UiTM Puncak Alam Campus, as they represent the future torchbearers of Malaysia and warrant careful consideration in safeguarding the nation's welfare and prosperity.

2. MATERIALS AND METHODS

2.1. Research ethics approval

This research has been reviewed and approved by the Faculty of Health Sciences Research Ethics Committee.

2.2. Study Design

This study used a cross-sectional study design to identify the relationship of breakfast habit, physical activity and academic achievement among undergraduates.

2.3. Study Location

The present study was conducted in UiTM Puncak Alam Campus.

2.4. Participants

The study population were 376 full-time undergraduate students of UiTM Puncak Alam Campus, recruited by random sampling method.

2.5. Inclusion and exclusion criteria

Participants involved in the study must be between 18-30 years old and being full-time undergraduate students from any faculties in UiTM Puncak Alam Campus. Participants must demonstrate a willingness to voluntarily participate in the study and provide informed consent. Participants must have the cognitive and linguistic capacity to understand and communicate effectively in the language in which the study is conducted. Individuals below 18 years old or above 30 years old are excluded from participating. Individuals who are a part time students or undergoing post graduate program are also excluded. Individuals who express unwillingness or inability to comply with the study procedures, including follow-up visits and data collection, will be excluded. Individuals who do not have sufficient proficiency in the language of the study to provide informed consent and participate effectively will be excluded.

2.6. Study Variables

Breakfast habit

Breakfast habits of the respondents were assessed by using questionnaire (O'Neil et al., 2014a) where they were asked on how frequent they consume breakfast in a week. The frequency of breakfast consumption in a week was used to determine whether the respondent is a breakfast eater or breakfast skipper. Respondent will be classified into breakfast eaters if they consume breakfast five times or more in a week and if consume less than five times a week, they will be classified as breakfast skippers (O'Neil et al., 2014b).

Physical activity

Physical activity was assessed by using the International Physical Activity Questionnaire Short Form (IPAQSF) that consisted of 9 items questionnaires which recorded physical activity into four intensity levels: 1) vigorous-intensity activity such as aerobics, 2) moderate-intensity activity such as leisure cycling, 3) walking, and 4) sitting, within last 7 day recall (Meh et al., 2021). Respondents filled all the questionnaire items in English by themselves unassisted.

Academic achievement

Academic achievement of the respondents was assessed by using Cumulative Grade Point Average (CGPA). It is also a multiple-choice question where the CGPA is ranged and divided into four categories: 1) first class with CGPA 3.50-4.00, 2) high with CGPA 3.00-3.49, 3) low with CGPA 2.00-2.99 and 4) third class with CGPA 1.99 and below, in accordance to UiTM guidelines on exam grades (Pejabat Timbalan Naib Canselor Akademik dan Antarabangsa, 2021).

Other variables

Other variables are the demographic data of the respondents which include age, gender, weight, height and faculty. The BMI of the respondents were calculated and categorized into: 1) obesity with BMI ≥ 30 kg/m², 2) pre-obesity with BMI 25-29.9 kg/m², 3) normal weight with BMI 18.5-24.9 kg/m² and 4) underweight with BMI < 18.5 kg/m² (World Health Organization, 2010).

2.7. Statistical analysis

The data collected were exported to IBM Statistical Package for Social Sciences (SPSS) Statistics version 22.0 to be analysed. A descriptive analysis was used to measure the frequencies and percentages of respondents' socio-demographic data, breakfast habit, physical activity level and level of academic achievement. Pearson's Chi-square test was then used to identify the relationships of breakfast habit, physical activity and CGPA of the respondents. The p -value of more than 0.05 ($p > 0.05$) indicates the relationship of those variables is not statistically significant. On the other hand, p -value of less than 0.05 ($p < 0.05$) shows that there is a significant association between the variables.

3. RESULTS

3.1. Socio-demographic data

A total of 376 undergraduate students, ages ranges from 18 to 26 years old participated in this study (Table 1). The majority of respondents were female (84.8%) while 15.2% of them were male. The measurement of body mass index (BMI) showed that the majority of them were normal weight (47.6%) followed by obese (26.1%), underweight (14.4%) and overweight (12.0%). Half of the respondents were health sciences students (50.0%) and others were students of business management (22.9%), pharmacy (5.9%), accountancy (5.6%), education (5.6%), hotel and tourism management (5.6%), art and design (2.9%) and architecture, planning and surveying (1.6%) (Table 1).

Table 1. Socio-demographic data of the respondents (n=376)

Variable	n	(%)
Age groups		
18-20 years old	111	29.5
21-23 years old	170	45.2
24-26 years old	95	25.3
Gender		
Male	57	15.2
Female	319	84.8
BMI		
Underweight	54	14.4
Normal weight	179	47.6
Overweight	45	12.0
Obese	98	26.1
Faculty		
Health sciences	188	50.0
Pharmacy	22	5.9
Business and Management	86	22.9
Accountancy	21	5.6
Education	21	5.6
Art and design	11	2.9
Architecture	6	1.6
Hotel and tourism management	21	5.6

3.2. Breakfast habit

Table 2 shows the distribution of breakfast habits among respondents. The number of respondents who had breakfast regularly and who skipped breakfast was almost equal, where 49.5% of them were breakfast eaters and another 50.5%.

Table 2. Distribution of breakfast habits of respondents (n=376)

Variable	n	(%)
Do you take breakfast every day?		
Yes	186	49.5
No	190	50.5

3.3. Physical activity

Table 3 shows the distribution of physical activity of the respondents. Based on the table above, most of them reported to be engaged in vigorous (54.3%, n=204) and moderate (51.3%, n=193) activities within 1-2 days/week. The least number of respondents were those who regularly engage in vigorous activity (6.4%, n=24) and there were only 5.6% (n=21) of them who engaged in moderate activity for 5-6 days/week. On the other hand, respondents who engaged in minimal activity within 1-2 hours/day (32.7%, n=123) were the highest and the least were those who answered more than 6 hours in a day.

Table 3. Distribution of physical activity of respondents (n=376)

Variable	n	%
Vigorous activity		
Never	58	15.4
1-2 days/week	204	54.3
3-4 days/week	65	17.3
5-6 days/week	25	6.6
Everyday	24	6.4
Moderate activity		
Never	52	13.8
1-2 days/week	193	51.3
3-4 days/week	87	23.1
5-6 days/week	21	5.6
Everyday	23	6.1
Minimal activity		
1-2 hours/day	123	32.7
3-4 hours/day	99	26.3
5-6 hours/day	87	23.1
More than 6 hours	67	17.8

3.4. Academic achievement

Majority of the respondents (62.5%) have high CGPA which ranged from 3.00-3.49 and only 16.2% obtained first class CGPA ranged from 3.50-4.00. The rest of them have low CGPA which ranged from 2.00-2.99 (Table 4).

Table 4. Distribution of CGPA of respondents (n=376)

CGPA	n	%
First class	61	16.2
High	235	62.5
Low	80	21.3

3.5. Results of Pearson's Chi-square test

Table 5 shows the association between breakfast habit and physical activity. Based on Pearson's chi-square test, physical activities which include vigorous ($p=0.457$), moderate ($p=0.687$) and minimal activity ($p=0.071$) are not associated

with breakfast habits. When asked on how often they engage in vigorous activity, more than half of breakfast eaters answered 1-2 days/week (51.1%) and the same goes with breakfast skippers where half of them responded 1-2 days/week (57.4%).

Table 5. Relationship between breakfast habit and physical activity (n=376)

Variable	Breakfast habit		X ²	P value
	Breakfast eater n=186	Breakfast skipper n=190		
How often do you engage in				
Vigorous activity			3.64	0.457
Never	29(15.6%)	29(15.3%)		
1-2 days/week	95(51.1%)	109(57.4%)		
3-4 days/week	33(17.7%)	32(16.8%)		
5-6 days/week	13(7.0%)	12(6.3%)		
Everyday	16(8.6%)	8(4.2%)		
Moderate activity			2.26	0.687
Never	21(11.3%)	31(16.3%)		
1-2 days/week	97(52.2%)	96(50.5%)		
3-4 days/week	46(24.7%)	41(21.6%)		
5-6 days/week	11(5.9%)	10(5.3%)		
Everyday	11(5.9%)	12(6.3%)		
Minimal activity			7.03	0.071
1-2 hours/day	50(26.9%)	73(38.4%)		
3-4 hours/day	56(30.1%)	43(22.6%)		
5-6 hours/day	48(25.8%)	39(20.5%)		
More than 6 hours	32(17.2%)	35(18.4%)		

Regarding moderate activity, the result shows that half of both breakfast eaters (52.2%, n=97) and breakfast skippers (50.5%, n=96) claimed that they engage in moderate activity within 1-2 days/week. In minimal activity section, majority of breakfast eaters, 30.1% (n=56) claimed that they engage in minimal activity for 3-4 hours/day. On the other hand, the highest response from breakfast skippers falls on 1-2 hours/day (38.4%, n=73) and only 18.4% (n=35) of them engage in minimal activity for more than 6 hours/day.

Table 6 shows the association between physical activity and academic achievement. Based on Pearson Chi-square test, it showed that physical activity was not statistically associated with academic achievement.

Table 6. Relationship between physical activity and CGPA

Variable	CGPA			X ²	P value
	Low n=80	Moderate n=235	High n=61		
Vigorous activity					
Never	16(27.6%)	33(56.9%)	9(15.5%)	4.115	0.847
1-2 days/week	39(19.1%)	134(66%)	31(15.2%)		
3-4 days/week	15(23.1%)	40(61.5%)	10(15.4%)		
5-6 days/week	5(20.0%)	15(60.0%)	5(20.0%)		
Everyday	5(20.8%)	13(54.2%)	6(25.0%)		
Moderate activity					
Never	11(21.2%)	31(59.6%)	10(19.2%)	0.001	0.981
1-2 days/week	49(25.4%)	120(62%)	24(12.4%)		
3-4 days/week	14(16.1%)	59(67.8%)	14(16.1%)		
5-6 days/week	4(19.0%)	11(52.4%)	6(28.6%)		
Everyday	2(8.7%)	14(60.9%)	7(30.4%)		
Minimal activity					
1-2 hours/day	26(21.1%)	76(61.8%)	21(17.1%)	9.138	0.166
3-4 hours/day	25(25.3%)	62(62.6%)	12(12.1%)		
5-6 hours/day	11(12.6%)	56(64.4%)	20(23.0%)		
More than 6 hours	18(26.9%)	41(61.2%)	8(11.9%)		

4. DISCUSSION

4.1 Breakfast habit

A total of 49.5% of the respondents were breakfast eaters while the remaining 50.5% were breakfast skippers. Majority of the respondents claimed breakfast as an important meal, however, many of them were still skipping their breakfast. The prevalence of skipping breakfast is usually higher than skipping lunch and dinner among university students, with female students overwhelmingly surpass the male students (Abro et al., 2021). Overslept and shortage of time to take breakfast were among the most reported reasons for skipping breakfast (Abro et al., 2021). There were also some personal preferences such as does not like to eat early and no appetite (Nakade et al., 2017). Slow adaptation to campus life may also be the reason why they missed breakfast especially among younger students who live in the campus (Suhett et al., 2022). This is because some of them were used to live with parents before entering university where everything is prepared including breakfast (Higashi et al., 2022). Thus, students with poor time management were more likely to miss breakfast especially when they have lectures early in the morning (Khurshid et al., 2018).

4.2 Physical activity

Regarding physical activity, the present study has found that more than half of the respondents were engaged in

vigorous and moderate activities within 1-2 days/week. This finding reflects that most of the respondents did not meet the recommendations for moderate physical of at least 150 minutes/week (Tafireyi & Grace, 2022). The result is supported by Kljajević et al. (2022) who noticed a profound decline in university students' motivation and act to physical activity for weekly moderate and vigorous physical activity. Nevertheless, we do not have any data to ensure if the current findings on the physical activity status of the respondents correspond to their physical activity status prior to university enrolment. This study also could not claim that the student's engagement in vigorous physical activity as the amount of time spent on vigorous physical activity was not assessed. Previous study, however, has notable claims on how lifestyle seems to change significantly upon entering university and being inactive is one of the obvious changes that has been noticed (Fagaras et al., 2015). Physical activity declines dramatically during the transition of young adults to early adulthood especially when entering university (Silva et al., 2022). The significant change in physical activity among university students was mainly because of a lack of time and their tight schedule (Pan et al., 2022). In addition, students with low motivation and high perceived barriers were also more likely to adopt a sedentary lifestyle (Sáez et al., 2021). Lack of interest, time, phone addiction, poor dietary intake, and low social and self-esteem were among the perceived barriers that have been identified in students (Al Salim, 2023; Lin et al., 2022; Saffari et al., 2022). In a previous study focused on physical activity among university students in Malaysia, it was suggested that a majority of students demonstrated an inclination towards physical activity and were aware of its positive impacts on health (Stephen et al., 2021). Similarly, two other extensive studies conducted in Malaysia among adults aged 18 and above found that a substantial proportion engaged in physical activities within their domestic environments, driven by various motivating factors (Alias et al., 2022; Nik-Nasir et al., 2022). The facilities and environmental offerings at UiTM Puncak Alam Campus appear to be reasonably conducive to promoting physical activity among its students. However, it is important to note that the present study lacked comprehensive data to thoroughly analyse the potential influence of these amenities on the respondents' levels of physical activity. Further investigation is warranted to delve deeper into this intriguing relationship.

4.3 Level of academic achievement

This study found an average academic achievement of the respondents at high CGPA which ranged from 3.00-3.49.

4.4 Relationship between breakfast and physical activity

This study found no relation between breakfast and physical activity among respondents in the study. We could

not find the answer to this result, since we did not do any further evaluation on the matter. However, past studies demonstrated the lack of relationship between breakfast and physical activity may be due to the energy gained from having breakfast is only significant in the morning but not for the whole day. The energy obtained from breakfast may decline after a few hours (Sasabe et al., 2021; Zakrzewski-Fruer et al., 2021). This could be the reason why respondents reported their physical activity and breakfast habits being in no relation. Other non-dietary factors might also influence respondents on overall daily physical activity, for instance, morning snacks or early lunch (Roshanmehr et al., 2022). Contrary to the findings of this study, some studies do find a positive relation between breakfast intake and physical activity. However, these positive relations were seen to be outdone by other factors including the food selection in accordance with subjects' physical activity (Carrillo-López et al., 2021), the nutrient content in the food (Kinoshita et al., 2022), level of knowledge on healthy eating (Pop et al., 2021), the subjects' concern on body image (Gifari et al., 2022), food selection or preference (Leech et al., 2021) and self-motivation on healthy lifestyle (Kuipers et al., 2021). As of current, the relationship between the two domains is still debatable as studies came with undecisive patterns. Thus, it is believed that there could be no direct relationship between the two, but there might be other mediators between the two which has not been understood yet.

4.5 Relationship between physical activity and academic achievement

The result of the current study has found no relationship between physical activity and academic achievement among the respondents. Breakfast intake has been studied to improve mood, concentration and motivation and act as pathway to better academic achievement (Javaid, 2020). Though there were studies that demonstrated a positive relationship between physical activity and academic achievement, their findings were dependent on several determinants including the types of nutrients in the breakfast meal (Liu et al., 2019), regularity of intake and the manner of assessments of the undergraduate programs itself (T. L. Burrows et al., 2017; Liu et al., 2021). This finding inevitably mirrored the university lifestyle devoted the majority of the hours a day to studying rather than physical activity and breakfast intake. It is a common culture to see that academic motivation exceeds the healthy needs that are acquired by our body. Therefore, the passed grades are probably attributed to other factors that are mainly seen as mental well-being rather than physical activity or breakfast intake. This has well been established by many previous studies on the positive outcome of good mental well-being to academic achievement (Abdullah et al., 2022; T. Burrows et al., 2017; Manippa et al., 2021). But again, mental well-being does not have a sole contributor. Spiritual (Salehan

et al., 2022) and socioeconomic status (Mann et al., 2022) are among vital synchronous contributors.

5. CONCLUSION

In conclusion, half of the respondents were breakfast skippers. This study did not find any relationship between breakfast intake, physical activity and academic achievement. The findings in this study are arguable since it applied self-administered questionnaires in which subjects may under or over appraised themselves. However, this study has opened more opportunities for research in the future to find the long-term effect of breakfast intake and breakfast skipping on physical activity and academic achievement among university students up to their adulthood. The future study may also investigate other possible pathways on how breakfast quantity and quality may affect morning or daylike physical activity and how it correlates with the activity and function of cognitive function and mental health.

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RESEARCH ARTICLE

ICT use and preference among hypertensive patients during COVID -19 pandemic in Selangor: A cross-sectional study

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Abstract:

Patients with hypertension acquire health information from healthcare practitioners or online sources. During the pandemic, patients are likely to search for health-related information primarily through information and communication technologies (ICTs). This paper aims to assess the use and preference of ICTs among hypertensive patients. We conducted a cross-sectional online survey-based study from April to October 2020 involving 96 patients with hypertension. The questionnaire collected information regarding demographics, patients' preference for ICTs platforms, quality of online information and belief towards the use of ICTs. A Pearson chi-square test for association and adjusted regression analysis were performed. Among all patients who participated, 99% reporting owning smartphone, with an active internet connection. The most used ICT for obtaining information about hypertension was web browsers, followed by YouTube and Facebook. Social media use was significantly associated with education level and residential area. The outcome of the regression analysis indicated that males were 1.31 times more likely to use social media platforms than females. Finally, females were three times more likely to associate internet-based health education with better blood pressure control. Understanding how people with hypertension utilise and prefer ICTs may aid in improving their outcomes through the possible uses and benefits of ICTs. By determining the most frequently used ICT platform, health practitioners can devote more attention to it.

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1. INTRODUCTION

Hypertension (HPT) is globally the most significant changeable risk factor associated with premature death and cardiovascular problems (Mills et al., 2020). Systolic and diastolic blood pressure (BP) values of ≥ 140 mmHg and ≥ 90 mmHg are categorised as hypertension. Presently, about one billion individuals have hypertension, accounting for seven million deaths annually. The Institute of Public Health (2019) places hypertension prevalence in Malaysia at 30% or 1 out of three Malaysian might suffer from hypertension (Institute for Public Health (IPH), 2019). Another prevalence study in rural area in Indonesia found that almost half of the participants were diagnosed hypertension (Diana et al., 2018). Hypertension is a growing global problem attributed to poor lifestyle aspects like improper diet (e.g., high sodium but low potassium intake) and a sedentary lifestyle (Zaki et al., 2021). Additionally, inadequate education and income levels contribute to rising hypertension prevalence (Fongwa et al., 2019).

The COVID-19 pandemic has increased people's reliance on the internet in all facets of their daily lives. This includes

relying on the internet for guidance on health issues via teleconferences, websites or health applications (Quesada-Arencibia et al., 2018; Simon, 2021; Tirosh et al., 2019). Patients with hypertension continue to seek health information during the pandemic, according to a previous study, and patients seek health information via online and offline platforms (Ab Hamid et al., 2022). Globally, Internet use has increased, and there are estimated to be approximately 5.1 billion Internet users. In Malaysia, many platforms are used to disseminate health information and provide clinical services such as face-to-face intervention and the use telehealth. Currently, the government has increased the use of digital healthcare services to counteract the adverse implications of the pandemic (Lee, 2020). Several government-run clinics and hospitals have chosen virtual consultation to keep patients on track with their doctors (Lee, 2020; Simon, 2021). The introduction of this latest consultation modus operandi reduces the need for the physical meeting of patients and health care providers. As the number of patients seeking online health information for illness management such as health-related websites grows (Ab Hamid et al., 2020a; Ab Hamid et al., 2020b), it is the

responsibility of healthcare practitioners to provide reliable, validated, and fact-based information.

The present digital era has seen extensive adoption and offers individuals several ways to access health-related information. Presently, individuals access much information using Information, Communication and Technologies (ICTs) platforms. ICTs comprise computing and mobile-device based technology for information retrieval and exchange (e.g., text messaging, email, and social media platforms) (Perron et al., 2010). About 80% of US individuals admit to using online modes to access health and lifestyle information (Harris et al., 2011). ICT provides several benefits like minimal cost, user privacy, convenience, and data privacy, thereby making individuals comfortable searching for information they might not share with others. Moreover, individuals rely on online information to understand health needs, diagnoses, therapy approaches, and identify medical alternatives (Chen et al., 2020). Allam and colleagues conducted a review and reported that ICT use was positively correlated with hypertension management (Baderol Allam et al., 2021). It was also discovered that a majority of the patients manage systolic blood pressure levels using electronic counselling provided by experts (Liu et al., 2020). This finding indicates that the use of ICT for health information is increasing, thereby requiring health educators to have better ICT working knowledge to better offline and online patient health consultations. Put differently, bedside manners have been vital for patient education for more than 100 years. It is now required to have an ICT-specific approach seamlessly integrated with the consultation process (Gray et al., 2020).

Despite the probable advantages of ICTs in the health sector, there is little research concerning ICT utilisation and patient choices for managing hypertension in Malaysia. Nonetheless, limited study was done to investigate the ICT preferences among patients especially in Asian region, such as in Malaysia and Indonesia. In a qualitative study by Ab Hamid et al. (2022) discovered that patients with hypertension seek health information through intrapersonal and online resources. It is hypothesised that numerous demographic aspects, such as gender, age, place of stay, and highest education are correlated to ICT use, belief, and preference. Accordingly, the present study is designed to ascertain ICT preferences, correlations between ICT and identified demographic aspects, the degree of belief in ICT for Malaysian patients suffering from hypertension. The researchers believe that enhanced understanding concerning ICTs and patient choices might lead to better health-specific results in the future.

2. MATERIALS AND METHODS

The present study uses a survey-based approach to obtain cross-sectional information between April and October 2020. During this time, Malaysia was on the Movement Control

Order (MCO) due to the Covid-19 pandemic. The sample consisted of 96 hypertensive patients who indicated personal ICT preferences. The recruitment criteria comprised more than 18 years old and diagnosed with hypertension. Patients associated with psychiatric ailments or illiteracy were kept out of the scope of the study. The Research Ethics Committee from research institution approved the study (UiTM Research Ethics Committee, 600-IRMI (5/1/6). Patients were recruited after obtaining informed consent. Moreover, it was ensured that patients' personal and medical information was kept discreet.

The research by Chérrez-Ojeda and colleagues was referred for preparing the questionnaire. It comprises patient demographics and clinical data (Cherrez-Ojeda et al., 2019). The questionnaire was prepared to evaluate how patients gathered disease-specific information; furthermore, data concerning patient propensity for using ICT to obtain health-specific information was collected. Questionnaire validity was established using pilot testing; subsequently, data gathering was commenced. Twenty hypertensive individuals and eight experts were enrolled for questionnaire validity. Item-level-face validity index (I-FVI) based scale-level face validity index (S-FVI/Ave), comprehension and clarity-based S-FVI/Ave, and universal-agreement based S-FVI/UA scores were over 0.80 for the two groups; hence, validity was established. Respondents were required to indicate their preferences concerning hypertension-specific information gathering using a particular technology. They were also asked to indicate information quality. Additionally, the respondents were asked to quantify their belief concerning the positive effect of health information on blood pressure.

Study details were advertised online for recruiting interested individuals. The coverage for advertisement is only in Malaysia. Before individuals updated the form, they were informed about the study objective and their participation. The questionnaire had researchers' contact details, thereby facilitating communication if more information or clarification was required. An online link was provided to patients to fill in the study questionnaire.

The evaluation comprised descriptive analysis. Categorical parameters were indicated using percentage and occurrences. In addition, standard deviation and mean values were reported for continuous parameters. ICTs were considered using three categories: 1. Web-based (blogs, browsers, and YouTube), 2. social media (Twitter, Facebook, and Instagram), and 3. messaging platforms (WhatsApp, Skype, Email, and Telegram). The respondents responded yes or no for every ICT category for the platforms utilised for gathering hypertension-specific information. Usage frequency comprised three categories: less-than-three, three-to-five, and more than five hours per day. ICT quality was ascertained using a five-point scale: 1 (not useful, nor interesting, poor quality), 2 (Mildly interesting and useful but low quality), 3 (moderately interesting and useful but average quality), 4 (very interesting, useful, good quality),

and 5 (extremely interesting, useful, very good quality). A Likert-type measure was used for assessing the degree of belief: 1 (strongly disagree), 2 (Agree), 3 (Not sure), 4 (Agree), 5 (Strongly agree). There were two education categories: tertiary or higher and secondary or lower. Residence and work demographics were studied using two categories: urban or non-urban, and working or not working, respectively. Gender, age, residential area, work status, and education were independent parameters for every analysis. ICT platform choice and usage were indicated descriptively. In addition, the effect of independent variables (gender, education level, residential area and working status) on ICT platforms was assessed using the Pearson chi-square test; this assessment was conducted to gather details about hypertension.

ICT platform choice was analysed using binary logistic regression; on the other hand, multiple logistic regression was used to evaluate the degree of belief associating ICT use with an improvement in hypertension; blood pressure was analysed using gender, age, highest education level, working status, and residential region. The confidence interval was set 95%, and the adjusted odds (AO) ratio values were computed. SPSS v26 (Statistical Package for Social Sciences) was used for data analysis. The significance level was set at <0.05 for all tests.

3. RESULTS AND DISCUSSION

The sample had a mean age of 49 years (SD = 11), comprising 52% males; 64% of the respondents were educated to the tertiary level. About 56% of the sample comprised the urban population; 62% of the respondents were working (Table 1).

Table 1. Demographic characteristics (n=96)

Variable	n (%)	Mean (SD)
Age		49 (11)
Gender		
• Female	46 (48)	
• Male	50 (52)	
Education level		
• Secondary and lower	35 (37)	
• Tertiary and above	61 (64)	
Residential area		
• Urban	54 (56)	
• Non-urban	42 (44)	
Working status		
• Working	59 (62)	
• Not working	37 (38)	

3.1. Choice and quality rating of ICT platforms

Considering the studied sample, 90.6% (n=87) of individuals indicated using websites to look for information about hypertension; Facebook, 62.5% (60 people) and YouTube, 63.5% (61 people) were other information sources (Figure 1). Moreover, Skype was the least popular (15.6%, n=15).

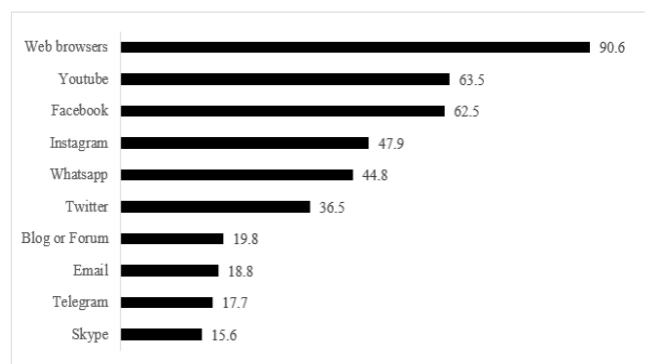


Figure 1. Choice of ICT platform among patients with hypertension

A majority (63.2%) of the respondents suggested that websites were useful, very interesting, and offered good quality information; Instagram (63%) was the second preferred information source by the respondents (Figure 2). Majority of respondents graded blogs to be moderately interesting, useful, and of average quality. In contrast, most respondents rated Skype as not interesting, nor useful or very low quality. On the other hand, Whatsapp and Skype were considered moderately interesting and useful for messaging applications.

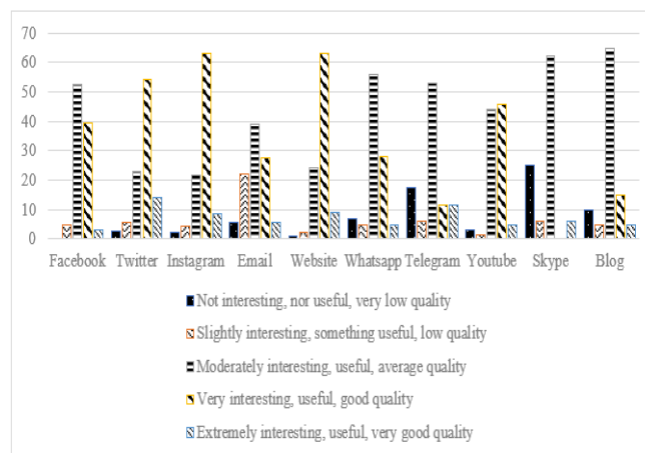


Figure 2. Percentage of quality rating of the health information according to ICT platform

3.2 Association between the use of ICT platforms and demographics

Social media use was significantly affected by education level and residential aspects ($p < 0.01$; $p < 0.03$, respectively). Nevertheless, education level, residential aspects, gender, and work status were not significantly correlated to ICT platforms (Table 2).

Table 2. Association between the use of ICT platform and gender, education level, residential area and working status to seek information about hypertension

Platform	Gender N (%)			Education level N (%)			Residential area N (%)			Working status N (%)		
	Female	Male	p-value	Tertiary and above	Secondary and below	p-value	Urban	Non-urban	p-value	Working	Not working	p-value
Social Media	34 (50)	34 (68)	0.52	50 (82)	18 (31)	<0.01	43 (80)	25 (30)	0.03	46 (78)	22 (60)	0.05
Web-based platform	42 (91)	47 (94)	0.61	58 (95)	31 (89)	0.24	49 (91)	40 (95)	0.40	57 (97)	32 (87)	0.06
Messaging apps	17 (37)	17 (34)	0.76	19 (31)	15 (43)	0.25	18 (33)	16 (38)	0.63	19 (32)	15 (41)	0.41

3.3. Likelihood of chosen demographic aspects and the use of ICT platforms

The outcome of the binary logistic regression indicated that males were 1.31 times more likely to use social media platforms than females; this observation was statistically significant with $p = 0.02$ (Table 3). Education, residential, and work aspects had no significant effect on ICT platform usage likelihood.

Table 3. Likelihood of gender, education level, residential area and working status to the use of ICT platforms

Parameter	Social media applications		Messaging applications		Web-based platforms	
	OR (95 CI)	p-value	OR (95 CI)	p-value	OR (95 CI)	p-value
Gender	1.31 (0.50-3.38)	0.02	1.16 (0.50-2.70)	0.73	0.65 (0.13-3.37)	0.61
Male						
Education	3.39 (1.12-9.75)	0.22	1.53 (0.57-4.14)	0.40	0.50 (0.08-3.20)	0.46
Secondary and below						
Residential area	1.86 (0.69-4.98)	0.75	1.06 (0.43-2.62)	0.90	4.36 (0.65-29.18)	0.13
Non-urban						
Working status	1.19 (0.41-3.50)	0.46	1.16 (4.43-3.11)	0.78	0.20 (0.02-1.34)	0.10
Not working						

Binary logistic regression. P-value was set at 0.05

3.4. Patients' belief that using ICT to get HPT information could improve BP reading

Females were three times more likely to associate internet-based health education with better blood pressure; this observation was statistically significant with $p < 0.01$. Also, individuals with tertiary education levels were five times more likely to associate online health information with better BP compared to their less-educated counterparts; this observation was statistically significant with $p < 0.01$ (Table 4).

Table 4. Likelihood of gender, education level, residential area and working status to the use of ICT platforms

Parameter	Adjusted OR (95% CI)	p-value
Gender	3.34 (1.48-2.52)	<0.01
• Female		
Education level	5.31 (1.93-14.59)	<0.01
• Tertiary and above		
Residential area	1.33 (0.58-3.04)	0.50
• Urban		
Age	1.00 (0.96-1.04)	1.00

Multiple logistic regression. P-value was set at 0.05

Ninety-six participants in this study used ICTs to seek health information; among all platforms, websites were the most preferred choice. ICTs offer numerous advantages to patients. For instance, ICT use may facilitate the formation of peer groups aimed at sharing similar circumstances, cultivating better problem-solving capability, and enhancing assurance to work towards life improvement (Cherrez-Ojeda et al., 2019). Health-seeking propensity might determine how patients select specific ICT platforms. Policymakers and healthcare practitioners are increasingly concerned about offering health education preferred by and appropriate for a broad and diverse population. Choices concerning health information platforms vary with sociodemographic aspects (Schmidt et al., 2021). A previous qualitative study identified during the COVID-19 pandemic, the majority of hypertensive patients relied on online health information (Ab Hamid et al., 2022). Present research emphasizes ICT platform choice and its correlation with specific demographic aspects and individual beliefs concerning ICT advantages for managing hypertension. The present research comprised a sample where 99% of individuals could access the internet. There are numerous platforms for searching and accessing health-specific information online; however, the web browser was the most popular choice. Web-based health information was rated as good quality, useful, and very interesting. Research conducted in Ecuador indicated that the website was the most popular platform used by patients suffering from hypertension (Cherrez-Ojeda et al., 2019). Another study also found that patients with chronic kidney disease preferred web-based Internet to obtain information regarding their disease (Cherrez-Ojeda et al., 2018). This observation could be attributed to web browsers' numerous benefits; browsers allow patients to access health portals easily, without time and place restrictions. Moreover, browsers can be used on numerous devices that allow remote access and anonymity (Shepherd et al., 2000). Furthermore, numerous websites created by the private sector, governments, or individual bloggers provide rich medical education (Ab Hamid et al., 2020b). For example, the Malaysian Ministry of Health offers the MyHealth portal that can be used to know hypertension-specific medical information. The present study suggests that Facebook was the most popular information-seeking platform, next only to

websites. Facebook offers support group functionality where patients can narrate experiences and receive support from group members; it could be the reason for Facebook's popularity among hypertension patients.

WhatsApp was the most popular messaging application used by patients wanting health-specific information. Using WhatsApp, patients can share text, audio, video, images, and other information without paying. The messaging app is easy to use, and all individuals can utilise the features, notwithstanding educational aspects. Our observation aligns with the present data concerning Malaysian WhatsApp users. In May 2020, 98.7% of Malaysian internet users preferred using WhatsApp for messaging; Telegram and Skype were other popular platforms used by 40.1% and 14.5% of users, respectively (Muller, 2020). Furthermore, a Malaysian study indicates that using WhatsApp for health information had a beneficial outcome in disease treatment (Noor Haslinda I. and Muhamad Hanafiah J., 2019). In comparison, another study in Korea found that there was an increasing trend of consumers using Twitter to post about mhealth between 2010 and 2016 (Lee et al., 2019). Our study indicates that urban residents with tertiary or higher education had a greater likelihood of using social media platforms for gathering health information. The observation might be because of the urban and educated lifestyle where individuals operate social media profiles and access the internet through this platform type. In addition, research conducted in China suggests that better-educated individuals have a higher likelihood of utilising digital health facilities for managing hypertension (Chen et al., 2020). We determined that social media use among men is about 50% more than women. Nevertheless, residential, educational, and work aspects have no statistical significance concerning ICT platform use. We assert that most patients rely on ICT platforms for online health education, thereby justifying the above observation. All subjects enrolled in this study were smartphone owners having internet access; therefore, these people could access online health information regardless of time and place. Nevertheless, this observation should be relied upon cautiously because of the study sample size. On the other hand, the use of health information technology platforms varied significantly between rural and urban population (Greenberg et al., 2018). The non-urban population has relatively less digital health awareness; this digital divide might explain this difference. Lesser health literacy, poor digital skills, handicaps, income differences, and poor English proficiency might explain the digital divide. Also, structural aspects like internet access, geographical restrictions, and electronic hardware availability might add to the digital divide.

Our observations suggest that tertiary education raises a positive patient outlook about online health information and hypertension management by 5 times more as compared to lower education levels; females were three times more likely to associate online health education with positive outcomes concerning hypertension management. Stronger belief

encourages patients to utilise ICT and seek health information online (Holden and Karsh, 2010). Our findings align with a study that correlated females with a higher likelihood of internet use for gathering health information (Schmidt et al., 2021). Additionally, a meta-analysis outcome associates females and more educated individuals with a higher propensity for internet use for health information. Information quality concerning online health significantly affects patient belief and tendency to seek health information using the internet (Wang et al., 2021). Nevertheless, considering the abundance of health information present on the internet, there are concerns about information accuracy, quality, and reliability. The research was conducted to assess website quality, understandability, and actionability pertaining to hypertension-specific portals available on the Malaysian web; it was found that about 50% of the surveyed websites had average quality and poor actionability (Ab Hamid et al., 2020b). In addition, a study assessed 122 websites to understand online information quality related to pulmonary arterial hypertension. The results indicated a lack of comprehensiveness, readability, and information transparency (Saleh et al., 2020). Moreover, there are few quality standards plagued by quality consensus and restricted checks, thereby leading to health-specific information being conflicting, unreliable, and, at times, wrong (Chen et al., 2020).

The present study has some limitations. Firstly, the patient sample comprised individuals from Malaysia; hence, there might be a difference between the characteristics of this sample and other ethnicities. Also, study sampling was not performed at a large scale to support generalisations for all Malaysian hypertension patients. Furthermore, it is possible that health information platforms assessed for this study might face obsolescence in the future. In addition, this study did not quantify the specific platforms used by patients and the factors contributing to this use. Nevertheless, to the best of the researchers' knowledge, this is the first study that evaluates online health information use and choices pertaining to Malaysian hypertension patients. The study also used an expert-assessed and approved online questionnaire.

4. CONCLUSION

In conclusion, Malaysian internet users resorting to online health information is increasing over time. The study indicates web browsers are the most popular choice for obtaining online information concerning hypertension; patients reported a very high preference for web browsers. Also, males were found to use more ICTs as compared to females. Further research having a larger sample must be conducted to substantiate the observations. Hypertension-specific health information categories and website types used by patients should be considered information extracted using web browsers.

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RESEARCH ARTICLE

Potential of aedes breeding site with different types of container at plant nurseries in Klang

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Abstract:

Dengue fever which transmitted by the Aedes has been one of the most widespread vector-borne disease. The most important thing in reducing dengue infection cases is by controlling the populations of the Aedes mosquito by destructing Aedes breeding sites. Aedes breeding sites can be determined by conducting a larval survey. Most of the studies conducted were focusing on residential area. However, the mushrooming nursery within housing vicinity has become potential breeding places for aedes since it provides potential artificial and water source to the vector. There were nine plant nurseries have been observed, overall cleanliness and distance from nearest housing area were measured. During the observation, pots, plates, tires, and bucket mostly found in nurseries and may harboring Aedes, hence this study has focused on the container survey and larval collection. Noteworthy, a total of 68 containers were found positive for breeding sites, and most likely the artificial container with larger surface area harboring more than lesser surface area. Adding up to that situation, the relationship between the type of container and likelihood of breeding potential has scored a great observation too. To conclude, aedes breeding places in the nearby nursery might increased potential dengue fever transmission for nearby residences.

Keywords: Aedes breeding site, artificial container, container survey, plant nursery.

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1. INTRODUCTION

Dengue fever is considered as one of the most widespread vector-borne diseases which has affected 128 countries in this world (Brady et al., 2012). According to the Ministry of Health, the total number of dengue cases in Malaysia for 2018 is 80,615 cases being reported with 147 deaths due to dengue. Most dengue cases occurred in Selangor state with 45,349 dengue cases followed by Federal Territory of Kuala Lumpur and Pulau Pinang with 7,591 cases and 6,071 cases, respectively. Due to the increase of the dengue cases in Malaysia, the most important thing in reducing the dengue infection cases is by controlling the populations of the Aedes mosquito since the transmission requires Aedes mosquito as the vectors. Hence, the control should be targeting the habitats that are more productive such as the container characteristic that led to the breeding of the Aedes. Aedes larvae usually can be found either in natural or artificial containers. The common container for the breeding site of the Aedes can be found discarded tires, flowerpots, flowerpot plates, rain barrels and other places that have stagnant water which is a suitable place for the mosquito to lay their eggs (Faiz Madzlan et al, 2016).

Usually, the larval survey will be conducted at the housing area since it is near with the human population. Plant nursery can be an example of a potential Aedes breeding site as they have many artificial containers such as flower pot plates, rain barrels and canvas sheets. Besides that, Petaling Jaya City Council (MBPJ) Health and Environment Department director Dr Chitra Davi N. Vadivellu has said that Aedes larvae also can be found at the plant leaves that can hold water. Some studies have proved that Aedes sp. especially Ae. aegypti can breed in plant leaves such as ornamental bromeliads (André B. B. Wilke, 2018).

In response to this problem, this study aims to identify the potential Aedes breeding site at plant nursery. The purpose of this study also can help to identify the relationship between the type of container and larvae populations. Several plant nurseries in Klang will be selected for this study and the premise will be inspected to identify the potential breeding site and number of positive containers.

Reducing the Aedes breeding site is important in order to reduce the Dengue cases in an area. Identification of the Aedes breeding site is usually being conducted at the residential area since it is close to the community. Gardening

utensils were found as the common breeding site for the Aedes which include flower pot, flower pot plates and watering cans (Ramlee, 2013). However, these things also commonly can be found at the plant nursery. There is not much study being conducted at the plant nursery because most of the study is more focused at the community area such as residential area or institutional. Besides that, some of the ornamental plants such as Bromeliads has been proved can be a breeding site for Aedes (Wilke, 2018). This has increased the number of potential breeding sites at the plant nursery. So, this study is important to identify any natural or artificial breeding site that can be found in a plant nursery and if this potential breeding site can give impact to the Aedes population. Besides that, it also can help to educate the owner of the plant nurseries about the potential breeding sites of Aedes in the plant nurseries.

2. MATERIALS AND METHODS

The aim of this study is to identify the potential breeding sites of Aedes species at plant nursery. This study will be carried out using the quantitative research approach. Under the quantitative research approach, the observational research design that will be used for this study is the cross-sectional study. Setia (2016) has referred to the cross-sectional study as the measure of the outcome and the exposure in the study participant at the same time. The participant for this study will be selected using the convenience sampling where any plant nurseries in the study area that are able to take part for the study will be included. All the plant nurseries that are willing to take part in this study will be observed and inspected for the potential breeding sites.

The method of data collection that will be used for this study is survey and larval collection. The data will be collected via survey of all the containers either artificial or natural containers (Chen, 2009). The information such as type of container, number of potential containers, and container with positive breeding will be recorded. Then, the larvae will be collected using the dipping or pipette and will be placed in a universal bottle. Each of the larvae samples taken will be labelled with the location being found and type of container. Next, the identification of larvae will be taken in the lab to identify the species of the larvae. The identification of the larvae has to be conducted to classify either it is Aedes aegypti, Aedes albopictus or others.

Based on data collection that has been made, descriptive analysis will be used to summarize the number of larvae collected at the different location and type of container found. Percentage of the potential breeding sites found and positive breeding sites will be determined to identify the highest type of container that could be the breeding site for the Aedes. Besides that, the index of available container (IAC) will be calculated for any potential breeding sites and Breeding

Preference Ratio (BPR) will be calculated for any positive breeding site using above formula: -

Breeding Preference Ratio (BPR) =

$$\frac{\text{Index of Contribution to Breeding Sites (ICBS)}}{\text{Index of Available Container (IAC)}}$$

Index of Contribution to Breeding Sites (ICBS) =

$$\frac{\text{Amount of positive container for each type}}{\text{Total amount of positive container}}$$

Index of available container (IAC) =

$$\frac{\text{Amount of potential container for each type}}{\text{Total amount of potential container}}$$

3. RESULTS AND DISCUSSION

3.1. Cleanliness and the distance of the plant nurseries from residential area

There are nine (9) plant nurseries have been observed in Kapar, Klang by using the cluster purposive sampling. Only nurseries with less than 100 meters distance were chosen with minimum size of 20-meter X 20-meter area. Nursery with lesser operating area were not included as they might be only a temporary plant storage area and does not have any permit of operation. Cleanliness was observed based on the plants and material arrangement and tagging area. The housekeeping and its roster were also observed and scored. Relative cleanliness rubric adapted from Rahman et al (2021) has suggested the score less than 2 is considered poor while score more than 4 is good.

In general, 33.30% of nurseries observed were in poor condition (Table 1). The indication has showed that lack of staff in maintaining the area as well as lack of awareness on the housekeeping benefit has potentially increased the possible Aedes breeding area due to less observation given to the water retention container. On top of that, cleanliness and proper housekeeping may reduce the possible aedes breeding places should the container were stacked properly and less expose to rain or plants watering activities. Poor housekeeping was also observed with the container were located with direct exposure to the rain and open, under the flowerpot rack. According to study by Rahman (2021), containers that located at outdoor in vegetation area has a higher chance for producing larvae. This is because this environment can enhance the mosquito breeding by enabling a resting site for the female mosquitoes to lay eggs and provide sugar feeding resource for larvae.

Table 1. Information regarding the plant nurseries

No.	Plant Nursery	Distance from nearest housing area (m)	Cleanliness
1	Plant Nursery 1	32	Good
2	Plant Nursery 2	22	Good
3	Plant Nursery 3	29	Good
4	Plant Nursery 4	45	Poor
5	Plant Nursery 5	98	Good
6	Plant Nursery 6	29	Good
7	Plant Nursery 7	44	Poor
8	Plant Nursery 8	20	Poor
9	Plant Nursery 9	69	Good

3.2. Determination of potential Aedes breeding sites at plant nurseries

Potential breeding places for Aedes can be varies between all possible artificial containers or possible natural, plant-based containers. In this study, the observation in the nurseries has leading to the tabulation data on possible containers for breeding places (Table 2). Throughout the observation, there were three type of container were mainly observed to be 'everywhere' in the nurseries, namely, flowerpot plates, bucket, and tires with the total number of 10, 13 and 13 respectively. It was noted that these items are essential for nurseries operation and thus, each nursery may or may not possibly turn these type of containers as potential aedes breeding places depending on the handling and upkeep of the surrounding area.

It was also observed that 14 bromeliads plants were found and observed to be highly potential as breeding places in 2

different nurseries. Bromeliads is a species of plants that have stackable – hard -leafy characteristic which may keep the water between their leaves. The water from plant watering, rain or from dews may collected at the heart of the plant thus provides good water source for breeding places. Maintaining bromeliads to be free as breeding places considered labour intensive thus need more workers to take care of this plants. Other container which was also found during the survey are plastic barrel, plastic bottle, watering can, canvas, and artificial ponds. These items also considered as highly potential breeding places due to their capacity that may have water retention capacity.

It was noteworthy that, most of the artificial container that has been inspected containing rainwater since it was a rainy season during the study period. Overall classification of natural and artificial container type found was depicted in Figure 1.

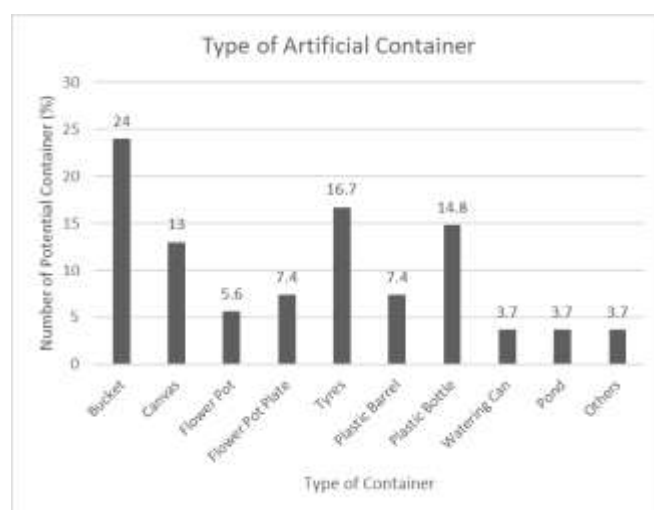


Figure 1. The percentage of potential artificial breeding places

From the result obtain for the container survey, bucket has the highest percentage for artificial container that can act as a potential breeding site with 24%. This is because most of the plant nurseries being observed will have bucket in their premise. This bucket usually will be used as a watering medium for the plant at the premise. Improper storage of the bucket could lead to higher chance to be a breeding site for the aedes. In this study, this type of container can proved can be a breeding site for the aedes when one of them were positive with aedes albopictus. The stagnant water in the breeding container were due to the rainwater since the container were placed at an open area. Next, in this study tires were known as the second highest to act as the potential breeding sites for the aedes.

Table 2. Potential breeding sites at plant nurseries

Nur s	Type of Container												Potential Container	Contain er (+ve) Breedin g
	Natural Container				Artificial Container									
	Bromeliad s Plant	Others	Flowerp ot	Flowerpo t plate	Tyre s	Canva s	Buck et	Plastic Barrel	Plastic bottle	Waterin g Can	Pon d	Other s		
1	10	-	-	1	1	5	-	3	-	-	2	1	22	2
2	-	-	-	1	-	1	-	-	-	-	-	-	2	1
3	4	-	2	-	5	-	-	-	-	-	-	-	11	2
4	-	-	-	3	-	-	3	-	-	-	-	-	6	-
5	-	-	-	-	4	-	3	-	-	-	-	1	8	3
6	-	-	-	-	-	-	2	1	-	-	-	-	3	1
7	-	-	-	2	-	-	-	-	-	2	-	-	4	-
8	-	-	1	-	2	1	3	-	8	-	-	-	15	-
9	-	-	-	3	1	-	2	-	-	-	-	-	6	2

Even though there were no positive breeding for this type of container in plant nursery, study by Lenhart (2006) has recommend being more aware on this type of container since it can produce up to 70% of aedes pupae especially during the rainy season. Adding up, a study by Gautam (2012) has proved that discarded tires can be a high-risk container since it also can be a breeding site for aedes during pre-monsoon and post monsoon season. Next, plastic bottle has the percentage of 14.8% to be accommodate in the plant nursery. The high percentage of plastic bottle in the plant nursery are due to the half-cut plastic bottles use at the legs of the shelves. This is a method used by the nursery owner to prevent the shelf leg from sinking into the muddy grown. Besides that, improper disposal of plastic bottle in the premise also contribute to the high percentage of plastic bottles

Next, a total of 13% of the potential place for breeding are from the canvas used to cover the soil at the plant nursery. The water accommodate on the canvas are due to the rainwater as well plant watering activities. However, this situation might be different during hot season since the water may be evaporated to the atmosphere, hence reducing the possible breeding places. Basically, improper placement of flowerpot plate can lead to water contained in it. The owner should place the unused flowerpot plates in the closed area or keep it in upside down manner to reduce the risk of being a harboring place for Aedes to lay their eggs with water in it. Other than that, plastic barrel used in the plant nursery to keep water for the plant can be a potential container since the plastic barrel does not been closed properly and the usage of abate is considered compulsory in preventing immature stage of aedes mosquito to develop. Lastly, container such as watering can, pond and other categories has the lowest percentage which are 3.7%. However, there is low possibility for the Aedes mosquitoes to breed if the container is regularly clean and practice a proper storage for the container to avoid any possibility for the Aedes mosquitoes to breed.

3.2. Calculation of Epidemiological Indexes by Container Classification

During the larval survey, there were 11 positive Aedes container were found in different artificial container which are flowerpot plates (3), tires (5), bucket (2) and barrel (1) respectively.

The larvae were identified as aedes genes since it has 2 lateral spines on each side of the thorax and a straight row of 7 to 12 comb scales at the 8th abdominal segment. The larvae were identified as *Aedes albopictus* since the comb scales exhibit a medical spine without subapical spines. Henceforth, in due to these expected findings, the calculation of the index of available container (IAC) was tabulated in Table 3. It was clearly evidence that ICBS of Aedes breeding in this study that focusing on the nine nurseries observed showed that the highest index contribution for breeding places is tires (0.4), followed by plastic barrel (0.25), and bucket (0.15) respectively.

Table 3. Index of available container by container classification

Characteristic	Type of container	Total number of potential containers	Total number of breeding sites	ICBS
Natural container	Bromeliad's plant	14	-	0
Artificial container	Bucket	13	2	0.15
	Canvas	7	-	0
	Flowerpot	3	-	0
	Flowerpot plate	10	3	0.

Tires	13	5	0.4
Plastic barrel	4	1	0.25
Plastic bottle	8	-	0
Watering can	2	-	0
Pond	2	-	0
Others	2	-	0

However, previous study related to container preference shows that bucket is known as the most frequent breeding sites. This is because the bucket has the capacity to contain considerable volume of water for the Aedes to breed (Nicolás Flaibani, 2020). Besides that, area of the opening surface for the container is large enough for the female mosquitoes to rest and breed on it while for bromeliads plant, even though it has the highest IAC, the probability for the mosquitoes to breed is low due to insufficient volume of water that contain in it. This can contribute to larval mortality due to lack of food, overcrowding and other sources of environmental stress (Shultis, 2009).

In this study tires have shown the highest ICBS with the reading of 0.4 in overall scoring. This number indicate that, among the highest potential in observed nurseries, it has 4-time higher chances in becoming the breeding places for Aedes. Similar finding was also observed by previous study by Dila (2020) and Rahman (2021) which were found that unused tires are among the highest for the contribution of Aedes breeding sites. This is because water that stored in used tyres are protected from the sunlight which make it more suitable places for the Aedes to breed since the female Aedes mosquitoes preferred to rest in less lighting area or shaded area (Dejene et al.,2015).

Next, container such as plastic barrel found in the plant nursery also has a substantial index of ICBS with score of 0.25, where it indicates that 1 out of 4 barrels found, there was a positive aedes breeding evidence in this study. This statement can be proved by previous study where the water barrel was also found to be the most frequent potential container even, so it was least found to have positive breeding as their opening surface of the barrel lead to less detectable containers (Nicolás Flaibani, 2020).

Overall observation and analysis from this study has indicated that containers found in the nurseries area could be potentially becoming Aedes breeding places. This substantial finding on the aedes breeding places as well as the cleanliness and distance from the nearest residential area has put an alarming situation if the nurseries was not taken into consideration for optimum prevention and control action by the authority. The fact that mosquito optimum flight range is between 200 meters and up to 2 kilometers with the help of transport may put

community in alarming situation day by day. According to WHO, aedes mosquito could fly up to 400 meters to look for any water-filled containers to lay their eggs.

The good source of breeding container and water source in nurseries may lead to hidden breeding places should the authority only relying on the address basis of the dengue fever patient. It is important to keep an eye on possible capacity of 'less explored' area such as nurseries in their preventive and control action. Fogging and larvicidal activity should not only be focusing to the dengue prone residential areas, but to extend the capacity of possible breeding places within the vicinity of confirm dengue cases area.

4. CONCLUSION

This study helps to identify any natural and artificial container that has a potential to act as a breeding site for Aedes. Some of the container that can be found in the plant nursery include bucket, discarded tyres, plastic barrel, flower pot plate, flower pot, watering can, pond, plastic tray and water tank. Artificial container are found in the plant nursery has a potential to be a contributor for the increasing of Aedes population. Most of the potential container detected are due to the rain water or container that used to keep water for the used in plant nursery which is the best condition for Aedes to breed. Besides that, the relationship between the type of container and positive breeding site has been determine where they likely to breed in the container that has large surface area such as bucket and shaded area such as tyres and bucket. This study is conducted during rainy season since previous study shows that the population of Aedes larvae are the highest. Future consideration for determining regression of distance of nurseries to the number of confirm dengue cases might give a clearer view on possible hidden, less explored, less human density plant facilities onto which capabilities they may cause the dengue fever outbreak escalates time to time.

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RESEARCH ARTICLE

Investigating Indoor Air Quality (IAQ) and Sick Building Syndrome Symptoms (SBSS) using generalized linear model

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Abstract:

Prediction of Indoor Air Quality and Sick Buildings Syndrome Symptoms (SBSS) was developed to predict the relative humidity (RH) inside the building. The developed generalized linear model (GLM) model consider relative humidity as dependent variables and independent variables consists of Indoor Air Quality Parameters (IAQ) such as ventilation performance indicator, physical and chemical parameters besides present SBSS. Primary data was collected, and distribution of questionnaires was conducted at the same time. Three models were developed which named Model A, Model B and Model C. A logarithmic link function was considered with a Poisson probability distribution. Particular attention was dedicated to cases with Relative Humidity < mean (Model A), Relative Humidity mean range (Model B) and Relative Humidity > mean (Model C). Results indicate that best performance was Model A which outperformed Model B and Model C. It showed that there were a few contributions of SBS and IAQ towards RH inside the building such as dizziness, drowsiness, heavy headed, headache, temperature and PM₁₀. This study showed that Model A (R²=96.8%) outstand Model B (86.9%) and Model C (93.5%) due to the data collected mostly distribute lower than mean value of RH.

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Keywords: Indoor Air Quality, Prediction, SBSS, School, Generalized Linear Model

1. INTRODUCTION

Develop and developing countries people spent almost 90% per day their times indoors which become most important and gain growing attention due to larger proportion of their time in indoor area either in offices or homes (Cheng et al., 2022; Pottier et al., 2021). Previous research studies showed that indoors air is more contaminated than ambient air (Mansor et al., 2020; Awada et al., 2022). The most common indoor air pollutants that been monitored was formaldehyde (HCHO), particulate matter (PM) or known as respirable particulates, volatile organic compound (VOCs), carbon monoxide (CO), carbon dioxide (CO₂) and ozone (O₃) (Mentese et al., 2020; Wolkoff., 2018; Ye et al., 2014). Assessments of indoor air quality are carried out for various reasons, which include identifying sources of pollutants in

indoor environments and assessing their potential adverse effects on the health of occupants. Another purpose is to determine whether indoor air quality meets recommended standards and guidelines for health and comfort, as well as to evaluate the effectiveness of ventilation systems and other measures for controlling indoor air quality. Such assessments also aim to identify potential risks associated with indoor air pollution and develop strategies for minimizing them. Ultimately, indoor air quality assessments provide valuable information and guidance to building occupants and owners on maintaining a healthy and comfortable indoor environment. Sick Building syndrome (SBS) is one of the scopes to determine the IAQ which covers unspecified adverse health effects due to poor IAQ. The wording “syndrome” used in this scope due to unidentified factors or sources have not been

fully confirmed yet (Yin et al., 2022; Lucialli et al., 2020). Previous research has demonstrated that prolonged exposure to poor indoor air quality can lead to various health problems and symptoms, which vary in severity depending on the intensity of the indoor air pollution sources (Aziz et al., 2023). Buildings that have been found to cause such problems are referred to as "sick buildings". Sick building syndrome (SBS) is characterized by a wide range of personal symptoms that are believed to be caused by exposure to indoor environmental sources, although the exact cause of these symptoms remains unclear. A combination of multiple factors or single factors was the cause of SBS. Roughly, the factors can be caused by humidity, insufficient ventilation, chemical pollutants which caused by indoor environments, light, biological pollutants which can come from external sources and temperature (Kwon et al., 2019; Argunhan et al., 2018). WHO identified SBS by complaints that used as one indicator to identify the occupants' symptoms such as general health problems or neurotoxic, nose, eyes and throat irritation, skin irritation, odours and taste sensations and nonspecific hypersensitivity. Latest studies showed that potential sources that contribute to SBS was paints, cleaning agents, building products, combustions of fuels, cosmetics and many more (Abdullah et al., 2018) air pollution and prediction modelling can be used to inform in advance contingency plans which helps in reducing the adverse impacts of air pollution on population, especially on the sensitive group, as their internal organs are fragile. The complexity of indoor air pollutants and SBS can be represented by Generalized Linear Models (GLM) because of its data contain qualitative and quantitative data and GLM can be used in different types of data which mainly in prediction and therefore giving early useful information for community. This study was conducted to develop the relationship between IAQ with SBS using GLM which important for occupants' safety and comfortability. Good Indoor Air Quality (IAQ) contributes to a favourable environment for occupants, the performance of teachers and staff and a sense of comfort, health, and well-being. These elements combined to assist a building in its core mission, which is educating community (Ziang et al., 2022; Rosbach et al., 2016). Studies of air pollutants movement indicate that indoor levels of pollutants may be two to five times and occasionally more than 100 times higher than outdoor levels. Performance ventilation indicator, chemical and physical parameter was important to be measured to investigate how outdoor sources influence air flow inside the buildings. Data collected was utilized for determine the acceptance of the pollutants inside the building with the standard which is Industrial Code of Practice Indoor Air Quality (ICOP-IAQ) 2010 was important as a baseline data. Due to the complexity of indoor air pollutants, qualitative and quantitative model used which is better compared to others basic model because no assumptions are being made throughout the modelling process, which can be used in different scenarios which therefore give more accurate and precise indoor air quality of real-world conditions (Zhai et al., 2020; Korsavi et al., 2022; Derby et al., 2016). Model prediction is important for

regulatory agencies in setting indoor air quality regulations to protect our young children health and well-being.

2. MATERIALS AND METHODS

2.1 Study Area and Data Collection

Sekolah Kebangsaan Tanjung Gelam (103° 4'50.64"E, 5°24'46.89"N) was choose as study area. The school located at Kuala Nerus district at Terengganu, Malaysia. The study was conducted in the teacher's room at level 3 of the school buildings. The teacher's room consists of 11 teachers. Age range of the teachers involved were <25 years old (54.5%), 25-39 years old (9.1%), 40-55 years old (27.3%) and >55 years old (9.1%). Site selection was chosen to determine the comfortability of the teachers in their rooms. This is due to the study area used ceiling fans rather than air conditioning. Besides ceiling fans, the rooms ventilation was windows and doors. Layout and location of the classrooms showed in Figure 1.



Figure 1. Study area

This study was measured physical, chemical and ventilation performance indicators of the study area. Chemical parameters consist of carbon monoxide (CO) ppm, formaldehyde (HCHO) ppm, respirable particulate (PM) $\mu\text{g}/\text{m}^3$, and total volatile organic compound (TVOC) ppm. The physical parameters included relative humidity (RH) %, temperature (T) $^{\circ}\text{C}$, and air movement (AM) m/s and the ventilation performances indicators were carbon dioxide (CO_2) ppm. Primary data monitored consists of 10 days of working hours for sampling with 10 minutes time intervals and distribution of questionnaires was conducted at the same time. Table 1 showed the instruments used to measure ventilation performances indicators, chemical and physical parameters. Based on Industrial Code of Practice (ICOP) 2010, instruments placed at a height between 75 and 120 cm from the floor. Questionnaire distribution involved teachers inside the buildings that have been monitored. The questionnaire consists of 5 section that involved general information, background factors, nature of occupation, environmental

conditions and symptoms that involved past and present symptoms which adopt from Industrial Code of Practice Indoor Air Quality (ICOP-IAQ 2010). Present symptoms consist of drowsiness, feeling heavy headed, headache, dizziness, nausea/vomiting, cough, irritated and stuffy nose and more, while for past situation consists of the situation at the study area for the past three months such as the temperature either it is too low or high, draught, dry air, unpleasant odours, dust and dirt and passive smoking.

Table 1. List of instruments

Instruments	Parameters
TSI Climomaster Model 9545	Temperature, relative humidity, and air movement
DustTrak DRX Aerosol Monitor 8533	RSP (PM ₁₀ , PM _{2.5})
Q-Trak Indoor Air Quality Monitor 7575	Carbon dioxide and carbon monoxide
Formaldehyde meter Portable VOC Monitor MiniRae 30000	Formaldehyde TVOC

2.2 Data Analysis

Descriptive analysis was conducted due to its fundamental component in helping to analyze the data. There are several descriptive statistics that were evaluated in this study such as mean, median, mode, standard deviation, variance, and range. Statistical distribution measures, also known as descriptive statistics or summary statistics are used to summarize the information from collected or set of data. In this study mean values was used to compare with the ICOP-IAQ 2010 guidelines

Correlation analysis was also used in this study which used to determine the relationship between two variables ‘x’ and ‘y’. In correlation, there is no difference between dependent and independent variables. Correlation can be positive or negative. When the two variables move in the same direction, for instance, one variable increases, followed by another variable, then the variables are positively correlated ($r=1$). However, when two variables are inversely proportional to one another, then the variable is negatively correlated ($r=-1$).

In addition, Generalized Linear Model (GLM) commonly used to estimate associations between the total carbon footprint and the sources of the emission was also used in this study (Mentese et al., 2020). Therefore, GLM was applied to find associations between source of CO₂ and total carbon footprint data of this study. The GLM are junction of linear and non-linear models with a distribution of exponential family (normal, inverse normal, binomial, Poisson and gamma functions) and logistic models. The GLM is formed by the following three components (Tong et al., 2018):

- Random components: n values of the response variable ($y_1, \dots, y_n$)
- Systematic component: a linear structure for the regression model ($\eta = \beta x^T$), where $x^T = (1, x_{i1}, x_{i2}, \dots, x_{in})^T$, $i=1 \dots m$ represents the explanatory or independent variables and;
- Link function: a monotone and differentiable function g , which connects the random and systematic components relating dependent variable mean (μ) with the linear structure in equation 1:

$$g(\mu_i) = x_i^T \beta, i = 1 \dots K \quad (1)$$

where ($\beta = \beta_1 \beta_2 \dots \beta_p$) are the values of parameters to be estimated. Thus, if we consider for the function g the identity function we have:

$$g(\mu_i) = \mu_i \quad (2)$$

Then

$$\mu_i = E(Y_i) = x_i^T \beta \quad (3)$$

The resulting model is the linear regression model. If alternatively, consider the function g as a logarithmic function and Y_i has a Gamma distribution, then the model will result in a Gamma regression model and each term β_i is the effect of variable X_i in $g(\mu_i)$ (Mentesene et al., 2020; Pekey et al., 2008; Lu et al., 2015; Ul-Saufie et al., 2013). Each β_i represents the “effect” of variable X_i in the function $g(\mu_i)$. In this case the objective is to estimate indoor air quality based on other variables, like past and present symptoms besides indoor air quality parameters that consists of physical and chemical parameter (Mentese et al., 2020; Lazovic et al., 2015). Statistical Package software for Social Sciences SPSS 10.0 for windows was used to build and analyse the model.

Each distribution has unique link function. The distribution most used on the estimation of air pollution health impacts in Gamma function (Aroonsrimorakat et al., 2013; Soleimani et al., 2019), of which link function is $\eta = \log(\mu)$, then $\mu = e^{\eta}$. Thus, η follows a linear model’s assumptions rather than μ , using matrix notation showed in Table 1:

$$\log(\mu) = \beta x^T + f \quad (4)$$

Table 2. General parameter

Model Information	
Dependent Variable	RH
Probability Distribution	Gamma
Link Function	Log

3. RESULTS AND DISCUSSION

Study area consists of 11 workers which are teachers that classified into 68.4% was female and 31.6% male. 52.63% of the occupants was working at the stay area more than 5 years. Respondents consists of several age stage which are 40-57 years old (57.9%), 25-29 years old (15.8%), <25 years old (21.1%) and >55 years old (5.3%). Most of the occupant believe that present symptoms inside the building was cause due to environment of workstation was 84.2%, 10.5% not agreed that environment of the workstation was cause the symptoms and 5.3% was not sure the cause of the present symptoms. These findings were important to determine the background of the study area. Table 3 showed descriptive statistics for indoor air quality (IAQ) in the study area and most of the time comply with the ICOP-IAQ 2010. All chemical parameters were under limit, but physical parameters have a few times that follows the standard but for physical parameters there were a few times that the air movements were insufficient due to the value was lower than the standards range and the temperature was exceed the limit for a few times which cause decrease comfortability among the occupants inside the teacher's room.

Table 3. Mean of the study area and Standard value of ICOP-IAQ

Parameter	Mean	Standard ICOP-IAQ
T (°C)	27-31.45	23-26
RH (%)	70.45-83.35	40-70
AM (m/s)	0.105-0.18	0.15-0.50
CO ₂ (ppm)	353-432.5	<1000
CO (ppm)	0-0.8	10
HCHO (ppm)	0.02-0.04	0.1
PM ₁₀ (mg/m ³)	0.0255-0.0385	0.15
PM _{2.5} (mg/m ³)	0.0235-0.034	0.15
PM ₁ (mg/m ³)	0.0215-0.0335	0.15

GLM models were used to investigate the complex relationships between the physical, chemical, ventilation performance indicators and sick building syndrome symptoms in the teacher's room.

$$\ln [RH] = \alpha + \beta_1 var_1 + \beta_2 var_2 + \dots \beta_n var_n \quad (5)$$

Based on these results, RH can be expressed as the product of exponential terms:

$$[RH] = e^{(\alpha + \beta_1 var_1 + \beta_2 var_2 + \dots \beta_n var_n)} \quad (6)$$

The first term contains the regression intercept, and the rest terms contain binary variables, originated from GLM model as explained above. This methodology as applied to three tested models A, B and C. The three models presented in table 4 differ only in data considered. In model A, we considered the low temperature of observations recorded. In model A we considered the observations recorded standard (RH<70.45%), Model B was (RH70.45-83.35) and Model C (RH>83.33%). These considerations are shortly resumed in table 3.

Table 4. Specific models short description.

Model	Restriction	Dependant variable	covariates
A	RH< 70.45	Temp min	Headache, Feeling heavy headed, Dizziness, Skin rash itchiness, T, PM ₁₀
B	RH 70.45-83.35	Temp med	Headache, Skin rash, Temperature and PM ₁₀
C	RH >83.335	Temp max	Headache, T max, Feeling heavy headed, CO ₂ , PM _{2.5} , Hoarse dry throat

The β coefficient obtained with methodology implemented for two models.

Model	Equation
A	$\ln RH_{min} = 1.392 + 0.265[Headache, 1] + 0.219[Headache, 2] - 0.240[Feeling Heavy Headed, 1] - 0.201[Feeling Heavy Headed, 2] - 0.080[Dizziness, 1] - 0.024[Skin itchiness, 1] - 0.031[Skin Itchiness, 2] + 0.091 T_{min} + 0.0337 PM_{10}$
B	$\ln RH_{med} = 6.441 + 0.067[Headache, 1] + 0.036[Headache, 2] - 0.019[Dizzines, 1] + 0.001[Skin rash, 1] + 0.005[Skin rash, 2] - 0.070 T - 1.524 PM_{10}$

$$\begin{aligned}
 &C \\
 &InRH \text{ max} \\
 &= 4.555 + 0.030\{Headache, 1\} \\
 &+ 0.027[Headache, 2] + 0.006T \\
 &- 0.027[Feeling Heavy Headed, 1] \\
 &- 0.024[Feeling Heavy Headed, 2] \\
 &- 0.001CO_2 + 0.136PM_{2.5} \\
 &- 0.004[Hoarse and Dry Throat, 1] \\
 &- 0.007 [Hoarse and Dry Throat]
 \end{aligned}$$

Equation above showed that RH was increased by 0.265 and 0.218 unit when respondent was feeling [headache, 1] variables [yes, often] or [headache, 2] for [yes, sometimes], and go up by one unit, 0.240 or 0.201 unit in decreasing one unit of [Feeling heavy headed,1] or [Feeling heavy headed, 2], 0.080 unit for the decrease in one unit of [Dizziness,1], 0.031 unit when [skin itchiness,2] decreased by one unit, 0.091 unit increase in one unit of temperature (T) and 0.337 unit in increasing one unit of PM₁₀ for Model A. Basically RH has interaction with increasing of headache, temperature and PM₁₀ and inversely proportional with skin itchiness, feeling heavy headed and dizziness (Abdullah et al., 2019). Previous study stated that there is increasing evidence that air pollution, and particularly small particulate pollutants, can induce transient increases in the risk—or triggering—of myocardial infarction, stroke, congestive heart failure, ventricular arrhythmias, asthma, and respiratory infections. A few small studies have suggested that various forms of air pollution may be linked to headache, as have two Canadian studies that compared trends in hospital visits for headaches and pollutant levels. To our knowledge, no studies have evaluated whether indoor air pollution and particularly fine particulate matter which triggers migraines or other headache syndromes using case-crossover physical parameter such as temperature and relative humidity, which directly compares levels of pollutants and physical variables at the time of presentation for headaches to corresponding levels on preceding and subsequent weeks (Tietjen et al., 2012).

Table 5 shows a resume of the statistical model results performance for two models (A, B and C). The first column of Table 3 presents the statistics tests most often used in generalized linear models and represent measures of dispersion (generalized and/or corrected), which permit to test the quality of models. Values from Table 4, confirm that model A is the one with best performance results shown by statistical tests. These statistics tests are obtained using all the deviations obtained between the estimated and recorded (residuals) for each observation. Considering the Akaike Information Criterion, the objective is to minimize AIC. From the three models, model A is the one with lowest AIC, which means that evidence for the model A is the best compare with Model B and C. The same can be concluded when analysing AICC (Akaike Information Criterion corrected by minimizing the number of model parameters). When comparing with the quantile of a chi-square distribution with n-p degrees of freedom (n-number of observations, p-number of estimated

parameters) it is possible to measure the suitability of models. Results of deviance show that the three are suitable. Another measure of goodness of fit is the Pearson chi-square test, which leads to the same conclusions when compared with the quantile of the chi-square distribution with n-p degrees of freedom. Table 6 shows the likelihood ratio chi-square test, which compares each model with the null model. Regardless of model A is considered the best, each model individually, has a greater explanation of the dependent variable using some of the explanatory than any other model without explanatory variables.

Table 5. Resume of model's results performance.

Goodness of Fit ^a			
	T min	T med	T max
Deviance	.000	.001	.000
Scaled Deviance	11.000	11.000	11.000
Pearson Chi-Square	.000	.001	.000
Scaled Pearson Chi-Square	11.000	10.989	11.016
Log Likelihood ^b	-1.958	12.967	6.718
Akaike's Information Criterion (AIC)	5.916	43.934	8.564
Finite Sample Corrected AIC (AICC)		223.934	
Bayesian Information Criterion (BIC)	30.293	47.515	12.941
Consistent AIC (CAIC)	41.293	56.515	23.941
Dependent Variable: RH min Model: (Intercept), Headache, Feeling heavy headed, Dizziness, Skin rash itchiness, T min, PM ₁₀ min ^a			
Dependent Variable: RH med Model: (Intercept), Headache, Dizziness, Skin rash itchiness, T med, PM ₁₀ med ^a			
Dependent Variable: RH max Model: (Intercept), Headache, T max, Feeling heavy headed, CO ₂ max, PM ₁₀ max, Hoarse dry throat ^a			

a. Information criteria are in small-is-better form.

b. The full log likelihood function is displayed and used in computing information criteria.

Table 6. Models' likelihood ratio chi-square test performance

Model	Likelihood Ratio Chi-Square	df	Sig.
RH min	8.399	9	.000
RH med	22.001	7	.003
RH max	30.057	9	.000

Dependent Variable: RH min

Model: (Intercept), Headache, Feeling heavy headed, Dizziness, Skin rash itchiness, T min, PM₁₀min^a

Dependent Variable: RH med

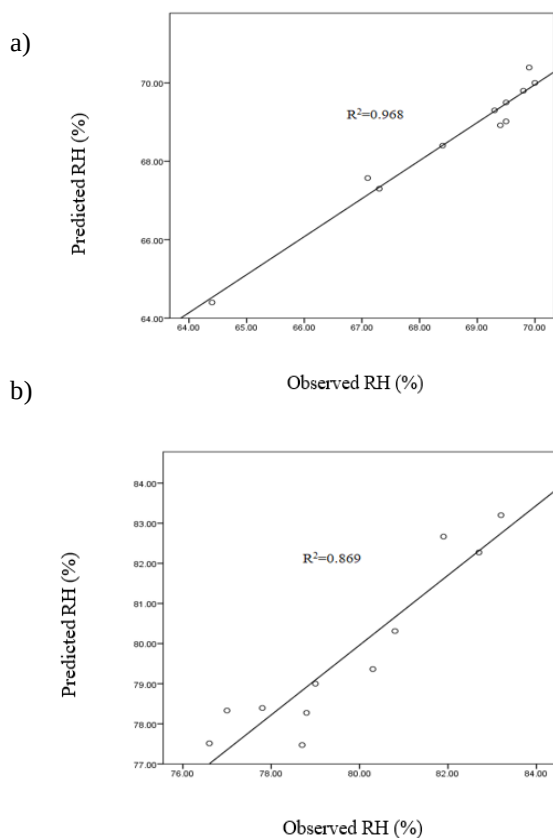
Model: (Intercept), Headache, Dizziness, Skin rash itchiness, T med, PM₁₀med^a

Dependent Variable: RH max

Model: (Intercept), Headache, T max, Feeling heavy headed, CO₂max, PM₁₀max, Hoarse dry throat ^a

a. Compares the fitted model against the intercept-only model.

Figure 2 shows the scattered plot with rh measures versus temperature values predicted by three models (A, B and C). The R^2 values for model A outstanding than model B due to the R^2 of model A ($R^2=0.968$) higher than model B ($R^2=0.869$) and C ($R^2=0.935$). The calculation of R^2 showed that model A was the best fitted model with $R^2=96.8\%$.



c)

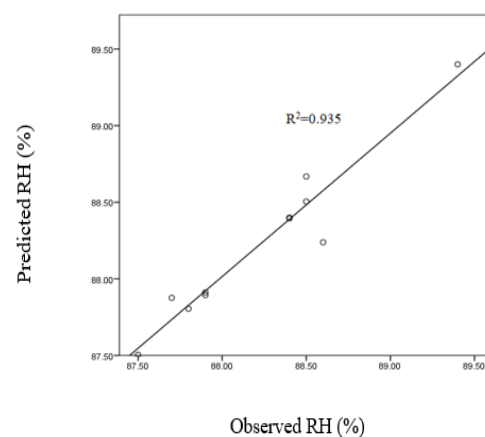


Figure 2. Model Validation.

a) Model A, b) Model B, c) Model C

4. CONCLUSION

In conclusion, this study showed that there were a few contributions of SBS and IAQ towards temperature inside the building such as dizziness, heavy headed, headache and itchiness, besides PM₁₀ and temperature. This study showed that Model A ($R^2=96.8\%$) outstand Model B (86.9%) and Model C (93.5%). Results shows a good accuracy for situations. The model is important tool in situations where there are no measurements of relative humidity, but it is possible to achieve data from other gaseous air pollutants and SBS.

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RESEARCH ARTICLE

Factors influencing awareness and practice on household solid waste management among rural areas residents at Alor Pongsu, Kerian District

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Abstract:

Improper household solid waste management may cause various diseases to humans and bad impact on the environment. In addition, the majority of rural areas still practice dig and burn as a common practice of household waste management due to lack of an proper effective waste management system. Descriptive correlational study involving a total of 142 respondents in Alor Pongsu, Kerian district, Perak. Data were collected using face-to-face interview using a set of questionnaires for socio-demography profiles together with awareness and practice level on household solid waste. Data Analysis were done using SPSS for both; descriptive statistics on socio demography and Chi-Square for determining relationship between parameters. Awareness and practice on managing solid waste at home among residents in the study area were at moderate levels. Mean awareness on household solid waste was 6.965 (SD = 3.209) and the mean for practice level was 2.429 (SD = 0.593). Age, marital status, education level, problem in household solid waste management and training on household solid waste management were significantly correlated with awareness level ($p < 0.001$). Meanwhile training on household solid waste management was significantly correlated with practice level on proper household solid waste management among the resident ($p < 0.005$). Sustainable management of household solid waste practice amongst residents in rural area could be achieved by focusing on awareness and practice elements.

Keywords: Awareness, household solid waste management, practice, rural areas

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1. INTRODUCTION

The number of people throughout the globe has now exceeds 7 billion people worldwide. In addition, world prosperity has improved over the last few decades, resulting in more resources depletion and waste production. However, majority of the infrastructure service including waste management system were focused in urban area as compared to rural areas even though 46% of the people in the world were still living in rural areas (Mihai et al., 2017).

Waste management comprised an activity of waste collection, transportation, treating, disposing of, managing waste, and monitoring waste. This term usually applied to man-made materials, the process of which is usually done to reduce their adverse impact on health of human, the environment, or aesthetics (Adogu et al., 2015). Most waste in our community comes from household activities such as cleaning, cooking food, house sweeping, burning fuel and other domestic activities. In addition, humans also produced household solid waste by discarding equipment, used clothing, old furniture, and used products such as newspapers and old books.

Proper waste management can be achieved through waste separation and engagement of reuse, recycling, and composting waste at home. However, due to a lack of facilities, source isolation programs usually do not exist in local communities especially in rural area (Viljoen et al., 2021, Masjhoer et al., 2022, Mamady et al., 2016). The main reasons for poor level in management of household solid waste in communities are due to the lack of sufficient infrastructure, inadequate awareness, reduced involvement of major household stakeholders, and inadequate coverage of collection systems. To make matter worse, this condition also led to the existence of illegal dumping site where rural area is frequently exposed to such threat (Triasi et al., 2015, Borrel et al., 2014). To reduce waste production and improve household waste management, public should be aware of the various aspects of waste management and practice the correct methods toward better ways to manage household solid waste. (Sultana et al., 2021).

In urban areas, local authorities imposed an assessment tax annually. These generate income for the local authorities and in return, the urban resident will get amenities services such

as garbage collection, cleaning drains, beautifying landscapes, streetlights, and maintaining of traffic lights. However, there is no assessment tax in rural areas, therefore, the basic amenities service is not as inclusive as in urban area. This includes waste collection as well. As a solution, landfilling (dig and dump), open burning, and illegal dumping on untreated vacant land are the common methods used by rural residents to manage and dispose of their household solid waste (Yoda et al., 2014).

In conjunction with that, this study intends to explore level of practice and awareness towards solid waste management and its relationship with socio-demographics factors among residents in rural area. Findings from this study could provide a better insight for researchers and authority in finding a win-win solution for household waste management in rural area.

2. MATERIALS AND METHODS

2.1 STUDY LOCATION

The research took place in Alor Pongsu, a petite township situated within the Kerian district, which is part of the state of Perak, Malaysia. Alor Pongsu was chosen as the study site due to its geographical location, specifically its proximity to a predominantly agriculturally zoned residential area. Additionally, local administrative data categorized this region as a rural area, falling outside the jurisdiction of local service zones.

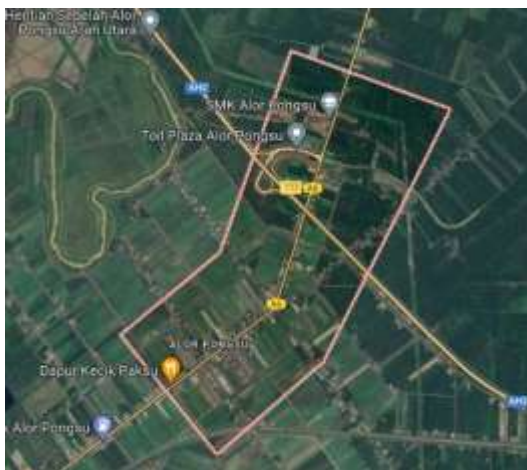


Figure1: Map of Alor Pongsu, Kerian District, Perak State, Malaysia
(Source; Google Map, 2023)

2.2 STUDY DESIGN

A descriptive correlational study was conducted from October 2022 until February 2023. Face-to-face interviews with the respondents have been conducted for data collection. Respondents' anonymity and confidentiality were strictly maintained.

2.3 STUDY PARTICIPANT

All the rural residents above 18 years old with at least 1-year duration living in Alor Pongsu, Kerian district are eligible to participate in this study. According to the data by the Alor Pongsu chief's office, there are 2500 families with 4998 male and 5174 female lived in Alor Pongsu. Sample sizes were determined using the following formula:

$$\text{Sample size} = (Z^2 \times P(1-P)) / e^2 \div 1 + (Z^2 \times P(1-P)) / (e^2 N)$$

N = Population size

z = z-score based on confidence level, 95% confidence level = > 1.96 z-score

e = margin of error

P = standard of deviation

Confidence level was set at 95% and margin of error was at 8%. As a result, a total of 142 sample sizes are required for this study.

2.4 STUDY INSTRUMENT

To assess the awareness and practice of household solid waste management among rural residents at Alor Pongsu, Kerian district, the structured questionnaires adopted from Sultana et al., 2021 were used in this study. The questionnaire involved 37 items and it has been divided into three sections namely, socio-demographic, awareness, and practice of household solid waste management. The questionnaires were provided in bi-lingual versions of Malay and English.

The first section is the socio-demographic questionnaires consisting of 11 items that are used to identify the characteristics of the rural residents. This section included age, gender, education, monthly family income, occupation, marital status, types of solid waste, and household waste problems. The second section is awareness on household solid waste management questionnaires. This section consists of a 12-item questionnaire and the respondents were told to answer either yes or no or don't know option. There were three classifications for awareness level which are low (0-4), moderate (5-8), and excellent (9-12) based on the total score of maximum 12 point. Third section is practice of household

solid waste management questionnaires that consists of a 14-item questionnaire. For this section, the respondents were asked to give their opinion about their practice on management of solid waste based on using a 5-point Likert scale from 1=never, 2= seldom, 3= sometimes, 4= often, and 5= always. The level of practice on household solid waste management was categorized by poor level (total mean from 0-1), moderate level (total mean from 2-3) and excellent level (total mean from 4-5).

2.5 DATA ANALYSIS

SPSS version 28 was used to analyze the data in this study. Descriptive statistics of frequency, percentage, mean, and standard deviation (SD) were used for variables as appropriate. Inferential statistics were used to identify the relationship between awareness and practice with socio-demographic. A significant level was set at $p < 0.05$.

3. RESULTS AND DISCUSSION

In this section, it is explained the results of research and at the same time is given the comprehensive discussion.

3.1. Socio-demographic Characteristics of the Respondents

Table 1 shows socio-demographic characteristics of the respondents in rurals areas at Alor Pongsu Kerian, District. For age, according to the results of the research that has been done, most respondents are aged 48 years to 57 years and for gender, female was most of the respondents which were 76 (53.5%) and followed by male, 66 respondents (46.5%). Muslim residents dominate the area with a proportion of 99.3 % followed by other religion.

For marital status, shown that 88 (62.0%) of respondents were married, 33 (23.3%) respondents were unmarried, 11 (7.7%) were widowed and another 10 (7.0%) were divorced. In terms of occupation, the data indicated the following distribution: 13 respondents (9.2%) held government jobs, 4 respondents (2.8%) worked in the private sector, 40 respondents (28.2%) identified as housewives, 27 respondents (19.0%) were involved in business, 28 respondents (19.7%) were self-employed, and 30 respondents (21.1%) selected "other" as their occupation.

Table 1: Distribution of socio-demographic characteristics of the respondents (N=142)

Variable	Category	Frequency (n)	Percentage (%)
Age	18 years to 27 years	22	15.5
	28 years to 37 years	29	20.4
	38 years to 47 years	34	23.9
	48 years to 57 years	35	24.6
	≥58 years	22	15.5
Gender	Male	66	46.5
	Female	76	53.5
Religion	Islam	141	99.3
	Hindu	0	0
	Christian	0	0
	Buddhist	1	0.7
	Others	0	0
Marital Status	Married	88	62.0
	Unmarried	33	23.2
	Widowed	11	7.7
	Divorced	10	7.0
Occupation	Govt job	13	9.2
	Private job	4	2.8
	Housewife	40	28.2
	Business	27	19.0
	Self service	28	19.7
	Other	30	21.1
Education	No education	7	4.9
	Primary	38	26.8
	Secondary	81	57.0
	University	16	11.3
Monthly family income (RM)	<1000	4	2.8
	1000-1500	105	73.9
	1501-2000	29	20.4
	>2000	4	2.9

Types of solid waste	Recyclable waste	134	94.4
	Non-recyclable waste	1	0.7
	Others	7	4.9
Problem in household solid waste management	No good system for disposal waste	130	91.5
	Cost is high	2	1.4
	Lack of container to collect waste at home	9	6.3
	Others	1	0.7
Training on household solid waste management	Yes	7	4.9
	No	135	95.1

Regarding education levels, the majority of respondents, 81 individuals (57.0%), had completed their education up to the secondary level. Seven respondents (4.9%) reported having no formal education, 38 respondents (26.8%) had attained education up to the primary school level, and 16 respondents (11.3%) had reached the university level.

As for income, it can be concluded that the monthly income of Alor Pongsu residents fell within a moderate range. Specifically, 105 respondents (73.9%) reported incomes ranging from RM 1000 to RM 1500 per month. Four respondents (2.8%) had incomes below RM 1000, 29 respondents (20.4%) fell in the income range of RM 1501 to RM 2000, and four respondents (2.8%) reported incomes exceeding RM 2000.

Based on the collected data, it was observed that the majority of respondents, totaling 134 individuals (94.4%), reported that they generated recyclable waste. Only one respondent (0.7%) indicated that they produced non-recyclable waste, while seven respondents (4.9%) mentioned other types of waste.

Furthermore, the study aimed to determine if respondents had received any training in household solid waste management. The results revealed that the vast majority of respondents,

accounting for 135 individuals (95.1%), had not received any training in household solid waste management. In contrast, a small minority, consisting of seven respondents (4.9%), reported having received such training.

3.2.Awareness level on household solid waste management among residents

Table 2 presents the distribution of awareness levels regarding household solid waste management among residents in the rural areas of Alor Pongsu, Kerian District. The analysis revealed that the mean awareness score among these residents was calculated to be 6.965 (SD=3.209) out of a maximum possible score of 12 points. Consequently, it can be inferred that the overall awareness level within this population falls within the moderate range.

Specifically, the majority of respondents (78.87%) exhibited a moderate level of awareness when it came to household solid waste management. A smaller percentage of respondents (11.97%) demonstrated an excellent level of awareness, while a further subset (9.15%) showed a lower level of awareness on this subject.

Table 2: Distribution of awareness level on household solid waste management among residents in rural areas at Alor Pongsu, Kerian District (N = 142)

Variable	Correct		Incorrect		M* ± SD**
	n	%	n	%	
Household solid waste management committee are needed in the community.	68	47.9	74	52.1	0.479 ± 0.501
Every people must know about household solid waste management.	141	99.3	1	0.7	0.993 ± 0.084
Local authorities have no role to play in the household solid waste management.	16	11.3	126	88.7	0.113 ± 0.376
Respiratory distress, diarrhoea and many other diseases arise due to improper waste management.	123	86.6	19	13.4	0.866 ± 0.342
Household solid waste can't reuse or recycle.	85	59.9	57	40.1	0.599 ± 0.491
Everybody awarded of electronic	2	1.4	140	98.6	0.014 ± 0.118

household solid waste management.					
Waste disposal on open places will be harmful for human health.	129	90.8	13	9.2	0.908 ± 0.289
Community people are awarded of any legislation which governs household solid waste management.	4	2.8	138	97.2	0.028 ± 0.166
All streets should be clean and free of waste.	142	100	0	0	1.000 ± 0.000
Incineration is the effective disposal mechanism for household solid waste management.	19	13.4	123	86.6	0.134 ± 0.342
Delay in household solid waste disposal causes of many difficulties.	121	85.2	21	14.8	0.852 ± 0.356
I am always concern about collect and dispose of household solid waste management.	139	97.9	3	2.1	0.979 ± 0.144
Total mean = 6.965 (SD = 3.209)					

*M** mean of score.

*SD*** standard deviation

3.3. Practice level on household solid waste management among residents

Table 3 shows the distribution of the respondent's level of practice on household solid waste management at Alor Pongsu, Kerian District. According to the finding, the mean for practice score of household solid waste management was 2.429 (SD = 0.593) which out of a maximum of 5 points. The results showed that the level of the practice on household solid waste management among residents in rural areas at Alor Pongsu, Kerian district was at moderate level which indicates 98.59% of the respondents, while only 1.41% of the respondents had low level of practice on household solid waste management.

Table 3: Distribution of practice level on household solid waste management among residents in rural areas at Alor Pongsu, Kerian District (N = 142)

Variable	Never n (%)	Seldom n (%)	Someti- mes n (%)	Often n (%)	Always n (%)	M* ± SD**
Use different bins for waste disposal.	128	12	0 (0.0)	0 (0.0)	0 (0.0)	1.113 ± 0.359
Throw waste to drain.	89 (62.7)	43 (30.3)	0 (0.0)	0 (0.0)	0 (0.0)	1.444 ± 0.625
Kitchen waste as compost for gardening.	103 (72.5)	26 (18.3)	3 (2.1)	3 (2.1)	0 (0.0)	1.387 ± 0.713
Reuse of grocery bags.	78 (54.9)	42 (29.6)	4 (2.8)	4 (2.8)	0 (0.0)	1.634 ± 0.812
Reuse of old material	105 (73.9)	27 (19.0)	0 (0.0)	0 (0.0)	0 (0.0)	1.331 ± 0.604
Throw waste to open dump.	27 (19.0)	83 (58.5)	1 (0.7)	1 (0.7)	1 (0.7)	2.056 ± 0.702
Throw waste to open field.	134 (94.4)	7 (4.9)	0 (0.0)	0 (0.0)	0 (0.0)	1.063 ± 0.272
Put waste in bin without cover.	2 (1.4)	2 (1.4)	21 (14.8)	21 (14.8)	109 (76.8)	4.641 ± 0.775
Put waste in plastic bag.	36 (25.4)	18 (12.7)	21 (14.8)	21 (14.8)	32 (22.5)	2.965 ± 1.485
Segregate bio-degradable and non-biodegradable wastes	133 (93.7)	7 (4.9)	0 (0.0)	0 (0.0)	0 (0.0)	1.078 ± 0.317
Keep all garbage in one garbage bin	0 (0.0)	0 (0.0)	18 (12.7)	18 (12.7)	122 (85.9)	4.845 ± 0.400
Burn the solid waste	0 (0.0)	2 (1.4)	24 (16.9)	24 (16.9)	112 (78.9)	4.732 ± 0.582
Dispose the solid waste regularly.	0 (0.0)	0 (0.0)	38 (26.8)	38 (26.8)	102 (71.8)	4.704 ± 0.488

Dispose solid waste to waste collector.	141 (99.3)	1 (0.7)	0 (0.0)	0 (0.0)	0 (0.0)	1.014 ± 0.168
Total mean= 2.429 (SD = 0.593)						

*M** mean of score.

*SD*** Standard Deviation

3.4.Relationship between socio-demographic and awareness level on household solid waste management among residents

Table 3.4 displays the connection between socio-demographic characteristics and the level of awareness regarding household solid waste management among rural residents in Alor Pongsu, Kerian District. After conducting the analysis, several noteworthy findings emerged.

Table 3.4: Relationship between Socio-Demographic and Awareness Level on Household Solid Waste Management (N=142)

Variable	Category	n	t	p
Age	18 years to 27 years	22	45.692	<0.001*
	28 years to 37 years	29		
	38 years to 47 years	34		
	48 years to 57 years	35		
	≥58 years	22		
Marital Status	Married	88	23.263	<0.001*
	Unmarried	33		
	Widowed	11		
	Divorced	10		
Education	No education	7	57.425	<0.001*
	Primary	38		
	Secondary	81		
	University	16		
Problem in household solid waste management	No good system for disposal waste	130	13.329	0.038*
	Cost is high	2		
	Lack of container to collect waste at home	9		
	Others	1		
Have you received any training on	Yes	7	54.139	<0.001*

household solid waste management	No	135
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**p-value is significant at 0.05.*

Firstly, age ($t = 45.692$, $p < 0.001$), marital status ($t = 23.263$, $p < 0.001$), education ($t = 57.425$, $p < 0.001$), issues related to household solid waste management ($t = 13.329$, $p = 0.038$), and receiving training on household solid waste management ($t = 54.139$, $p < 0.001$) were all found to have a statistically significant relationship with the level of awareness concerning household solid waste management among the rural residents in Alor Pongsu, Kerian District.

The results further reveal a significant correlation between the age of the respondents and their awareness level regarding household solid waste management ($t = 45.692$, $p < 0.001$). This correlation may be attributed to the fact that most of the respondents fell within the age range of 18 to 47 years, encompassing both young and middle-aged individuals.

Additionally, marital status was found to be significantly related to awareness ($t = 23.263$, $p < 0.001$), indicating that there is a significant correlation between marital status and the level of awareness among the respondents.

Furthermore, among the socio-demographic characteristics, education exhibited a highly significant correlation with the awareness level concerning household solid waste management ($t = 57.425$, $p < 0.001$). This suggests that respondents with higher levels of education possessed greater knowledge about household solid waste management compared to those with lower educational backgrounds.

Additionally, the questions related to problems in household solid waste management were also found to be significantly correlated with the awareness level regarding household solid waste management ($t = 13.329$, $p = 0.038$). This underscores that respondents who faced issues or challenges in managing household solid waste demonstrated a notable relationship with their awareness levels on this topic.

Training on household solid waste management had a positive effect on high awareness level on the management of solid waste at home. This can be further elucidated by the study's findings, which indicated a significant correlation between respondents who had undergone training in household solid waste management and their level of awareness. ($t = 54.139$,

$p < 0.001$). The other socio-demographic characteristics were non-significant with awareness level on household solid waste management.

3.4. Relationship between socio-demographic and practice level on household solid waste management among residents

Table 4 shows the result for the relationship between socio-demographic characteristics between levels of practice on household solid waste management among the respondents. It was found that training on household solid waste management was significantly correlated with practice ($t = 8.783$, $p = 0.003$). It can be concluded that respondents who had received training have a good practice level on managing their waste, reflecting on things they have been taught during the training session. The rest of other variables such as age, gender, religion, marital status, education, occupation, family income, residential status and types of solid waste were not significantly correlated and were not related to towards practices on household solid waste management.

Table 4: Relationship between Socio-Demographic and Practice Level on Household Solid Waste Management (N=142)

Variable	Category	n	t	p
Age	18 years to 27 years	22	3.728	0.444
	28 years to 37 years	29		
	38 years to 47 years	34		
	48 years to 57 years	35		
	≥58 years	22		
Gender	Male	66	0.010	0.920
	Female	76		
Religion	Islam	141	0.014	0.905
	Hindu	0		
	Christian	0		
	Buddhist	1		
Marital Status	Others	0	6.700	0.085
	Married	88		
	Unmarried	33		
	Widowed	11		
Occupation	Divorced	10	2.944	0.709
	Govt job	13		
	Private job	4		
	Housewife	40		
	Business	27		
	Self service	28		
	Other	30		

Education	No education	7	3.361	0.339
	Primary	38		
	Secondary	81		
	University	16		
Monthly family income	<1000	4	0.715	0.870
	1000-1500	105		
	1501-2000	29		
	>2000	4		
Residential status	Own	112	0.543	0.461
	Rented	30		
Types of solid waste	Recyclable waste	134	0.121	0.941
	Non-recyclable waste	1		
	Others	7		
Have you received any training on household solid waste management	Yes	7	8.793	0.003*
	No	135		

* p -value is significant at 0.05.

4. DISCUSSION

4.1 Socio-demographic characteristics of the residents in rural areas at Alor Pongsu, Kerian district

This study predominantly comprised participants from young and middle age groups, ranging from 18 to 47 years old, with a higher representation of female respondents. This demographic composition can be linked to occupation, as the study identified "housewife" as the most common occupation among the participants. Consequently, data collection predominantly involved female respondents, as they are typically responsible for managing household solid waste, including garbage disposal. This factor likely contributed to their increased interest and willingness to participate in the study. A similar pattern was observed in Owerri Municipal, Imo State, Nigeria, as reported by Adogu et al. (2015), where the majority of respondents fell within the age range of 21 to 40 years old, with 180 of them being female. This dominance of female participants in the study indicated a heightened interest among women in household solid waste management. Moreover, females often reported being actively involved in

activities such as lawn mowing and waste disposal tasks compared to their male counterparts.

Regarding education levels among respondents in rural areas of Alor Pongsu, Kerian District, the study found that a substantial portion had attained secondary education, with 16 respondents having received a university-level education, while the remaining respondents had primary education or no formal education. These findings closely resemble those of a previous study conducted in rural areas of Kota Bharu, Kelantan, as documented by Fadhullah et al. (2022). In the Kota Bharu study, the majority of respondents had completed secondary education (57.4%), followed by university-level education (31.1%), and primary education (8.0%). Thus, a consistent pattern emerges, indicating that the education level in rural areas tends to be predominantly at the secondary level.

The study also revealed that a significant portion of the respondents had not received any training on household solid waste management. This lack of training can lead to a limited exposure to proper waste management practices, causing them to continue practicing incorrect waste management methods. Such a situation can have detrimental effects on both the environment and human health. A study conducted in Mugda, Dhaka (Sultana et al., 2021) yielded similar results, with respondents in Dhaka also lacking training in household solid waste management. This underscores the importance of training in this field, as inadequate training can result in lower levels of awareness and suboptimal waste management practices.

Furthermore, the study found that most respondents were able to identify recyclable components within their waste, such as plastic bottles, plastic bags, food wrapping paper, and food waste. However, despite this awareness, many respondents tended to dispose of these recyclable materials in their backyards or burn them, possibly due to habitual behavior and a lack of sensitivity to the importance of recycling in household solid waste management. Only a few respondents practiced recycling, such as using food waste for composting, reusing plastic bags, and repurposing old materials into new items. This situation aligns with the findings of Razali et al. (2018), who reported that the majority of households in Malaysia lagged behind in waste separation and recycling practices compared to other countries.

Additionally, a similar pattern was observed in a study by Fadhullah et al. (2022) among residents in the East Coast of Malaysia, emphasizing the need for awareness programs initiated by local authorities and community involvement to

educate people about proper household solid waste management. This sentiment was echoed in a study by M. A. Abas et al. (2021), which investigated the willingness of rural communities to pay for improved solid waste management in rural areas of Kelantan.

4.2 Awareness level on household solid waste management among residents

The present study's categorization of moderate awareness levels among rural respondents in Alor Pongsu, Kerian District mirrors the findings of previous research in Lahore, Pakistan, and is likely influenced by a combination of socio-demographic factors, educational backgrounds, and the availability of educational information through various channels, including media.

The study's assessment of awareness levels concerning household solid waste management among respondents in rural areas within the Alor Pongsu, Kerian District categorized their awareness as moderate. These findings are consistent with a prior study conducted in Lahore, Pakistan by Shahzadi et al. in 2018, which similarly reported that the majority of participants exhibited a moderate level of awareness. It is plausible that these outcomes are influenced by a combination of factors, including the respondents' educational backgrounds, income levels, cultural influences, and access to educational resources related to household solid waste management.

Furthermore, these findings align with previous research conducted by Shahzadi et al. (2018) and Sultana et al. (2021), which asserted that individuals with higher educational statuses tend to exhibit a greater awareness of household solid waste management. The congruence in results across these studies may be attributed to shared socio-demographic characteristics, educational levels, challenges in household solid waste management, and the role of media in disseminating information about household solid waste management.

4.3 Practices level on household solid waste management among residents

The study highlighted the challenges of composting kitchen waste due to knowledge gaps and space limitations among respondents. Moreover, the practice of collecting waste without covers, while consistent with findings in Accra, differed from practices in Nigeria, underscoring the influence of local waste management systems and infrastructure on

household practices.

Regarding the practice levels of household solid waste management among residents in rural areas within the Alor Pongsu, Kerian District, the study revealed a moderate level of practice. Notably, a significant number of respondents did not utilize separate bins for waste disposal, instead choosing to accumulate all their garbage in a single container. This practice was often attributed to the limited availability of garbage containers in their households. Additionally, a substantial portion of the respondents did not engage in the segregation of biodegradable and non-biodegradable waste before disposal, primarily due to a lack of knowledge about waste segregation at home, which contributed to the observed moderate practices.

These findings parallel those of a previous study conducted in urban Accra (Yoda et al., 2014), which reported that a majority of respondents did not engage in garbage separation. Specifically, only 17.3% of respondents practiced waste separation during storage, while the remaining 82.7% did not partake in waste separation at home. This lack of waste separation practices creates a conducive environment for the proliferation of disease vectors such as cockroaches and mosquitoes, as well as rodents like rats and mice, posing potential threats to public health.

Furthermore, this study uncovered that a significant portion of the respondents did not utilize their kitchen waste for composting in gardening, primarily due to insufficient knowledge about composting practices and space constraints at home. This contrasts with a prior study conducted in Uganda (Almasi et al., 2019), which reported different outcomes. In Uganda, respondents were more inclined to use their kitchen waste for gardening, largely because they had received education on proper household solid waste management practices.

Additionally, most respondents in this study habitually collected their household solid waste without using a cover. This practice is considered poor waste management since it can attract disease vectors drawn to the waste's odor. These findings align with a previous study conducted in Accra (Yoda et al., 2014), where only a small minority of respondents used covered plastic bins to prevent direct exposure to flies and to contain odors.

However, it's important to note that in Nigeria (Adogu et al., 2015), the results diverged from the findings of the current study, with respondents practicing waste collection using

covers. This disparity may be attributed to the presence of a more robust waste collection system and the availability of covered waste containers in Nigeria.

The study also revealed that a significant majority of respondents tended to resort to burning solid waste when they accumulated a substantial volume of it although most respondents are aware that burning waste will cause toxic chemicals such as Nitric Oxide (NO), Sulphur Dioxide (SO₂), and Polyoxometalates (POMs) to be released into the air. Burning waste such as plastics also can cause release of Dioxin (C₄H₄O₂) which these toxic chemicals can have adverse effects on the human respiratory system the environment.

4.4 Relationship between socio-demographic and awareness level on household solid waste management among residents.

This study underscores the critical role of awareness in household solid waste management among rural residents. Age, marital status, and problems related to household solid waste were identified as significant factors influencing awareness levels, with findings consistent with prior research in some cases and diverging in others, likely due to contextual differences.

Awareness of household solid waste management holds paramount importance in achieving excellence in waste management practices among rural residents. The current study unveiled a significant correlation between the age of respondents and their awareness levels. This finding aligns with a previous study conducted by Fadhullah et al. (2022), which also observed that age plays a pivotal role in influencing awareness levels regarding the management of household solid waste. This connection can be attributed to the notion that age is linked to an individual's maturity, and it serves as a crucial factor in shaping awareness regarding environmental health and hygiene.

Moreover, marital status emerged as another significant factor correlated with awareness levels in this study. Specifically, married respondents displayed a higher awareness of household solid waste management. This outcome is consistent with the findings of a study by Abbas et al. (2020), which noted a similar trend. According to Abbas et al., married individuals tend to exhibit more positive attitudes toward household solid waste management than their single counterparts. This inclination may be attributed to the increased responsibilities and cultural factors associated with

marriage, leading married individuals to better manage their household waste and appreciate the significance of waste reduction, reuse, and recycling.

Additionally, the current study identified a significant correlation between issues related to household solid waste, such as the absence of an effective waste disposal system and a lack of containers for waste collection at home, and awareness levels in household solid waste management. In contrast, a study by Sultana et al. (2021) found no significant relationship between waste management issues and awareness levels. This discrepancy may be explained by the presence of waste management facilities in the area studied by Sultana et al., potentially mitigating the impact of such issues on awareness levels.

In the course of this study, education also exhibited a significant correlation with the level of awareness, with respondents who had received education demonstrating a moderate to excellent level of awareness regarding household solid waste management. Conversely, those who had not received any formal education displayed a lower level of awareness, which was categorized as poor. These findings are consistent with a prior study conducted in Thailand (Laor et al., 2018), where individuals lacking formal education similarly exhibited lower levels of awareness regarding household solid waste management.

Furthermore, the study also identified a significant correlation between training in household solid waste management and awareness levels. This relationship stems from the fact that individuals who had undergone training in household solid waste management had access to comprehensive information and knowledge on the subject. As a result, their awareness levels were generally higher compared to those who had not received such training.

4.5 Relationship between socio-demographic and practices level on household solid waste management among residents

The findings of the present study revealed that residents in rural areas of Alor Pongsu, Kerian District exhibited a moderate level of practice in household solid waste management. Notably, the research showed a significant correlation between respondents who had received training in household solid waste management and their level of practice. A substantial portion of the respondents had not received any

such training, which consequently led to inadequate waste management practices, primarily characterized by open dumping and open burning. These results align with prior research conducted in Nigeria (Adogu et al., 2015), where respondents similarly practiced suboptimal waste management, resorting to open dumping and burning. The common factor in both studies was the absence of formal training in waste management, with 96.1% of respondents in the Nigerian study sharing this characteristic.

Additionally, a study conducted in Mugda, Dhaka (S. Sultana et al., 2021) yielded parallel results, where a majority of respondents (81.25%) had not received any training in household solid waste management. Collectively, these findings from rural regions in various countries emphasize the recurring theme that residents in such areas often lack access to formal training in household solid waste management, resulting in the perpetuation of traditional waste management methods.

In conclusion, these studies underscore the critical importance of providing training in waste management to ensure effective and responsible waste disposal practices at the household level.

5. CONCLUSION

The results of this study indicate a moderate level of awareness and practice regarding household solid waste management among the surveyed individuals. In terms of the association between socio-demographic factors and awareness, it was observed that age, marital status, education, issues related to household solid waste, and participation in training on household solid waste exhibited positive correlations. Conversely, when examining the relationship between socio-demographic factors and the practice of household solid waste management among rural residents in the Alor Pongsu Kerian District, only participation in training on household solid waste displayed a positive correlation.

In addition, the investigation revealed that a majority of the respondents resort to open dumping and open burning as their waste management methods, primarily because a significant portion of them lacked any training in household solid waste management. These findings underscore the importance of imparting appropriate information and training to the rural community on proper waste disposal techniques, pointing towards a potential solution for addressing the waste management challenges in the Alor Pongsu area.

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RESEARCH ARTICLE

Assessment of food safety knowledge, attitudes and practices among home-based food consumers in Kubang Pasu District

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Abstract:

The COVID-19 pandemic restrictions have led to the growth of home-based online food businesses. The objective of this cross-sectional study was to assess the present status of food safety knowledge, attitudes and practices (KAP) among home-based food consumers in Kubang Pasu district. A validated, reliable online questionnaire was distributed among the community via social medial platforms. A total of 150 participants completed the questionnaire. The result showed that home-based food consumers had moderate attitudes (56.6 ± 15.3) and practices (61.3 ± 18.4) but have poor knowledge (49.5 ± 14.7) of food safety. Further statistical analysis using Chi-square test revealed that gender and monthly income were the factors associated with food safety knowledge, whereas gender and current employment status were the factors associated with food safety practices ($p < 0.05$). The study suggested that some aspects related to cross-contamination and time-temperature control should be given more attention. Therefore, awareness of food safety among home-based food consumers should be strengthened to prevent occurrence of food borne disease by taking into account the factors associated with the KAP. Food safety education should not only focus on theoretical aspects of knowledge but also positive attitudes towards food safety and promote good food safety practices.

Keywords: Consumers, Food safety, Home-based vendors, KAP, Kubang Pasu

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1. INTRODUCTION

Opening a food business is not a simple task. Many regulatory requirements that must be met by the owners of the food premises prior to and during selling their products. In Malaysia, there are requirements for food safety standards such as Food Act 1983, Food Regulation 1985, and Food Hygiene Regulations 2009 to protect the public against food related hazards and frauds. According to the Food Act 1983, food premises are defined as premises that are used to prepare, package, storage, transport, distribute or sale of any food reproccess or process food which includes home -based food business. Home-based food business is referred to the handling of food in a private home for purpose of sale include preparing of food for local markets, school canteens, catering for events and online food sales from home (Food Standard Australia and New Zealand, 2021).

Food premises in Malaysia must follow requirement in Food Hygiene Regulations 2009 such as food premises must register with Ministry of Health Malaysia, have food traceability system from production to distribution, location of food premises are away from sources of contamination and maintained in good condition. Besides that, food handlers which are defined as individuals who are directly involved in the food preparation also must follow the requirement under Food Hygiene Regulation 2009. Most important requirement is all food handlers are compulsory to

be trained or attending food handler course conducted by Food Training School that approved by Ministry of Health Malaysia and getting typhoid vaccination (MOH,2009).

The pandemic of COVID-19 has resulted in an increased unemployment rate of 4.95% in January 2021 (MOE,2021). This is the direct result of business shutdown and global lockdowns, causing employees to lose their jobs (Daim and Yunus, 2021). Due to the movement control order (MCO) in Malaysia, many food businesses have switched to online delivery-based methods to reach out the customers (Ikbāl, Abdullah and Rahman, 2021) where about 44% of home-based food sellers started their business after the first lockdown (Shaw, 2021). Unfortunately, lack of regulations has increased the likelihood of foodborne diseases where evidence indicates that many cases of food-borne disease outbreaks are frequently related to home-prepared food (Azanza et al., 2018). Therefore, food safety issues should not be compromised in ensuring the quality of the food to be served is safe and secure from any harm (Sesotec, 2020). Moreover, awareness about food safety remains as a major issue for consumers in many countries whether in develop or developing countries (Odeyemi et al., 2019).

Most home-based food sellers are not aware of the importance of food safety during handling and preparing food at home. About 40.5% of food-borne outbreaks occurred at home (EFSA, 2019). The main risk factors

associated with reported food-borne illnesses at home are poor cooking, cross-contamination, and obtaining foods from an unsafe source (EFSA, 2015). Other risk factors related to home-based food sellers include clean water supply, environmental cleanliness and the quality of food that can threaten the customer's health (Osman, 2020). In addition, not all houses have a dedicated home kitchen space for food-related activities only. Some houses have to use the kitchen area for other daily activities such as laundry, school or work activities, socializing area due to limited space and even pets are free to roam around the house including the kitchen (Wills et al., 2015; Izyan et al., 2019).

Furthermore, home-based food sellers that deliver the food to the customers were untrained in food safety which can pose a risk to the consumer's health because the food can be contaminated if it is not packed properly and kept in the correct temperature (Limon, 2021). Moreover, the majority of the customers who order food through online platforms are not able to see whether their orders were prepared in a clean and hygienic manner. In 2020, we were shocked by one incident of death due to food poisoning after eating 'pudding buih' dessert purchased from an online home-based vendor. Another 99 victims suffered from diarrhea, vomiting and fever (Bernama, 2020). Investigations found that the usage of expired eggs by the trader for the making of the dessert was the source of food poisoning. So far, there are no changes in the existing Food Act in Malaysia to enforce regulations against those involved in the online food business (Osman, 2020). Therefore, it is very important to evaluate awareness of food safety in any society to obtain better health results (WHO, 2022).

At present, there are limited studies have been performed to assess food safety knowledge, attitudes and practices among home-based food consumers in Malaysia, especially in Kubang Pasu district. Therefore, this study aims to fill this gap by determining the level of food safety knowledge, attitude and practice (KAP) among home-based food consumers in Kubang Pasu district, Kedah and identify the relationship between demographic features with the knowledge, attitude and practice (KAP) scores.

2. MATERIALS AND METHODS

2.1 Study design, sample size and sampling

This cross-sectional study was conducted among home-based food consumers in Kubang Pasu district, Kedah using an online questionnaire. From the data, the relation between food safety KAP among home-based food consumers can be determined. According to the Department of Statistics (2020), the population size of Kubang Pasu is estimated to be 254,200 in 2020.

The sample size for this study was calculated using Raosoft software as suggested by previous researchers (Rajiah et al., 2015; Zulkarnain et al., 2022). The sample size was

calculated by keeping the margin of error at 8%, confidence interval at 95% and population size of 254,200. From the calculation, the number of sample size required for this study was 150.

An electronic questionnaire was prepared in Google Form and the link was distributed using social media such as WhatsApp, Facebook and Telegram within the Kubang Pasu community. This study successfully recruited 150 participants using a snowball sampling method, following similar approach from previous studies (Zulkarnain et al., 2022) where potential participants to take part in this study was approach and then, the participants were encouraged to share the link to recruit future participants among their acquaintances who are living in Kubang Pasu. The individuals who participated in this research had to be Kubang Pasu residents who had eaten home-based foods sold in the district at least once. The participants were provided with all the necessary information regarding the study, and at the beginning of the electronic questionnaire, their consent was requested by clicking the acceptance button. The participants were also informed that their involvement in the study was completely voluntary, and they were free to refuse to participate or withdraw at any time. The identity of the participants is kept anonymous.

2.2 Research instrument

The questionnaire for this study was adapted from the published article (Izyan et al., 2019). There are four sections in the questionnaire which were Section A (demographic information), B (food safety knowledge), C (food safety attitudes) and D (food safety practices). For each correct answer, a score of 1 was given while a score of 0 was given for wrong answer or "not sure". The total score for each domain was converted into percentage. A score of <50% is considered as having either poor knowledge, attitudes or practices towards food safety. A score between 50% to 75% is considered as moderate, while >75% is considered as good. The questionnaire was prepared in Malay and English languages. The validity and reliability of questionnaire was also tested through a pilot study and Cronbach's alpha coefficient was found to be 0.753.

2.3 Data analysis

Statistical Package for Social Science (SPSS for Windows version 20.0) was used to analyze the data obtained from this study. The demographic data, knowledge, attitudes and practices scores of participants was summarized using descriptive statistics in terms of percentage and frequency. Furthermore, the Chi-square test was used to identify the relationship between demographic factors with food safety knowledge, attitudes and practices (KAP) among home-based food consumers in Kubang Pasu District. The

significant value and confidence interval was set at 0.05 and 95% respectively.

3. RESULTS AND DISCUSSION

3.1 Demographic characteristics of the study participants

Table 1 summarized the demographic information for the participants in this study. Majority of the participants were between 46 to 55 years old (32.7%) with 66.6% female. Out of the 150 participants, 59.3% had a bachelor's degree and 33.3% earned less than RM2,500 per month. Most participants were working full time (62.0%).

Table 1. Demographic characteristics of the study participants (n = 150)

Variable	Frequency, n	Percentage, %
Gender		
Male	50	33.3
Female	100	66.6
Age		
18- 25 years	37	24.7
26- 35 years	22	14.7
36- 45 years	25	16.7
46- 55 years	49	32.7
56- 65 years	17	11.3
Highest education level		
Form 6/ Certificate/ Diploma	49	32.7
Bachelor's Degree	89	59.3
Master's Degree	10	6.7
Doctorate's Degree (PhD)	2	1.3
Current employed status		
Working full time	93	62.0
Working part time	9	6.0
Studying	25	16.7
Retired	11	7.3
Unemployed	12	8
Monthly income		
< RM 2,500	50	33.3
RM 2,501- RM 3,170	13	8.7
RM 3,171- RM3,970	8	5.3
RM 3,971- RM 4,850	12	8.0
RM 4,851- RM 5,880	13	8.7
RM 5,881- RM 7,100	38	25.3
RM 10,971 -RM 15,040	16	10.7

Figure 1 illustrates the participant's response to the question on whether they were confident in the food safety prepared by home-based vendors. The findings indicated that most participants sometimes (n=44) and rarely (n=32) had confidence in the safety of the food prepared by the home-based vendors. This result is consistent with the findings of a previous study, which showed that the majority of the respondents were not always confident about food safety when they purchased food from home-based vendors (Al Banna et al., 2022).

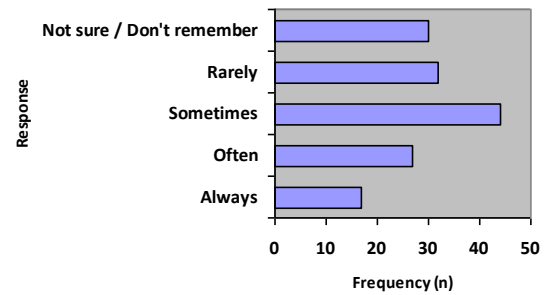


Figure 1. Confidence in the food safety prepared by home-based vendors

Figure 2 illustrates the participant's response to the question on the reasons for buying food from home-based vendors. Majority of the participants voted that saving their time was the main reasons for buying food from home-based vendors (62.0%). This finding is consistent with the previous research where consumers nowadays more preferred buy readymade meals that can save time (Raj, Suvarashini and Mishra, 2021). Participants also voted that easy to access (50.0%) and affordable price (50.0%) were another reason for buying the food, which is parallel with the finding from previous study (Al Banna et al., 2022). Although previous studies (Al Amin et al., 2020; Kumar et al., 2020) showed that consumers consider recommendations from friends and influencer regarding popular foods or beverages before making online food purchases or visiting any restaurants, the findings from this study are in contrast, showing that purchasing food from home-based vendors is now the least common reason (26%) for doing so.

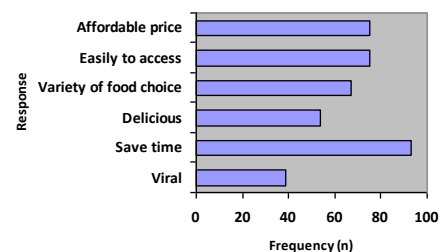


Figure 2. Reasons for buying food from home-based vendors

Figure 3 illustrates the participant's response to the question on whether they experienced any sign and symptoms of food poisoning after eating food bought from home-based vendors. This study revealed that the majority of the respondents did not experience any sign and symptoms of food poisoning after eating food bought from home-based vendors (83.3%). This study is pertinent to the cases of food poisoning recorded by the Malaysian Ministry of Health for the year 2021, when the number of cases reported was decreased 57% from the same period last year (Radhi, 2021). However, a study by Manko (2018) found more than half of the participants had an illness after eating the foods that

bought from food vendors such as upset stomach. Moreover, a study among food service operators in Kedah district include Jitra and Kubang Pasu reported that attitude of food service operators during preparation of food were synonymous with the occurrence of food poisoning incidence (Fatin, 2020).

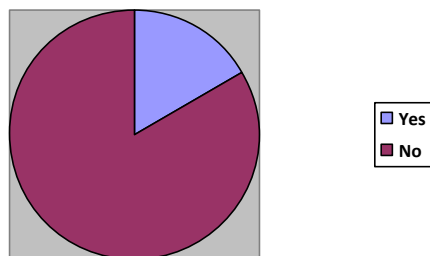


Figure 3. Experienced to food poisoning sign and symptom

Homes are acknowledged as one of the main places where the majority of food poisoning incidents take place (Maurer et al., 2008; Spittler, 2009; Redmond & Griffith, 2009), despite the fact that many consumers do not believe that homes can be a risky location for food poisoning. Home kitchens were multifunctional spaces with a lot more than just preparation and storage space. Home kitchens are used for a variety of purposes, which increases the risk of the entry of germs that can proliferate, spread, and contaminate food. *Salmonella*, pathogenic *Escherichia coli*, *S. aureus*, and *Campylobacter* are a few of the pathogens that have been identified in domestic kitchens (Byrd-Bredbenner et al., 2013). Moreover, there were studies that have found that the kitchen is more heavily contaminated with fecal coliforms than bathrooms (Borrusso and Quinlan, 2017).

3.2 Knowledge of food safety

Table 2 summarized the findings on food safety knowledge among home-based food consumers in Kubang Pasu District. Overall, participants in this study have poor knowledge on food safety (49.5 ± 14.7). Even so, 96.7% of the participants correctly answer questions regarding personal hygiene is vital to ensure food safe during food preparation. This study outcome is in line with Izzyan et al. (2019) which all most of participants agreed with the statement that personal hygiene is important to ensure safety of the food during preparation of the food. Besides that, 73.3% of respondent aware that home-based food sellers need to register under Food Safety Information of Malaysia (FoSIM). According to Chairman of Health and Environment Committee, home-based vendors are encouraged to register with FoSIM under Ministry of Health. Malaysia The registration of FoSIM was to help the home-based food business comply with the official guidelines on

food safety (Yeoh, 2020). Moreover, 89.3% of the participants were correct to questions regarding hand-washing procedures that is washing of hands with soap and water could reduce contamination of hands. The study outcomes are in line with reported by Abdul -Mutalib et al. (2012) that participants exhibited a high level of knowledge on hand-washing procedures and a recent study by Heard & Mori (2021) reported that COVID-19 pandemic had encouraged consumers to wash their hands more frequent and thoroughly before preparing or cooking the food compared before the pandemic.

Table 2. Food safety knowledge among home-based food consumers in Kubang Pasu District.

Statement	Correct (%)	Wrong (%)
1. Taking care of personal hygiene is vital to ensure safe food preparation.	96.7	3.3
2. Home-based food sellers need to register under FoSIM (Food Safety Information of Malaysia)	73.3	26.7
3. Wearing a watch during food preparation can cause food contamination.	57.3	42.7
4. Washing hands using warm water and soap before handling food reduces the risk of food contamination.	89.3	10.7
5. The use of mouth cover can reduce the risk of food contamination	92.0	8.0
6. Cooked food cannot be kept more than 4 hours at room temperature.	4.7	95.3
7. Foods "temperature danger zone" are between 5°C to 63°C.	39.3	60.7
8. The safe temperature of cooked food should be above than 63°C or below than 5°C.	40.7	59.3
9. Improper holding temperature of food is the leading factor of foodborne illness.	70.7	29.3
10. Freezer storage practices prevent the growth of harmful Bacteria.	83.3	16.7
11. Leftover cooked food can be kept in a refrigerator for more than 4 days.	40.7	59.3
12. Cooked food can be reheated many times.	48.7	51.3
13. Reheating food is more likely to contribute to food poisoning.	50.0	50.0
14. Preparation of the food in advance is more likely to contribute to food poisoning.	57.3	42.7
15. It is critical that the sources of the food are checked to ensure	92.7	7.3

that it is safe.

16. First-in first-out" (FIFO) method ensures the earlier ordered foods are used first.	72.0	28.0
17. The same towel can be used to wipe equipment, hand and table.	84.7	15.3
18. Food can be prepared on the floor if there is not enough working table.	75.3	24.7
19. Typhoid injection can prevent food handlers from typhoid infection.	70.7	29.3
20. Cross-contamination occurs when raw foods are stored together with ready-to-eat foods.	75.3	24.7
21. Cross contamination is one of the factors that contributed to food poisoning.	80.0	20.0
Total	^a 49.5±14.7	

^aTotal (Mean ± standard deviation) score of the participants.

There were same percentages (50%) of correct and wrong for statement regarding reheating food is more likely to contribute to food poisoning. A study by Abdullah & Ismail (2021) reported that food poisoning outbreaks in this study were caused by inadequate cooking and reheating (57.1%). There was a similar finding from MOH report, where 50% of food poisoning outbreaks were caused by improper handling of food procedures, such as prolonged handling and inadequate cooking and reheating (MOH, 2007). Besides that, there were (95.3%) of the participants gave incorrect responses regarding cooked food cannot be kept more than 4 hours at room temperature whereas more than (59.3%) of them gave incorrect responses related to leftover cooked food can be kept in refrigerator for more than 4 days. A study from Odeyemi et al. (2019), reported that many consumers were not aware of the likelihood of the food getting spoiled if left at room temperature for long. Moreover, similar findings by Webb & Morancie (2015) and Faour-Klingbeil et al. (2015) where majority of their participants had limited knowledge related to food temperature requirements.

According to CDC, the food cannot be left out at room temperature for more than 2 hours. Besides that, Hassan et al. (2014) reported that increase the surface temperature in Malaysia between the ranges of 2.7 °C–4.0 °C per century in past 400 years give effect to food poisoning outbreak. Furthermore, the hot and humid climate of our country can promote the growth of food-borne pathogen which can spread faster in the unsanitary environments especially in kitchen which usually the temperature was higher than at the dining room (Abdul-Mutalib et al., 2015). Therefore, the consumers are urged to adopt and adapt the WHO "The Five Keys to Safer Food Program" as outlined by the organization (WHO, 2022).

3.3 Food Safety Attitudes

The attitudes of home-based food consumers in Kubang Pasu district towards food safety is summarized in Table 3. Overall, participants in this study have moderate food safety attitudes (56.6 ±15.3). In this study, 86.6% of participants strongly felt that food should not be touched with a wounded hand. A similarly study by Sani & Siow (2014) reported that 82.8% of participants were aware about the danger of handling food with wounded hands but Faour-Klingbeil et al. (2015) reported that 43% of their participants were disagreed with this statement because they believe that food-borne pathogens cannot be transmitted through wounds if wounds were properly covered with the waterproof bandages.

88% of the participants agreed that hands should be washed by using water and soap before food preparation while 85.3% of participants agreed that working with dirty hands should be avoided but 14.7% of participants disagree with that statement. The previous study by Abdul-Mutalib et al. (2012), Al-Shabib et al. (2017), and Izyan et al. (2019) reported almost all participants agreed that hand washing is compulsory before food handling. According to CDC, handwashing is very important during food preparation because the germs can spread easily such as before, during, and after preparation of any food.

Table 3. Food safety attitudes among home-based food consumers in Kubang Pasu District.

Statement	Disagree (%)	Agree (%)
1. Food should not be touched with a wounded hand.	13.3	86.6
2. Defrosted food should not be refrozen.	35.3	64.7
3. Separate kitchen utensils must be used to prepare raw and cooked food.	16.7	83.3
4. Raw food and cooked food need to be kept separately.	14.0	86.0
5. The same towel can be used to clean different places.	84.7	15.3
6. Jewellery such as ring can be worn while handling food.	81.3	18.6
7. We should not rub our hand on the face while handling food.	26.0	74.0
8. The apron can be used as a towel to clean hand.	86.7	13.3
9. We must cover our mouth and nose when sneezing.	13.3	86.7
10. Working with dirty hand should be avoided.	14.7	85.3
11. Hands should be washed by using water and soap before preparing food.	12.0	88.0
Total	^a 56.6 ±15.3	

^aTotal (Mean ± standard deviation) score of the participants.

3.4 Food safety practices

Table 4 summarized the findings on food safety practices among home-based food consumers in Kubang Pasu District. Overall, participants in this study have moderate practices on food safety (61.3 ± 18.4). Most of participants in this study were found sometimes touch unwrapped food with bare hands (60%) and a similar study by Mama & Alemu (2016) found more than half of the respondent likely to touch food with bare hands and this practice had statistically significant association with the pathogen's infection. Moreover, study by Lieong, et al. (2017) found that 54.1% of consumer in Kuala Lumpur are still choose the food seller that touch the food with bare hand. Besides that, more than half of the participants (74.7%) sometimes refreeze defrosted food.

A similar study from Abdul-Mutalib et al. (2012) reported that about 83% of the participants are do not know about refreezing defrosted food while a study by Al-Shabib et al. (2016) found that 85% of the participants were aware about the defrosted foods should only refrozen once. The repeated thawing and refreezing of the food can pose a danger due to the increased number of microorganisms in the food. The previous studies by Buccheri et al. (2007) and Tokuc et al. (2009) also found similar results regarding the thawing and refreezing of the food. There was a similar result between never and sometimes use the same towel to clean different places (46.7%). According to Al-Shabib et al. (2016), about 50% of the participants always used that same towel to clean many places. This study was contrast with reported by Sani & Siow (2014) where more than 97.4% of the participants would use different clean clothes to wipe dining tables and food utensils but the finding by Abdul-Mutalib et al. (2012) found more than 40% of the participants' use the same towel to clean many places.

Most of participants showed good food safety practices by always keeping the raw food and cooked food separately (64.7%), clean the work area before start working (62%) and wash hands by using water and soap before start work (63.3%). Many previous studies reported that it is very important to practice self-hygiene especially hand hygiene because hand is the major agent that transmit microorganisms and intestinal parasites to foods (Aarnisalo et al., 2006). However, some respondent practice showed can cause directly or indirectly food poisoning or cross-contamination such as touch the food with bare hands, refreeze defrosted of food and wear jewerelly when handling the food.

Table 4. Food safety practices among home-based food consumers in Kubang Pasu District

Statement	Never (%)	Sometimes (%)	Always (%)
1. I touch unwrapped food with a bare hand.	35.3	60.0	4.7
2. I refreeze defrosted foods.	18.7	74.7	6.7
3. I use separate kitchen	10.6	34.6	54.7

utensils to prepare raw and cooked food.			
4. I keep raw food and cooked food separately.	8.6	26.7	64.7
5. I use the same towel to clean different places.	46.7	46.7	6.6
6. I wear jewellery while handling food.	50.0	42.7	7.3
7. I rub my hand on my face while handling food.	58.0	37.5	4.0
8. I clean the work area before start working.	7.3	30.7	62.0
9. I use my apron as a towel to clean my hand.	56.0	40.0	4.0
10. I chew gum while cooking.	86.0	12.0	2.0
11. I wash my hands by using water and soap before start work.	9.3	27.3	63.3
12. I use a tissue to cover my nose and mouth when I am sneezing.	10.0	32.0	58.0
Total	^a 61.3 ±18.4		

^aTotal (Mean ± standard deviation) score of the participants.

3.5 Relationship between demographic factors and food safety KAP levels among home-based food consumers in Kubang Pasu District

Table 5 summarized the relationship between demographic features with the level of food safety knowledge, attitudes and practices (KAP) among home-based food consumers in Kubang Pasu District. The results found that the gender and monthly income had statistically significant with the food safety knowledge ($p < 0.05$). A study by Tuglo et al. (2021) also reported that there were statistically significant between food safety knowledge with monthly income while a study by Stratev et al. (2017) found that the result showed there were no significant between gender and food safety knowledge. Moreover, the studies by Abdul-Mutalib et al. (2012), Ncube et al. (2020) and Ahmed et al. (2021) also did not find any significant between the participants' food safety knowledge and demographic factors such as age and gender.

Besides that, there was no significance found between the food safety attitude and the demographic factors. This finding is consistent with study by Ncube et al. (2020). However, a recent study by Ahmed, Akbar and Sadiq (2021) reported that current job was statistically significant with food safety attitude. There were statistically significant found between gender and employment status with food safety practices ($p < 0.05$). However, a previous study by Abdul-Mutalib et al. (2012) found that there was no

significant relationship between food safety practices and gender. Meanwhile, the same study by Ahmed et al. (2021) found that age, gender and current job were significantly with food safety practices.

Table 5. Relationship between demographic factors and food safety KAP levels

Variable	Knowledge		Attitude		Practices	
	χ^2	P-value	χ^2	P-value	χ^2	P-value
Gender	4.770	0.029*	3.646	0.056	8.254	0.004*
Age	9.689	0.046	4.743	0.316	7.254	0.123
Current employment status	8.122	0.087	4.191	0.381	10.934	0.027*
Monthly income	18.817	0.004*	5.928	0.431	6.663	0.353

* p-value is significant at <0.05

4. CONCLUSION

This study concludes that the level of food safety knowledge, attitude and practices (KAP) of home-based food consumers in Kubang Pasu district were satisfactory. However, some of the food safety knowledge need to be emphasis such as time- temperature control and cross-contamination. The relationship of demographic features with scores of food safety knowledge, attitudes and practices (KAP) showed that there were statistically significant between knowledge scores and practices scores with demographic features while no significant found for food safety attitudes. The food safety knowledge scores found that the gender and monthly income had statistically significant while for food safety practices had statistically significant with gender and current employment status.

The continuous education of food safety is important to increase awareness among home-based food consumers for prevent possible cross-contamination which can cause foodborne disease. Early education about food safety such as at school and kindergarten is crucial for them to have better understanding regarding food safety and also children is one of the categories of high risk with food poisoning. Education about food safety must not only focus on theoretical aspects of knowledge but also the positive attitudes towards food safety and promote good food safety practices. The foodborne disease outbreak which related to home-based vendors can be reduced when each and every one of us especially the consumers has enough awareness regarding food safety.

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RESEARCH ARTICLE

Prediction of Indoor Air Ventilation Performance in Kindergarten using Nonlinear Autoregressive Neural Network

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Abstract:

Introduction: Indoor air pollution has become one of the major issues that cause health issues for building occupants, especially people from sensitive groups such as the elderly and younger children. However, indoor air pollutants can be reduced by providing adequate ventilation to the building. Effective and adequate ventilation can help to dilute and remove pollutants, providing healthier air for the building occupants to breathe. The adequacy of ventilation can be determined by measuring the concentration of carbon dioxide (CO₂) in the building, as CO₂ is widely used as an indicator for ventilation. **Method:** To determine the ventilation performance, a method of forecasting through a modelling process using a nonlinear autoregressive neural network (NARNN) is developed. The CO₂ concentration data that was collected from kindergarten is used to construct and find the best-fitted model with a suitable number of neurons and hidden layers. This model can help predict the future concentration trend of CO₂ in kindergarten and determine the ventilation performance of the building. **Result:** The concentration of CO₂ in the building is decreasing through the operation hours, indicating it has adequate ventilation. The dataset of CO₂ concentration is used to develop a prediction model that consists of an artificial neural network (ANN) structure. A model with a 1-9-1 structure with a data division of 80:20 is the best-fit model for forecasting as it has high accuracy and is highly relevant to be used for prediction as it has the nearest R-value near one. **Conclusion:** Indoor air quality needs special attention from multiple authorities and organisations, especially in buildings that have younger children as occupants. Poor indoor air quality can pose a health risk to the occupants and disrupt their comfort while doing their activities in the building. The modelling technique is one of the most relevant and advanced methods to forecast the quality of a building, as it can help determine the future concentration of pollutants in the indoor environment.

Keywords: Indoor Air Quality, Modelling, Ventilation

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1. INTRODUCTION

Air pollution is defined as the release of pollutants into the air that are detrimental to human health, and the World Health Organisation (WHO) stated that nine out of ten people currently breathe air that exceeds the WHO's guidelines for pollutants, especially people from low- and middle-income countries (Jillian et al., 2021). Indoor air pollution contributes greatly to human wellbeing, as most people tend to spend around 90% of their time indoors, mainly at home or in the workplace (Tran et al., 2020). Indoor Air Quality (IAQ) is the air quality within and around any building or structure, especially as it relates to the health

and comfort of building occupants. Controlling the common pollutants indoors can help reduce the risk of indoor health concerns (USEPA, 2014). Indoor air pollution is a condition where the presence of chemical, biological, and physical contamination in the air of an indoor environment results in adverse health effects (OECD Statistics Directorate, 2022). With the increasing incidence of respiratory illness, health experts warn about the indoor air pollution hazard, as several studies show that indoor air pollution levels are much higher than those in an urban outdoor environment (Bureau, 2017). Generally, indoor air pollution is generated from various sources, including tobacco smoke, building materials, fixtures, cleaning and hygiene products, air fresheners, computers, printers, cooking, and other indoor activities, and

humans themselves are one of the sources of pollutants (Abu Mansor et al., 2020). Poor indoor air quality can lead to multiple diseases and health problems such as chest pain, asthma, fatigue, throat irritation, headache, loss of coordination and decreased lung function (Tran et al., 2020). Indoor air pollution is a leading risk of people die prematurely and 4.1% of global deaths are attributed by indoor air pollution (Ritchie & Roser, 2013).

To provide a good quality of air in the environment, ventilation is the most important way to maintain and improve indoor air quality. According to DOSH (2010), as stated in the Industry Code of Practice on Indoor Air Quality (ICOP IAQ) 2010, ventilation means the process of supplying air or removing air from space for the purpose of controlling air contaminant levels, humidity, or temperature within the space. In a poorly ventilated classroom, students are likely to be less attentive and to concentrate less well on instruction given by the teachers, and the magnitude of the negative effect of inadequate ventilation was even higher for tasks that require more complex skills such as spatial working memory and verbal ability to recognise words and non-words (Bakó-Biró et al., 2012).

Carbon dioxide (CO₂) is one of the gases that are present in indoor environments, and the presence of a high concentration of CO₂ indicates that the indoor environment is not properly ventilated. According to DOSH (2010) in ICOP IAQ 2010, the acceptable limits of CO₂ for indoor environments are 1000 ppm, where the value is the ceiling limit that shall not be exceeded at any time, and the readings above the value are indications of inadequate ventilation. The use of CO₂ for steering the ventilation system, as there are no pollutants, is more dominant than CO₂ for the indoor environment (De Gids, 2010). A study conducted by Ramalho et al. in 2015 found that CO₂ concentration has correlation coefficients with CO₂, and both formaldehyde and benzene were found in rural nurseries and schools. It is also found that CO₂ is often considered a surrogate of ventilation rate. The study also found that even with good ventilation, the reduction of pollution remained necessary to achieve satisfactory indoor air. This study also found that measurement of CO₂ (for mitigation purposes) is still recommended as an indicator for air stiffness.

The concentration trend of CO₂ in the indoor environment can be determine through the modelling process. Air pollution modelling is the term used to describe using mathematical theory to understand or predict the way pollutant behave in the environment or atmosphere. Modelling is the activity of using mathematical models while

using simple description of a system process to make calculations or predict what might happen (Cambridge Dictionary, 2022). Previous research on modelling the CO₂ concentration perfectly predicted the CO₂ concentration in most parts with three different approaches, which are open-loop, closed-loop, and multi-step prediction, and this study is able to be used in demand-controlled ventilation systems (Khazaei et al., 2018). Alavi et al. (2022) in their study developed and compared an algorithm that can predict in real-time whether or not the CO₂ level in an office will exceed the threshold solely on the basis of the previous measurement of CO₂ in the same office. Artificial neural networks (ANN) are computer systems developed to imitate learning, which is one of the most basic features of the human brain, and to automatically perform abilities such as deriving, creating, and discovering new information without any assistance (Kurnaz & Demir, 2022). Network learning takes place as the weights are adjusted along the layers according to the relationship between the inputs and the desired outputs. One of the most basic models is the multilayer perceptron (MLP) network, which is widely used in the approximation of nonlinear functions that describe complex relationships between independent and dependent variables in many applications (Benrhmach et al., 2020).

There are two models that can be used to determine the concentration of CO: linear regression (Zhou et al., 2021) and non-linear regression (Ben Cheikh et al., 2021). Linear regression is the relationship between two variables (X and Y) in a straight line ($y = mx + b$), while non-linear regression relates two variables in a non-linear (curved) relationship (Will Kenton, 2021). A non-linear autoregressive neural network (NARNN) consists of an input layer, an output layer, and hidden layers in between. It has been observed that only one hidden layer is enough for most applications, provided it has an adequate number of neurons (Ahmed & Khalid, 2017). The nonlinear autoregressive neural network (NAR), as shown in Figure 2.1, can be trained to predict a time series from that series past values $Y(t-1), Y(t-2), \dots, Y(t-d)$, called feedback delays, where d is the time delay parameter. The network is created and trained in an open loop, using the real target values as a response and making sure that the quality is very close to the true number in training. After training, the network is converted into a closed loop, and the predicted values are used to supply new response inputs to the network. (Benrhmach et al., 2020). Figure 1 below shows the architecture of a non-linear autoregressive neural network (NARNN), and Figure 2 shows the multiple layers in the neural network.

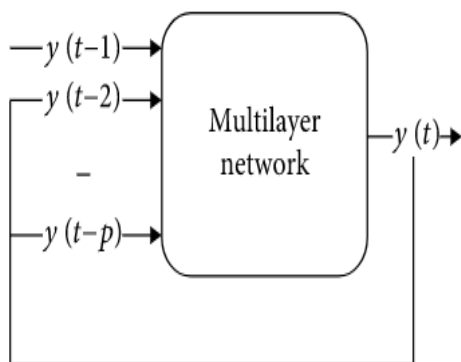


Figure 1: Architecture of non-linear autoregressive neural network (NARNN)

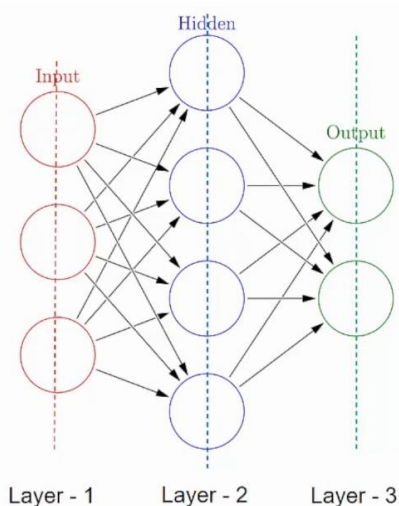


Figure 2: Multiple layers in the neural network

The ANN models gave better results than other models, especially for the ANN models that were built with non-constant variance (Feng et al., 2015). Gardner and Dorling (1998) gave an informative review of the applications of ANN in the atmospheric sciences. They pointed out the advantages of ANN when handling non-linear systems, especially when theoretical models are difficult to construct. There are disadvantages related to linear regression in air pollution modelling. Syaifei et al. (2015) stated that a linear equation is not enough to capture the true air quality because of its high complexity, and it is also related to the high fluctuation of the concentration due to the short time interval.

From the model, forecasting process can be done to determine the trend of CO₂. Forecast is projection, prediction or estimate some future activity, event and occurrence.

2. MATERIALS AND METHODS

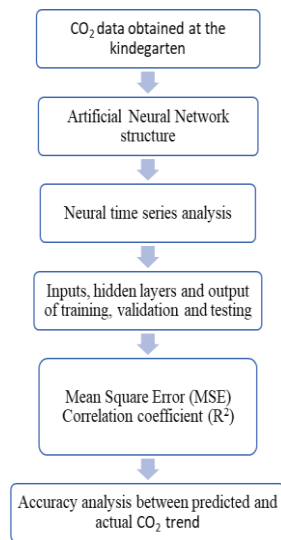
This study is carried out at Tadika Cahaya Elit located in Kampung Duyung, Kuala Terengganu, Terengganu, Malaysia (Plate 1). The sampling process was carried out for three days with a four hours period for each day starting from 0800 hours to 1200 hours in accordance with the operational time for the kindergarten. According to Department of Safety and Health (DOSH, 2010), carbon dioxide monitoring should be measure by real time monitoring to can be used to provide information on the variation of contaminants level throughout the day.

A sampling point is chosen based on the layout of the kindergarten and 4 hours of reading will be carried out at each sampling point. The location of the sampling point is selected and being determined based on guideline from ICOP-IAQ (2010). The air sampling instrument is suggested to be placed 1.1 meter from the floor, have minimal disturbance from the work activities in the area, at least 0.5 meters from the wall, indirectly in front of air supply diffuser, floor fans or heaters and preferably not on passageways. Since the building occupants are children, the sampling points is determine based on several factors including to avoid disturbance on the instruments by the children during the sampling periods. For this study, Q-Trak Multifunction Indoor Air Quality Monitoring Model 7575 is used to collect the reading of CO₂ at kindergarten. Q-Trak Multifunction Indoor Air Quality Monitoring Model 7575 has a high accuracy in measuring CO₂, temperature, carbon monoxide, and relative humidity. ICOP-IAQ (2010) stated that a valid sampling program must have equipment that have appropriate detection limit and it cover the assessment objective.



Plate 1: Location of Taska Permata Keluarga

This study was designed to predict the ventilation performance at the kindergarten by using Nonlinear Autoregressive Neural Network (NARNN). This study is carried-out by collecting CO₂ data from a kindergarten through real-time monitoring. Prediction of CO₂ concentration trend in the kindergarten will be carried out following Figure 3 below:

Figure 3: Flowchart of CO₂ trend prediction process

The method for data analysis in computational method. The data collected from sampling process undergo modelling process by using Nonlinear Autoregression Neural Network (NARNN). The data of the real time sampling can be used to validate the predicted data. This artificial neural network (ANN) is a neural model that is mainly based on the perceived work of human intelligence or known as model of the brain and it is particularly beneficial for forecasting the future using historical data (Shahabi et al., 2012). The analysis model will be simulated by using MATLAB version R2017b. ANNs are capable for mapping between input and output it consist of the network that is a data-driven mathematical tool and is composed of neurons that are organized in layers which are capable of learning the situation and making up the association process's input and output (Singh & Chakrapani, 2015). A prediction model for CO₂. The set of input and output will assist the constructing a complex non-linear structure for CO₂ modelling. The accuracy of the model can be assessed by its evaluating criteria including min square error (MSE) and correlation coefficient (R²).

In this study, a NARNN model with input of CO₂ data collected from the kindergarten will be developed to predict the trend of CO₂ at the building by filling data with time series regression model. The data set will undergo three process which are training, validation and testing and this model will be operated in the close and open loop. The equation this NARNN model is:

$$y(t) = b_0 + b_1 y(t-1) + b_2 y(t-2) + \dots + b_n y(t-n)$$

From the equation, $y(t)$ is the output at time t and b is the coefficient. Figure 4 shows the structure of NARRN that will be used for this study.

The outcomes from the NARNN can help to predict the trend of CO₂. The result from the outcome sis analysed using descriptive analysis. The number of hidden layers is adjusted to determine the best ANN time series model. From the outcome computed through this whole process, the CO₂ trend can be determined and can help to predict the indoor air ventilation performance of the buildings.

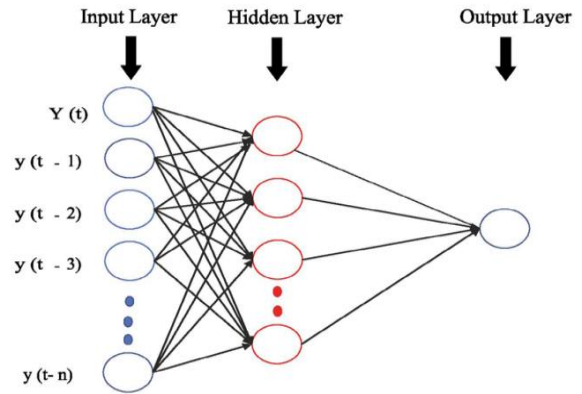


Figure 4: The NARNN Structure

3. RESULTS AND DISCUSSION

3.1. Trend of CO₂ in Kindergarten

The data obtained was analysed using a Microsoft Excel spreadsheet. Descriptive statistical analysis in terms of graphs was plotted to determine the trend of CO₂ concentration at the kindergarten. A box plot was constructed to represent the trend of CO₂ concentration at the kindergarten.

The averaging data show a decreasing trend of CO₂ through the operation hours, as shown in Figure 5. From 9.00 a.m., the CO₂ concentrations slightly decreased as the mean value of CO₂ concentration at 9.00 a.m., 347 ppm, increased to 534.19 ppm at 10.00 a.m. Then, the mean value of CO₂ concentration continues to decrease to 487.42 ppm at 11 a.m. and 463.11 ppm at 12 p.m. This indicates that the trend of CO₂ is decreasing through the kindergarten operation hours.

The high mean value of CO₂ concentration, which is 537 ppm at 9.00 a.m. and 534.19 at 10.00 a.m., is due to intensive learning sessions such as singing and spelling lessons that involve all of the students that are available at the kindergarten. These types of activities surely increase the respiration rates of the children, which contribute to the production of CO₂, and children are known to have a higher respiratory rate compared to adults. A study found that CO₂

that is stored in younger children is smaller than that stored in teenagers, as children have lower levels of haemoglobin than adults (Cooper et al., 1987). Young children also have a significantly higher metabolic rate than adults and therefore have a higher oxygen demand, which in turn results in higher respiratory rates (The Royal Children's Hospital Melbourne, 2016). During exercise or activity, the body uses more oxygen to provide energy and produces more CO₂ as the waste product created when producing energy during physical activities (Breath, 2016).

After 10 a.m. until 12 p.m., the concentration of CO₂ decreases to a mean value of 463.11 ppm. The decreasing trend of CO₂ indicates that the kindergarten building has a proper ventilation system to dilute excess CO₂ produced in the previous hour, while CO₂ also represents an indicator for ventilation. This means that the facility has enough ventilation to circulate and dilute the pollutants that are present in the indoor environment. Ventilation is intended to dilute and remove pollutants to acceptable levels for the health and comfort of building occupants, and it must be sufficient to maintain the building's integrity (Olli Seppänen & Jarek Kurnitski, 2023). Ventilation is important since it provides oxygen for metabolism and helps to dilute metabolic pollutants such as CO₂, removing and diluting other pollutants that emit within the space, and it is a major contributor to the health and comfort of building occupants (Maria Kapsalaki, 2013). Good ventilation system not only provide thermal comfort but also distribute adequate fresh air for the building occupants and remove the pollutants (Clements-Croome et al., 2008). It indicates that this premise is well-ventilated as the CO₂ concentration decrease through the time and it is important to keep removing the pollutants continuously from the indoor environment. Even the concentration of hazardous pollutants is below permissible limit, it also can contribute to health and satisfaction of children and as well as their performance of schoolwork and learning (Cabovská et al., 2022).

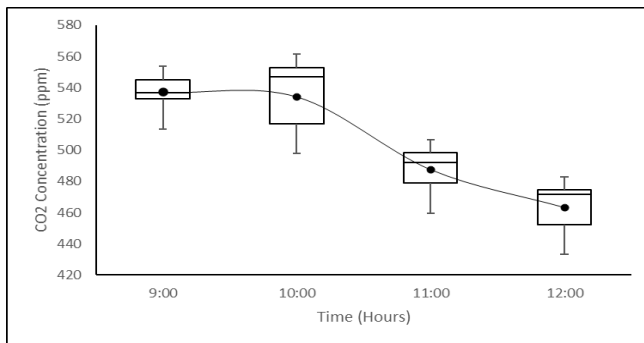


Figure 5: Box and Whiskers Graph of CO₂ Trend at the Kindergarten from 8.00 am until 12.00 pm.

Besides, ventilation can help reduce the probability of children getting infected by airborne diseases such as

COVID-19, influenza, and measles. According to the CDC (2020), good ventilation is a step that can reduce the number of virus particles in the air and reduce the likelihood of spreading diseases. Exposure of children to pollutants can pose a threat to their health as they are more vulnerable compared to adults. Children are sensitive to environmental pollutants due to the immaturity of their immune systems (Cabovská et al., 2022). Children are vulnerable to the effects of air pollution since they breathe more rapidly due to the limited space for the exchange of oxygen (O₂) and CO₂ in their lungs, and their respiratory system is still developing through their ages.

Through the descriptive analysis, the average maximum value of CO₂ concentration is 586 ppm and the mean value of average CO₂ concentration is 503.896 ppm, which indicates that the CO₂ concentration at the kindergarten is about half of the ceiling limit, which is 1000 ppm, as stated in the Industry Code of Practice on Indoor Air Quality (ICOP IAQ) 2010 by the Department of Safety and Health (DOSH). The concentration of CO₂ is still at the acceptable limit since the kindergarten is occupied with natural ventilation such as windows and mechanical ventilation such as fans. The descriptive statistical analysis of CO₂ concentration in kindergarten is shown in Table 1.

Descriptive Statistical	CO ₂ Concentration (ppm)
Mean	503.896
Median	506
Standard Deviation	39.514
Variance	1561.329
Kurtosis	0.050
Skewness	-0.362
Minimum	398
Maximum	586

Table 1: Descriptive Data of CO₂ Concentration at the Kindergarten

3.2. NAR Models Development for CO₂ Prediction

Prediction model used in this study is a non-linear autoregressive (NAR) model using MATLAB version R2017b which constructed with an input of CO₂ concentration at the kindergarten via a time series model. The NAR model has been tested using CO₂ concentration data that are collected from 0800 hours to 1200 hours for 3 days of sampling and the model is operated in closed loop and open loop. Overall, there were 144 data (n=144) used for the training, validation, and testing process. The proportion of data were divided as in Table 2 for each section.

Data Division	Training	Validation	Testing
60:40	60% involving 86 target timesteps	20% involving 29 target timesteps	20% involving 29 target timesteps
70:30	70% involving 100 target timesteps	15% involving 22 target timesteps	15% involving 22 target timesteps
80:20	80% involving 116 target timesteps	10% involving 14 target timesteps	10% involving 14 target timesteps
90:10	90% involving 130 target timesteps	5% involving 7 target timesteps	5% involving 7 target timesteps

Table 2: Data Division for Training, Validation and Testing

The NAR models used the training algorithm of Levenberg-Marquardt (LM), a type of training algorithm that automatically stop when the generalization stops improving as, indicated by an increase in the mean square error of the validation samples. The best ANN model structure for each CO₂ concentration data were selected by the correlation coefficient (R^2) and the value close to one indicate a close relationship and the suitability of the model for forecasting CO₂ trend at the kindergarten. The best model also has low mean square error (MSE) value which indicates the model has low statistical error when assessing the average squared difference between the observed and predicted data.

The development of the NAR model was based on the error and trial method, where the number of neurons was added one after another, as in previous studies that adapted the NAR model (Pawlus et al. 2013). The best network structure was accomplished by the neuron testing process from 1 to 15 and trained with three layers: an input layer, an output layer, and a hidden layer. A model with different data divisions was tested with this method, and the ANN structure was 'learned' from the past target data and underwent testing (Atikah et al., 2022). Each of the data divisions was tested 15 times by modifying the number of hidden layers (1 until 15) for each testing process, and the best dataset for each data division was selected. There are four ANN structures of the model selected for each data division, labelled Model 1, Model 2, Model 3, and Model 4, as shown in Table 3.

validation, and another 20% represent the 29 datasets for testing. Through the error and trial method for Model 1, the selected ANN structure model is 1-4-1, which consists of 4 neurons with the highest R^2 , which is 0.88999. The regression graph for Model 1 is shown in Figure 7.

Model 2 has 70:30 of data division where 70% represent the 100 datasets for training, 15% represent the 22 datasets for validation, and another 15% represent the 22 datasets for testing. Through the error and trial method for Model 2, the selected ANN structure model is 1-3-1, which consists of 3 neurons with the highest R^2 , which is 0.87817. The regression graph for Model 2 is shown in Figure 8.

Model 3 has 80:20 data division, where 80% represent the 116 datasets for training, 10% represent the 14 datasets for validation, and another 10% represent the 14 datasets for testing. Through the error and trial method for Model 3, the selected ANN structure model is 1-9-1, which consists of 3 neurons with the highest R^2 , which is 0.93427. The regression graph for Model 3 is shown in Figure 9.

Model 4 has a 90:10 data division, where 90% represent the 130 datasets for training, 5% represent the 7 datasets for validation, and another 5% represent the 7 datasets for testing. Through the error and trial method for Model 4, the selected ANN structure model is 1-7-1, which consists of 7 neurons with the highest R^2 , which is 0.92946. The regression graph for Model 4 is shown in Figure 10.

Among the selected ANN structures for each model, Model 3 with 1-9-1 and a data division of 80:20 is the best fitted model for forecasting as it has high accuracy and is highly relevant to be used for prediction as it has the nearest R-value near one, which is 0.93427, and the lowest value of mean square error (MSE), which is 609.17. The NAR model is a great one as it can capture and process non-linear and complex data, and it has been widely applied in various fields of study such as medicine, environment, and engineering. This model also has the capability of learning and determining the trend of CO₂ concentration as it has the capability to capture non-linear dynamics and high accuracy for the specific study location (Atikah et al., 2022). The trial-

Model	Optimum Neuron	Data Division	ANN Architecture	Predicted Equation	R-values			MSE Value
					Training	Validation	Testing	
1	4	60:40	1-4-1	$y = 0.75(x) + 1.3E2$	0.80529	0.72971	0.88999	1252.65
2	3	70:30	1-3-1	$y = 0.63(x) + 1.8E2$	0.82952	0.67013	0.87817	1299.05
3	9	80:20	1-9-1	$y = 0.71(x) + 1.4E2$	0.83068	0.79494	0.93427	609.17
4	7	90:10	1-7-1	$y = 0.76(x) + 1.1E2$	0.82312	0.80348	0.92946	631.79

Table 3: Data separation for prediction model of carbon dioxide using nonlinear autoregressive neural network (NARNN)

Model 1 has 60:40 data division, where 60% represent the 86 datasets for training, 20% represent the 29 datasets for

and-error method is implemented to achieve the optimal network structure for the developed model (Khan & Gupta,

2020). The trial-and-error method also help to the identification of the best structure and neuron number is in hidden layer that have the best fitness value for the best ANN model (Saemi et al., 2007). Implementation of LM algorithm is crucial which can reduce any bias during training, testing and validation during prediction process in the model (Alsumaiei & Alrashidi, 2020).

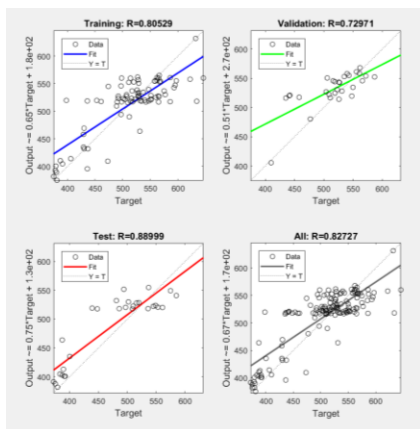


Figure 7: Regression Graph Model 1

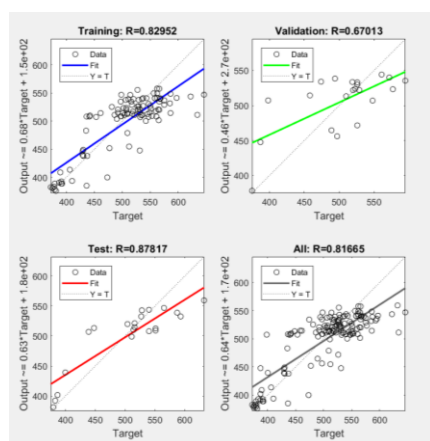


Figure 8: Regression Graph Model 2

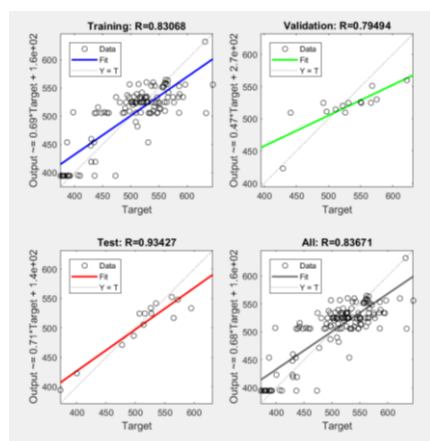


Figure 9: Regression Graph Model 3

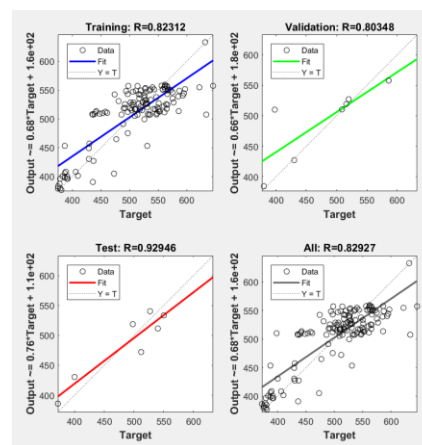


Figure 10: Regression Graph Model 4

Furthermore, the prediction model made by using the nonlinear autoregressive (NAR) model can help the authorities or researchers determine the ventilation performance for the indoor environment by measuring CO₂ concentration, as indoor air quality is necessary to the health and welfare of the building occupants. This is because the NAR model and time series have high accuracy for the R-value, are flexible, and yield good results from the datasets (Ali & Ahmad, 2019). The modelling approach can help to provide information as to realistic daily and longer-term exposure, and thereby it can feed into debates surrounding new indoor air quality legislation (Challoner et al., 2015).

The modelling process can be done before the operation or development of kindergarten premises, as it can help predict the condition of indoor air. It should also be regulated, as it is important to the health and welfare of building occupants. This is because modelling is critical for determining relative contributions from different sources, monitoring compliance with air quality regulations, and making policy decisions (USEPA, 2020). A “performance-based” approach where the achieved indoor air quality (IAQ) is checked at the design stage of the building is still lacking in regulation and standards and needs to be developed for building ventilation (Poirier et al., 2021). Thus, this ANN time series model is applicable for the long-term prediction of the ventilation performance of kindergartens by using the CO₂ concentration in the building. The modelling process surely can help to ensure that building occupants, especially children and people who are sensitive to pollutants that are present in the indoor environment, have a healthy and comfortable indoor environment, as modelling can predict the future condition of air in the indoor environment. A continuum model found that insufficient ventilation leads to the worsening of not only long-range airborne transmission but also short-range airborne transmission (Li et al., 2021). Furthermore, good IAQ can help create a favourable environment for the students and children, improve the

performance of teachers and staff, and foster a sense of comfort and well-being, which can assist the school in its core mission (USEPA, 2015). The statement indicates that healthy indoor air can boost and improve the learning process of children and teachers when they are not affected by the pollutants in the indoor environment.

4. CONCLUSION

In conclusion, maintaining the quality of indoor air in the building is an important aspect that is needed to be taken care of, especially in buildings that occupy people from sensitive groups, such as children. Ventilation has been the best approach to maintaining the quality of the indoor air, whether the building is occupied with mechanical or natural ventilation. If the circulation of inside and outside air still occurs, it can help to refresh the indoor air, dilute the presence of pollutants in the indoor environment, and prevent the occupants from facing building-related illness (BRI). Through this study, CO₂ datasets taken from the kindergarten can help develop a prediction model that can be used to predict the trend of CO₂ in the kindergarten. Thus, it can help to determine the ventilation performance of the building, as CO₂ is a reliable indicator to measure the ventilation performance of a building.

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RESEARCH ARTICLE

Empowering recovery: A case study on conservative management of scapular dyskinesia

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Abstract:

Scapular dyskinesia, often overlooked in athletes, significantly affects shoulder function and performance. This case study focused on a 23-year-old male badminton player who experienced moderate shoulder pain and limited range of motion after a traumatic injury during a game. The objective was to alleviate pain and improve scapular function through physical therapy approaches. Scapular joint mobilization and strengthening exercises were administered, resulting in reduced pain and increased shoulder joint range of motion. The study demonstrated that conservative management of the scapular joint and muscles had a beneficial effect on athletes with shoulder pain. Addressing scapular issues is crucial to enhance overall shoulder function and support athletes' performance. This research highlights the importance of recognizing scapular dyskinesia as a significant contributor to shoulder pain and advocates for holistic management strategies to aid athletes in their recovery.

Keywords: Joint mobilization; Motor control training; Shoulder pain; Scapular dyskinesia

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1. INTRODUCTION

The improper movement of the scapular during shoulder movement is often forgotten cause of pain and dysfunction among athletes. It is frequent among athletes who engage with repetitive in overhead movement, with a prevalence of 61% (Burn et al., 2016). Dyskinesia is a comprehensive term that refers to the inability of the scapular physiology, mechanics and motion to function normally (Benjamin Kibler et al., 2012). It can be caused by a variety of circumstances, for example, thoracic kyphosis, clavicular fracture non-union, high-grade AC instability, glenohumeral joint internal derangement and cervical radiculopathy (Benjamin Kibler et al., 2012; Longo et al., 2020; Panagiotopoulos & Crowther, 2019; Sattasuk et al., 2021). However, the most common causes of scapular dyskinesia are soft tissue changes, including inflexibility or intrinsic muscle pathology (Gorji et al., 2022; Longo et al., 2020).

Alterations in periscapular muscle activation are observed in scapular dyskinesia patients (Benjamin Kibler et al., 2012; Longo et al., 2020; Panagiotopoulos & Crowther, 2019). Inflexibility and stiffness of pectoralis minor and short head of the biceps muscles create a pull on the coracoid which results in anterior tilt and protraction of scapular. Reduced serratus anterior activation and strength contributing to a loss of posterior tilting and upward rotation of scapular (Benjamin Kibler et al., 2012; Longo et al., 2020). Hence, the imbalance of scapular position and motion impacted the degree of

freedom within each plane of shoulder mobility, resulting in shoulder pain (Benjamin Kibler et al., 2012; Panagiotopoulos & Crowther, 2019).

There are a wide range of physiotherapy approaches for patient with shoulder pain, however, the objective of this case study was to provide relief to the patient in terms of pain as well as the range of motion of the shoulder joint, which help in turn enhances the scapular function and overall shoulder function.

2. CASE DESCRIPTION

2.1 Case History

A 23-years-old male badminton player presented himself at Physiotherapy UiTM Clinic, reporting right shoulder pain and right scapular aching following a traumatic injury during playing badminton. During the smash, a loud click sound was heard. The patient immediately stopped playing badminton and applied ice to the shoulder to ease the pain. Since then, the discomfort persisted for 3 months, and he had difficulty using his right hand.

Prior to the onset of shoulder pain, the patient did not have any shoulder pain and actively participated in sports, for example badminton, futsal, and gym. Unfortunately, since experiencing shoulder pain, he was unable to play badminton and had limitation in lifting heavy objects. Patient was a

student from the Faculty of Hotel and Tourism Management, UiTM. He found his shoulder injury caused limitation in lifting heavy object during practical class and he needed to avoid certain movements during the class. However, he had no difficulty in managing his daily activities such as bathing, wearing clothes and other functional activities. His family was aware of his condition and advised him to get treatment as soon as he could.

The patient presented with mild C-shaped scoliosis at lower thoracolumbar level, with right concavity and left convexity. He reported that he only suffered lower back pain when sitting for lengthy periods of time (NRS: 2/10), which he said was tolerable with stretching exercises (NRS: 0/10). He received physiotherapy treatment for scoliosis from late 2018 till early 2019 at Sultanah Bahiyah Hospital. He was not aware he had scoliosis until he received the X-ray report for Universiti Teknologi MARA (UiTM) entry procedure.

2.2 Patient Understanding of their own problem

He acknowledged and understood that the shoulder pain symptoms highly correlated with sport injury and might have contributed to his scoliosis. Since then, he took a break from sport activities and avoided heavy lifting as it might improve the recovery process of his shoulder.

2.3 Patient's expectations and goals

The patient sought therapy to rehabilitate his shoulder injury before starting an internship involving heavy lifting and managerial duties. Proper rehabilitation, targeting specific impairments, and early planning for appropriate exercises were emphasized to ensure a successful recovery and fitness. The goal was to correct muscle stiffness and weakness, allowing him to return to the gym and prepare adequately for his upcoming responsibilities.

2.4 Body chart

During his first visit, he complained of sharp pain at right shoulder joint (referred to as P1) with numeric pain rating scale (NPRS) score as 6 out of 10 when completing any overhead motion and the pain increased during physical activities like badminton, workout, any overhead motion and heavy lifting during practical session of hotel management course with NPRS score of 8 out of 10 and side lying on right shoulder with NPRS score of 7 out of 10. He did not consume any pain killers but only rested or repositioned his shoulder to ease the pain. The pain would reduce immediately to a score of 2 out of 10 upon repositioning, however, it would remain consistent. He also complained of aching pain at right scapular (referred to as P2) upon prolonged sitting (3 hours) with NPRS score of 4 out of 10 and he would lie down to ease the pain, with NPRS dropping to 0 within 10 minutes. Figure 1 provides a detailed overview of the pain assessment findings.

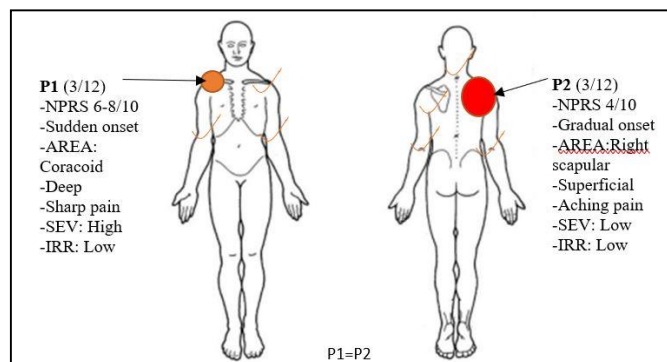


Figure 1: Body Chart

2.5 Objective examination

The patient was presented with a normal gait upon entering the physiotherapy department. However, patient had a faulty posture while sitting. It was observed that patient had a forward neck with a slouched posture. When he was in standing position, it was observed that he had dropped right shoulder, right scapular winging, a C-shaped scoliosis, hyperlordosis at lower thoracolumbar level, and his right hip tilted and rotated to left. Due to the C-shaped scoliosis and hyperlordosis, he prone to lean his body weight to the right side. There was no redness, contusion, or swelling observed on the shoulder joint. Following that, the range of motion of the shoulder joint was accessed using goniometer and the details are recorded in Table 1.

Next, accessory motion was assessed in the glenohumeral (GH) joint, acromioclavicular (AC) joint, and scapulothoracic (ST) joint. The GH and AC joints showed normal mobility without any symptoms. However, the ST joint, particularly its inferior and medial glide on the right scapula, exhibited reduced mobility. Muscle power assessment was performed using manual muscle testing (MMT) on the upper trapezius, middle trapezius, lower trapezius, rhomboid, and serratus anterior. Grade 3/5 was observed on the right side compared to the left side (grade 5/5). Specifically, the upper and middle trapezius showed weakness, accompanied by aching pain in the anterior region of the right shoulder. The lower trapezius weakness caused nagging pain in the scapula area. Additionally, weakness was noted in the rhomboid and bilateral serratus anterior, although no symptoms were reported.

During the palpation assessment, no tenderness was observed in the shoulder muscles, but bilateral upper trapezius muscles showed spasms, and the right pectoralis major and minor muscles were tight. To measure the length of the pectoralis minor, the patient was positioned supine, and measurements were taken from the acromion to the plinth. The right pectoralis minor measured 10.5 cm, while the left side measured 8 cm, indicating greater tightness in the right side.

Table 1. Range of motion of right shoulder

Range of motion (ROM)	Active ROM			Passive ROM	
	Range	OP	Findings	Range	Findings
Flexion (F)*	0 - 175°	0 - 180°	NPRS 4/10 at 175°	0 - 180°	NPRS 4/10 Click at ER
Extension (E)	AFROM	-	-	-	-
Abduction (Ab)*	0 - 130°	0 - 150°	NPRS 5/10 at 130°, NPRS >130°+	0 - 150°	NPRS 6/10
Internal rotation (IR)*	0 - 70°	0 - 90°	NPRS 2/10 at 90°	PFROM	NPRS 2/10
External rotation (ER)	AFROM	-	-	-	-
Combine movement* (F, Ad, ER)	-	-	-	F: NPRS 4/10 + Ad: NPRS 4/10 + ER: -	

- AFROM of left shoulder at all planes.

- OP: Overpressure;

*evaluate the movement after the treatment and following visit

To have a better understanding of the patient's circumstances, shoulder pain and disability index (SPADI) had been used on the first assessment to measure current shoulder pain and disability. The SPADI contained 13 items that assessed two domains: pain (5 questions) and disability (8 questions) (Agostinho et al., 2020; Breckenridge & McAuley, 2011). SPADI establishes good construct validity, and correlates well with other region-specific shoulder questionnaires (Kromer, 2021). In fact, it has high internal consistency with Cronbach α typically exceeding 0.90 (Breckenridge & McAuley, 2011; Hill et al., 2011). The first assessment revealed that the pain score was 15/50 and the disability score was 12/80. These findings indicate that the score is low, and that the prognosis is favorable.

2.6 Treatment

The case underwent a three-week period, after which the treatment commenced based on the assessment result. The treatment details were presented in Table 2.

On the third visit as in Table 3., patient claimed the pain at the shoulder joint during overhead motion and sleeping on the affected side reduced from 8/10 to 4/10, while the aching pain at scapular during prolong sitting reduced from 4/10 to 0/10, however, there was no significant changes in range of motion of shoulder joint. Therefore, the prior strengthening exercises were supplemented with scapular MWM and soft tissue manipulation (STM).

Upon evaluation, MWM and STM help to improve shoulder joint range of motion. Throughout the session,

patient education was provided on good posture, the pathophysiology of the condition, process of healing, and the benefit of exercises. Providing health education for patients is indeed essential in building a good attitude and habits related to exercises. Besides, health education also can identify the barriers to exercises such as time, motivation and types of exercises are suitable for them (Miñana-Signes et al., 2021).

Table 2. Treatment for patient at week 1 & 2

Purposes	Treatment
To reduce pain	ST joint mobilization Grade: II (Maitland's) Direction: Inferior and medial glide Repetition: 60 oscillations, 3 sets Grade: II (Maitland's) Direction: Inferior and medial glide Repetition: 60 oscillations, 3 sets
To improve mobility of scapular on thoracic plane.	ST joint mobilization Grade: III (Maitland's) Direction: Inferior and medial glide Repetition: 60 oscillations, 3 sets
To increase scapular muscular strength	1. Serratus anterior strengthening exercises – against the wall exercises Position: standing F: 3x/day I: 10 times, 3 sets T: - T: Closed kinetic chain strengthening exercises

	2. Rhomboid & middle trapezius exercises – wall push up Position: Standing F: 3x/day I: 10 times, 3 sets T: - T: Closed kinetic chain strengthening exercises
	3. Lower trapezius exercises Position: Sitting F: 3x/day I: 10 sec hold, 10 times, 3 sets T: - T: Resistant band strengthening exercise
Home exercise program	1.Serratus anterior strengthening exercise- - against the wall exercises 2.Rhomboid & middle trapezius exercises – wall push up 3.Lower trapezius exercises

Table 3. Treatment and evaluation for patient at Week 3.

Purposes	Treatment	Evaluation (ROM/ NPRS score)
To improve mobility of scapular on thoracic plane.	ST joint mobilization (Mulligan's) Direction: Inferior and medial glide with shoulder flexion. Repetition: 10 times sustain glide, 3 sets.	Flex: AFROM / ERP 1/10 IR: AFROM / ERP 1/10
To improve pectoralis muscle flexibility.	STM Type: Deep stroking Area: Pectoralis minor Duration: 10 mins	Abd: 0 – 150° / ERP 1/10
To improve patient awareness	Patient Education Educate on a good posture, pathophysiology of the condition, process of healing and beneficial of exercises	Patient understood regarding of his condition and improve in patient's awareness

3. DISCUSSION

From the assessment, the shoulder pain is likely caused by muscle strain due to trauma secondary to right scapular dyskinesis. Even though the incident occurred three months earlier, the pain signals are still firing, which could explain the severity of the pain. Apart from the trauma, the other contributing factor to the shoulder pain is winging of the right scapular, which is known as scapular dyskinesis, indicating a muscle imbalance. In fact, scapular dyskinesis could be the

main culprit for experiencing shoulder pain during any overhead motion. The alteration of scapular affects the efficiency of shoulder function in numerous ways, resulting in alteration in 3D GH angulation, AC joint performance, maximal muscle activation and optimal arm position and motion (Benjamin Kibler et al., 2012; Kibler et al., 2021).

Normally, the ratio of GH to ST motion in active arm elevation to 90° is around 2:1(Kolz et al., 2021). As the limb is elevated, the scapular center of rotation migrates proximally and laterally from the midportion in the first 30° of elevation towards the glenoid base in the next 60°. The coracoid and acromion processes shift superior and posterior at the same time, increasing the distance to humeral impingement (Panagiotopoulos & Crowther, 2019). But, during scapular motion, it was discovered that patient had reduced upward rotation and external rotation during arm elevation. It was correlate with scapular accessory motion finding, which it had reduced mobility in medial and inferior glide.

As a result of faulty scapular position, patient would feel discomfort when executing any overhead motion especially in abduction motion (NRS 5/10 at 130°), as it may increases in anterior capsular tension and shear with increase posterior labral compression (Kibler & Sciascia, 2019a). Besides, because the normal ratio of GH to ST movement in abduction is 5:4 (Jiang et al., 2020; Jildeh et al., 2021), hence, any improper scapular posture produces shoulder abduction motion in pain.

Therefore, joint mobilization for the ST was performed to improve the efficacy of the shoulder joint (Agarwal et al., 2016; Boruah, 2015). Maitland's joint mobilization restores the range of motion by applying a specific, oriented glide manually to a painful joint with a specific force intensity in relation to joint resistance (Lirio Romero et al., 2015; Satpute et al., 2022), while MWM technique is mainly depending on patient response. There is no specific grading system for force and amount of movement in MWM (Wang et al., 2022). MWM is based on the concept that minor position faults occur in articulating surfaces of joints following injury or strains. These faults can lead to movement restriction and pain, which are often worsened by the active contraction of muscles within the incorrect joint position. Hence, by applying accessory glide as corrective technique may correct the faulty position combined with the offending movement being perform actively by the patient and sustained for several repetition, the pain and function should be restored (Rao et al., 2018; Satpute et al., 2022). From the finding, MWM for ST joint improved ROM of the shoulder immediately compared to Mainland's joint mobilization. This suggests that improvement may also related to less force than other manual therapy and neuropsychological influence rather than a mechanical effect on capsular and ligamentous extensibility (Rana et al., 2021; Satpute et al., 2022).

The scapular stability and mobility are maintained by the upper and lower trapezius muscles, as well as the serratus anterior (Benjamin Kibler et al., 2012; Briel et al., 2022;

Jildeh et al., 2021; Panagiotopoulos & Crowther, 2019). When the trapezius and serratus anterior muscles contract, the scapula tilts upward. As the arm elevates above 90°, the lower trapezius activates and maintains scapular upward rotation, while the serratus anterior stabilizes the scapular medial border against the thorax, acting as a scapular external rotator. The lower trapezius muscle eccentrically activates to control excessive anterior tilt and is necessary in the descent of the arm from a position of maximal elevation (Kibler & Sciascia, 2019b; Phadke & Ludewig, 2013; Struyf et al., 2014). Because the patient had weakness in the upper trapezius, lower trapezius, and serratus anterior, it was observed that there was a delay in serratus anterior and lower trapezius activation while lifting and lowering the hand. Therefore, specific muscle strengthening exercises for scapular muscle are essential in shoulder rehabilitation to recorrect the scapula mobility pattern. In fact, strengthening exercises enhance hypertrophy and strength which benefit in tissue remodelling (Ferraro et al., 2014; Wilk et al., 2020), while closed kinetic chain exercises benefit in enhancing joint stability, stimulating co-activation and proprioception (Jaggi & Alexander, 2017; Kobesova et al., 2015).

In addition, the intrinsic muscle, pectoralis minor assists the serratus anterior muscle in anterior tilt, internal rotation, and protraction when the arm is in lower levels of elevation (ie, <60° of abduction). The weakness of the lower trapezius may lead to the excessive anterior tilting of the scapula, which, in turn, can result in inflexibility of pectoralis minor (Benjamin Kibler et al., 2012; Kamonseki et al., 2021; Pascoal et al., 2023). The inflexibility of the pectoralis can also lead to an abnormal humeral position, resulting in reduced humeral mobility (Anneli Lebert, 2017; Benjamin Kibler et al., 2012), as evidenced by the patient's limitations in abduction and internal rotation. Hence, beside than strengthening the lower trapezius, applying STM to the pectoralis muscles can enhance muscle flexibility and contribute to restoring the proper position of the GH joint.

4. CONCLUSION

Scapular dyskinesis, a common cause of shoulder pain and disability, involves limited scapular motion during arm movement. Patients often experience delayed activation of middle and lower trapezius and serratus anterior muscles. Conservative management, including scapular mobilization and strengthening exercises, proved effective in reducing pain and improving mobility in this case study. Health education is also crucial to promote good attitude and habits towards exercises. Nonetheless, this case study had some limitation due to the absence of the numerical result, which implies the potential utility of handheld dynamometer (HHD) and body surface electromyography (EMG) for future study.

ETHICAL CLEARANCE

The patient was informed, and written consent was taken.

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RESEARCH ARTICLE

Mental health status and challenges in clinical practice among physiotherapists in the private sector during the Covid-19 pandemic

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Abstract:

The covid-19 pandemic exposed healthcare workers, including physiotherapists, to mental health issues such as stress, anxiety, and depression in the private sector. In minimising the infection risk, they faced challenges operating their rehabilitation facility. This study aimed to identify the mental health status and challenges experienced by physiotherapists in private practice during the Covid-19 pandemic. The study setting for this cross-sectional research was conducted at Kuala Lumpur and Selangor, Malaysia. Data were analysed using SPSS 20.0 and described descriptively. A total of 80 private physiotherapists participated in the survey. Statistically, 82.5% of the respondents were females aged 22 and 56 (27.60 ± 5.073). They mostly worked in private organisations (86.3%), especially in Selangor (70.0%). About 61.3% of respondents experienced stress subjectively, and 71.3% and 83.8% had normal anxiety and depression levels, respectively. In clinical settings challenges, 70 (87.5%) respondents recorded that the most challenging was abiding by the healthcare policies were frequent sanitisation for modalities, plinths, and chairs. About 52.5% of participants faced challenges in applying social distancing due to lacking clinic spaces. About 48.4% of physiotherapists experienced decreased income. Additionally, 77.5% of respondents had difficulty applying physical examinations while using telerehabilitation. In conclusion, most physiotherapists in the private sector in Malaysia experience common psychological issues, such as depression and anxiety, except for stress.

Keywords: Challenges, Clinical practice, Mental health, Physiotherapists

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1. INTRODUCTION

Globally, the COVID-19 pandemic has caused considerable consequences, including social and psychological issues (Koontalay et.al., 2021). Healthcare workers are the most likely to be exposed to mental health issues and clinical difficulties during the pandemic. They were hindered since they were bound by various guidelines, leading to many challenges in their practice (Armocida et.al., 2020). A cross-sectional study reported that nurses and physicians in Wuhan, China experienced distress the highest (71.5%), followed by depression (50.4%) (Lai et.al., 2020) during the pandemic. Physical therapists experienced stress the most (Vyas & Sheth, 2021)), followed by anxiety and depression.

Businesses have been disrupted, and the loss of jobs and incomes has been due to progressive cases and Movement Control Order (MCO) implementation (Lee, 2020). The Covid-19 crisis posed a global threat to sustaining Malaysian professional therapeutic practices in the healthcare system in the private and public sectors, including physical therapists working in secondary or primary care (Dantas, Barreto & Ferreira, 2020; Hashim et.al., 2021). The problem continues to provide vital clinical care while adhering to World Health Organisation (WHO) policy on safety (Pinto & Carvalho, 2020). Inadequate infection control apparel, such as personal protective equipment (PPE), face shields, and masks, contribute to physical difficulties during practice (Aloa et.al., 2020). Global therapists were also experiencing problems managing their clinical settings,

such as practising social distancing (Alpaphao & Alpalho, 2020).

The responsibility for maintaining and enhancing movement recovery and functional ability is the nature of physiotherapy services (Thomas et. Al., 2020). Their work nature was passive manual therapy, which necessitated direct physical contact with patients, putting them at risk of Covid-19 infections (Alpaphao & Alpalho, 2020). Considering this, physical therapists continue to intervene through telerehabilitation approaches. Telerehabilitation is a remote rehabilitative approach via communication technologies encompassing services such as consultation and monitoring at home or in healthcare facilities (Pastora-Bernal et.al., 2021). However, the lack of face-to-face contact visits hampered the therapists' ability to diagnose patients' conditions (Howard & Kaufman, 2018). Furthermore, lacking technical understanding may impair the effectiveness of treatment delivery (Quigley, Johnson & McArthur, 2021).

Therefore, studying mental health status and clinical challenges during the Covid-19 pandemic is essential. There still needs more research, particularly in Malaysia, even though several studies have studied mental health issues and clinical barriers during the Covid-19 pandemic in developing countries. The epidemiology research on clinical obstacles among physiotherapists during the pandemic still needs to be explored. This study aims to understand better the mental health status and challenges faced in therapeutic practice concerns in Malaysia. The scope is focused on physiotherapists working in the private sector, specifically at clinics and physiotherapy centres in Malaysia.

2. METHODS AND MATERIALS

This cross-sectional study was conducted among private physiotherapists in Kuala Lumpur and Selangor, using a self-administered questionnaire through an online survey. Participants were selected through official addresses of the private physiotherapy centres or clinics in Kuala Lumpur and Selangor. They were subsequently provided with a survey link by email. Participants who agreed to participate in the study can access the questionnaire through the link given. The questionnaire contained a participants' information sheet describing the study's objectives.

The inclusion criteria included physiotherapists working at private clinics or physiotherapy centres for at least one month and being able to understand English. Any participants who presented with unknown psychiatric illnesses/diseases, such as schizophrenia and addictive behaviour, were excluded from the study (Noor, Yusof & Yacob, 2021). A total of 80 respondents completed the surveys, and their responses were analysed.

The questionnaire consisted of three sections containing participants' demographic data (Section A), mental health status questions (Section B), and challenges in practices during the Covid-19 pandemic questions (Section C). For mental health status assessment, Covid Anxiety Scale (CAS) and Hospital Anxiety and Depression Scale (HADS) were used. The CAS was an objective anxiety scale about fear of Covid-19. This research tool consisted of 5 questions about the subject's behaviour, specifically about Covid-19, with multiple choices answers. The choice scores were 0 (not at all), 1 (rare, less than a day or two), 2 (more than seven days), and 4 (nearly every day for the last two weeks) (Lee, 2020). The full cut-off scale was equal to more than 9, indicating anxiety symptoms problems. It has 90% sensitivity, 85% specificity, and moderate to excellent reliability.

Meanwhile, HADS was a measurement tool that accessed mood disorders, especially anxiety and depression symptoms, in medical practice (Zigmond & Snaith, 1983). This tool had two subscales which were the Hamilton Anxiety Depression Scale - Anxiety (HADS-A) and the Hamilton Anxiety Depression Scale- Depression (HADS-D), consisting of 14 items scales in total. Each of the statements was provided with four choices. The score ranges from 0 to 21 for each subscale (Noor, Yusof & Yacob, 2021). Higher scores on these questions indicated increased anxiety and depression symptoms (Zigmond & Snaith, 1983)). The minimum score presenting anxiety and depression was 8 (Noor et al., 2020). This tool was reported with higher sensitivity (90%) and specificity (86.2%) (18).

A modified previous self-developed questionnaire (Dantas, Barreto & Ferreira, 2020) was used, which focused mainly on the changes and challenges of physiotherapists in practice during the Covid-19 pandemic. This questionnaire consisted of 20 questions with four sections about clinical setup, telerehabilitation, therapist-related, and patient-related questions. The questions involved varied multiple choices with closed-ended questions. Specifically, clinical setup questions include; the number of patients before and after Covid-19, time spent with patients, challenges to healthcare policies, and economic effects. Meanwhile, Section 2 was the telerehabilitation questions. Meanwhile, sections 3 and 4 discussed therapists' and patients' related physical and mental health questions. Statistical Package for Social Sciences software Version 23.0 was used for data analysis and described descriptively.

3. RESULTS

Demographic characteristics

A total of 80 participants completed the survey. Each of the participants was from one centre or clinical setting. They were (17.5%) males and 66 (82.5%) females, aged

between 22 and 56 years (27.60 ± 5.073 years old). Most of them were Malay (75.0%), followed by Chinese (20.0%), Indian (2.5%), and others (2.5%), respectively. A total of 66 (77.5%) participants were unmarried. The participants primarily worked in the private centre (86.3%), especially in Selangor (70.0%), and 13.8% at private clinics.

Table 1: The demographic characteristics of the participants.

Variables	n (%)	Mean (SD)
Age (in years)		27.60 (5.073)
Gender		
Male	14 (17.5)	
Female	66 (82.5)	
Races		
Malay	60 (75.0)	
Chinese	16 (20.0)	
Indian	2 (2.5)	
Others	2 (2.5)	
Marital status		
Unmarried	62 (77.5)	
Married	18 (22.5)	
Physiotherapists' working sector		
Private center	69 (86.3)	
Private clinic	11 (13.8)	
Working state		
Kuala Lumpur	24 (30.0)	
Selangor	56 (70.0)	

The mental health status

Two objective scales were used to assess the participants' mental health status. Table 2 shows that all participants had an average Coronavirus Anxiety Scale (CAS) score. For the Hospital Anxiety and Depression Scale (HADS), most of the respondents had usual in both anxiety and depression domains with scores of 71.3% and 83.8%, respectively. Meanwhile, 17 (21.3%) and 6 (7.5%) participants scored borderline and abnormal in anxiety. Besides, for the depression domain, there were 9 (11.4%) and 4 (5.0%) participants, respectively.

Table 2: Scores of mental health status

Domains	n (%)
Coronavirus Anxiety Scale (CAS)	
Normal coronavirus-related anxiety	80 (100.0)
Probable dysfunctional coronavirus-related anxiety	0 (0)
Hospital Anxiety and Depression Scale (HADS)	
Anxiety	

Normal	57 (71.3)
Borderline Abnormal	17 (21.3)
Abnormal	6 (7.5)
Depression	
Normal	67 (83.8)
Borderline Abnormal	9 (11.4)
Abnormal	4 (5.0)

Challenges in clinical practices

Most physiotherapists estimated their average number of patients before Covid-19 was between 5 and 10. Meanwhile, 33 participants estimated their average number of patients was 0 – 5 during Covid-19. The average time spent for treatment on a single patient was about 30 minutes to 1 hour. A total of 58 physiotherapists agreed that a change in the time for the treatment could not affect the clinical practice after COVID-19. Some 15 (18.75%) participants reported increased average time spent on a single patient daily, whereas 12 (15.0%) reported decreased numbers.

Frequent sanitisation for modalities, plinths, and chairs was recorded as the most challenging healthcare policy to practice in the clinical setting, with 70 (87.5%) respondents agreeing (Table 3).

Table 3: Challenges faced by the physiotherapist during the Covid-19 pandemic

Adhere to healthcare policies	n (%)
Minimal contact therapy	46 (57.5)
Frequent sanitisation of modalities, plinths, chairs	70 (87.5)
More focus on the home program	28 (35.0)
Others	5 (6.3)
- Self-care towards symptoms and exposure of patient in a close environment	
- The patient is not honest regarding the symptoms	
- Only patient is allowed to come in	
- Had to work with PPE on / Wearing a complete set of PPE	
Challenges to practising social distancing	n (%)
Lack of awareness from patient	42 (52.5)
More number of patients who cannot be managed	36 (45.0)
None	11 (13.8)
Others	6 (7.5)
Challenges in Financial	n (%)
None	16 (20.0)
Decrease in income	39 (48.4)
Increase in cost of equipment	19 (23.8)
Increase of income	6 (7.5)

Challenges in telerehabilitation	n (%)
Patient lack of technical/IT knowledge	56 (70)
Poor internet connection	47 (58.8)
Poor video quality	35 (44.8)
Lack of physical testing	62 (77.5)
Patient poor motivation	30 (37.5)
None	7 (8.8)
Others	2 (2.5)
Challenges in the maintenance of the clinic	n (%)
Sanitisation	63 (78.8)
Gloves	60 (75.8)
Face mask	53 (66.3)
PPE kits	61 (76.3)
Plinth cover	34 (42.5)
Others	1 (1.3)

There was minimal contact therapy and more focus on the home program, and others were admitted by 46 (57.5%), 28 (35.0%), and 5 (6.3%) respondents, respectively.

This study also found that the challenges of practising social distancing during clinical practice are mainly due to limited space (52.5%), lack of awareness among patients, and many patients (38.3%).

A decrease in income was 39(48.4%). Meanwhile, an increase in equipment cost was 19(23.8) reported by the respondents during the Covid-19 pandemic.

About 55.0% of participants claimed they used none of any telerehabilitation modes such as Zoom meetings, Google Meet, WhatsApp video calling, and private video conference software. Lacking physical tests was predominantly becoming the most significant limitation for practising telerehabilitation among 62(77.5%) participants. Meanwhile, 56(70%) and 47(58.8%) respondents reported that a lack of technical knowledge with patients and a poor internet connection, respectively, limited their telerehabilitation practices.

Most participants faced challenges in providing sanitisation costs, PPE kits, gloves, and face masks (Table 6). Wearing a PPE kit or protective gear for more than 2 hours was recorded as the highest challenge by 34 (42.5%) respondents who need to change protective equipment 2 -3 times per day.

4. DISCUSSION

In this study, most participants claimed they felt more stress based on their subjective perceptions. Although this study did not quantify the participants' stress levels, it was consistent with previous studies using PSS-10 and DASS stress domains (Yahya & Othman, 2015; Aly et.al., 2021; Duarte et.al., 2021). In concentrating on a specific

population, a study (Duarte et.al., 2021) discovered that Brazilian physiotherapists experienced higher psychological stress during the pandemic than before Covid-19. These outcomes were probably related to the nature of the work, which posed the infection risk of triggering stress.

According to a study, unmanageable chronic or long-term stress can cause anxiety and lead to mental illness; major depressive disorder is the most prevalent (Khan & Khan, 2017). A global cross-sectional study over 31 countries (Htay et.al., 2020) reported that most healthcare workers (HCWs) experienced anxiety and depression working during the pandemic by using the Generalised Anxiety Disorder (GAD-7) scale and the Patient Health Questionnaire (PHQ-9). The same tools used (Aly et.al., 2021; Elkholy et.al., 2021; Hassany et.al., 2020) also showed a high prevalence of anxiety and depression, particularly among Egyptian HCWs.

In contrast, most respondents in this study demonstrated low psychological issues determined by both subjective and objective scales of anxiety and depression. The CAS results revealed that they had an average fear feeling toward Covid-19, as did HADS results for anxiety and depression. Similarly, (Vispute & Kumar, 2021; Kang et.al., 2020 & Tam et.al., 2020) a study in India found that physiotherapists experienced mild depression during the pandemic. It could be suggested that this was probably due to high knowledge about Covid-19 among the HCWs. Also, over 60% of HCWs had sufficient knowledge, favourable attitudes, and good preventative practices (Albahri et.al., 2021; Zhang et.al., 2020 & Yesse et.al., 2021). The Covid-19 pandemic is still a challenge for HCWs' mental health, although the physiotherapists in this current study experienced relatively common psychological issues. Those HCWs with complete PPE showed lower depression, anxiety, and stress levels (Chowdhury, 2021).

The pandemic hit HCWs' practices differently, as data from this study revealed that most physiotherapists faced challenges in their clinical settings. Previous qualitative studies found that inadequate personal protective equipment (PPE) and poor guidelines preparation exposed the US and UK healthcare providers to infections (Agarwal, Agarwal & Motiani, Arnetz et.al., 2020; Nyashanu et al., 2020). As a result, treatment modifications or protocols were developed by avoiding unnecessary hand handling, using face masks and sanitisers, and implementing home-based programs to sustain outpatient services (Muhammad & Musa, 2021).

Prolonged and repeated use of PPE or protective gear created another challenge. In this study, most participants wore the PPE for more than 2 hours during their practices and had to change it 2 to 3 times daily. In addition, some studies revealed that HCWs experienced more than four hours of PPE usage at least once per shift (Agarwal,

Agarwal & Motiani, Arnetz et.al., 2020; Swaminathan, Mukundadura & Prasad, 2020). Lengthened and persistent PPE utilisation also contributed to headaches, over-sweating, breathlessness, and skin problems (Swaminathan, Mukundadura & Prasad, 2020).

Mandating social distancing in healthcare regulations to prevent Covid-19 virus transmission is necessary. Nevertheless, this study found that private physiotherapists experienced barriers to practising physical distancing during their practices, such as needing more clinic spaces and patient awareness. Studies found that awareness of Covid-19 was correlated with attitude, which is also associated with prevention practices compliance, including social distancing (Alahdal, Basingab & Aloitaibi, 2020). Several studies discovered that the population in Asian countries like Iraq (53.2%) and Saudi Arabia (60-80%) had an awareness of Covid-19 (Alanezi et.al., 2020). Likewise, another study (Parmasad, Keating & Carayon, 2021) mentioned that space paucity and difficulty in monitoring patients' health were the problems of mandating physical distancing in general healthcare settings. These occurrences could be linked to the fulfillment of 2-meter floor markings, spaced seats, and efforts to continue providing services to many patients (Parmasad, Keating & Carayon, 2021). The visual cues were also considered an excellent approach to making people aware of social distancing, yet it could be inconvenient for HCWs and patients.

COVID-19 significantly impacted the global economy and finances due to lockdown implementation in many countries, including Malaysia, which significantly strained the healthcare system (Dhama et.al., 2021). According to a survey conducted in five nations, including Thailand, Malaysia, the United Kingdom, Italy, and Slovenia, average respondents encountered wage loss and reduced working hours. Similarly, this study found that most physiotherapists faced an income reduction in their practices. It was also reported that American physical therapists and Indian physiotherapists experienced even higher losses, especially among private practices (Dantas, Barreto & Ferreira, 2020).

This study also found that most of the physiotherapists in this study experienced increased equipment costs for sanitisation, PPE, gloves, and face masks. Sanitisation using disinfectants was routine in the community and healthcare settings (Dhama et.al., 2021). The cost of disinfectants was varied, with chlorine-releasing disinfectants being relatively low, unlike hydrogen peroxide (MDH, 2017). Added to this was the trouble of securing sufficient PPE supplies from the government, forcing them to purchase PPE the private supplier. It was due to price hikes on store PPE and the shortage (Haque et.al., 2021). Therefore, impaired economic global growth during the pandemic and preventative equipment

used might prompt healthcare providers' financial instability.

Switching from a conventional treatment to telerehabilitation was necessary during the Covid-19 pandemic. Telerehabilitation was beneficial in reaching patients regardless of distance, hence encouraging the physical distancing of cure accessible (Nuara et.al., 2021). However, there were limitations to practising telerehabilitation in this study, as admitted by most participants, as it does not allow comprehensive physical tests. Therefore, it might lead to wrong interpretations of patients' conditions due to preliminary findings on palpation and manual muscle tests. Patients with low internet literacy, such as video calling through applications such as Zoom and WhatsApp via smartphones, tablets, or desktops (Buabbas et.al., 2022), need help following the treatment. Patients of advanced age might have limited capacity and skills to use the devices and need caregivers to monitor them. Older people must be more familiar with modern technology (Alpalhoa & Alpalhoa, 2020) to compromise with telerehabilitation treatment effectively.

Poor internet connection in certain areas is another challenge for the providers of care (Buabbas et.al., 2022). A study found that some physiotherapists had difficulty assessing gait, and the patients might be unable to follow the therapist's exercise instructions properly due to no or weak internet connection (Shenoy & Shenoy, 2018). Therefore, implementing telerehabilitation would be beneficial, but some considerations, such as availability and affordability, must be addressed.

5. CONCLUSION

In conclusion, most physiotherapists in this experience common psychological issues, such as depression and anxiety, even though the results revealed that it is mild. The emergence of Covid-19 contributes to anxiety among service providers. Healthcare providers have identified various challenges in providing their services to their patients.

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RESEARCH ARTICLE

Unveiling phytochemicals in *P. guajava* leaves: Thin layer chromatography (TLC) investigation using methanol, chloroform and hexane

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Abstract:

Guava (*Psidium guajava* L.), a member of the Myrtaceae family, is a widespread tropical tree, grown in a wide variety of tropical and subtropical regions for its medicinal and nutritional properties. The fruit, bark, root, and leaves of the guava plant have all been used to treat various diseases and ailments. Guava leaves are the most often and extensively utilised part of the guava plant for traditional purposes, worldwide. Due to their diverse phytochemical composition, guava leaf extracts have been studied for their biological activities, including anticancer, antidiabetic, antioxidant, antidiarrheal, and antibacterial properties. In this study, *P. guajava* leaves were extracted by using organic solvents of different polarities. The groups of compounds in the extract were identified via thin-layer chromatography (TLC) and preliminary qualitative analysis. The leaves powder was macerated with methanol, chloroform, and hexane, in parallel. The TLC analysis was carried out by mixing hexane: ethyl acetate (7:3) and hexane: ethyl acetate (3:7) to identify polar and non-polar compounds in the guava leaves extracts. The preliminary qualitative analysis is performed to detect the presence of alkaloid and phenolics by using the Dragendorff's reagent and 5% ferric chloride solution. Results from the phytochemical screening shows the presence of flavonoids, terpene, alkaloids, carbohydrates, and phenolics. In summary, this project could provide valuable insights and supplementary details for the plant's monograph.

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Keywords: chromatography, guava, monograph, *Psidium*, sustainability

1. INTRODUCTION

Psidium guajava (*P. guajava*) plant, also known as guava (Figure 1; Globinmed, 2022), belongs to the Myrtoideae subfamily of Myrtaceae family (Gill, 2016). It was reported to have medicinal, nutritional, and industrial qualities. It is also a popular local crop because of its accessibility, low cost, transport and handling durability, and consumer preference (Medina & Herrero, 2016). The guava fruit has been produced and used in tropical places such as India, Bangladesh, Indonesia, Pakistan, and South America. It is originated in tropical America, but because of its adaptability, it is grown worldwide in tropical and subtropical regions (Díaz-de-Cerio et al., 2017). Guava has a lot of seeds that are quite viable, which contributes to its adaptability. The Spaniards are responsible for spreading the guava crop over the Pacific and the rest of the world. Unfavourable weather patterns have little impact on guava cultivation. However, the crop must be carefully managed to produce a high-quality harvest. Currently, India is the world's largest guava producer, followed by China, Thailand, and Pakistan (Gill, 2016). The guava's flavour, appearance, and the functional nutrients, are among the characteristics for its success in the agricultural & business (Uchôa-Thomaz et al., 2014).

The guava tree is a short tree that grows to a height of 7-10 metres. The plant forms a symmetrical dome and is distinguished by its thin, smooth, greenish-brown scaly bark that reveals a greenish layer underneath (Gill, 2016). The plant's extensive branching network results in various canopy shapes (Medina & Herrero, 2016). White, incurved-petalled flowers cover the plant, and the plant itself has a slight aroma. Guava leaves are smooth and have a light green hue (Figure 1). The leaves are coarsely hairy underneath, with prominent venation on the top surface (Gill, 2016; Kumar et al., 2021). The leaf form ranges from elliptic to oblong-lanceolate, rarely rounded, 4–10 cm long and 2.5–6 cm wide, and with short petioles 2–7 mm long (Medina & Herrero, 2016).

Guava leaves are the most often and extensively utilised part of the guava plant for medicinal purposes, worldwide. Numerous Latin American and Caribbean countries, as well as India, Bangladesh, Pakistan, Kenya, Nigeria, Madagascar, Malaysia, Namibia, South Africa, Papua New Guinea, Thailand, and Indonesia, have traditionally used guava-derived products to treat a variety of communicable and non-communicable diseases, including gastrointestinal disease, hepatic damage, bacterial and fungal infection, fever, rheumatism, respiratory illness, cough, diabetes, pain, wounds, mouth ulcers, uterine bleeding, blennorrhagia and menstrual

disorders. Due to their diverse phytochemical composition, guava leaf extracts have been studied for their biological activities, including anticancer, antidiabetic, antioxidant, antidiarrheal, and antibacterial properties (Ugbogu et al., 2022; Lok et al., 2023). As such, this study aims to extract *P. guajava* leaves using organic solvent of different polarities and identify the group of compounds (Figure 2) in the extract of this research sample, via thin-layer chromatography (TLC) and preliminary qualitative analysis.



Figure 1. A fruiting *Psidium* plant (left) and a mature *Psidium* fruit with seeds (right).

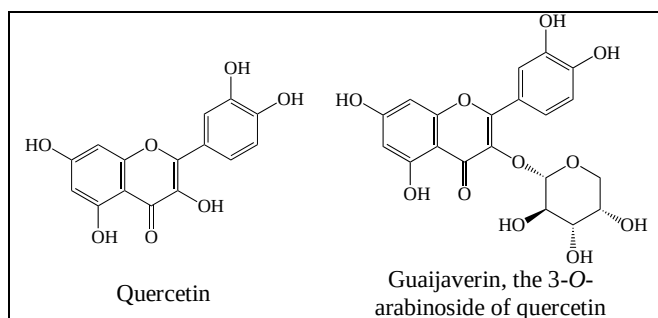


Figure 2. The structures of natural molecules from *P. guajava* (Prabu et al., 2014).

2. MATERIALS AND METHODS

2.1. Equipment and materials

The equipment includes pre-coated silica gel 60 F254 sheets (Merck, Darmstadt, Germany), TLC development glass chambers, Whatman filter paper number 1, Cole-Parmer ultraviolet (UV) viewing cabinet, and Bosch GHG 630 DCE heat gun. The plant specimen was *P. guajava* leaves. They were collected from a guava tree in Terengganu, Malaysia, in March 2022. The raw materials were authenticated by one of the authors (Mohsin, H. F.) by using macroscopic evidences. The chemicals were reagent grade, which include ethyl acetate, methanol, hexane, Dragendorff's reagent, anisaldehyde-sulfuric acid reagent, 5% ferric chloride solution, and standard quercetin (Sigma). Distilled water was also utilised to compose the TLC mobile phase.

2.2. Preparation of extracts

The extraction of *P. guajava* leaves was prepared according to procedures described by Biswas et al., (2013) and Seo et al., (2014). Prior to the extraction, the leaves were cut in small pieces and stored in drying rack for 3 days. After the guava leaves have dried, they were put into a blender and ground into a powder. The sample is weighted prior to the extraction. The solvent extraction were methanol, chloroform, and hexane. 100 ml solvents were added to the 10 g of powdered leaf samples in the separate flask, covered with an aluminium foil, to prevent evaporation and light. The samples were agitated and the extracts were filtered after a week by using Whatman filter paper No. 1. Subsequently, they were dried at 40°C using a rotary evaporator. The weight of each extract was then measured and recorded.

2.3. Thin layer chromatography (TLC)

The procedures for TLC screening were modified from Moura et al., (2012) and ALhaidari et al., (2019). The TLC plate was prepared using a pre-coated silica gel 60 F₂₅₄ sheets (Merck, Darmstadt, Germany) as a stationary phase with a length of 10 cm and 5 cm in width. Using a pencil, one centimetre was drawn from each baseline to denote the solvent front and sample. The mobile phase consisting of hexane: ethyl acetate (7:3) was prepared and transferred into TLC tank. Using a capillary tube, three drops of each extract and a quercetin standard were put at the bottom of the TLC plate. The plate was then put for separation in a saturated TLC tank. When the mobile phase reached two-thirds the length of the plate, it was removed from the tank and left to dry at room temperature until the solvent has been completely removed. The silica plate was examined using UV light with a wavelength of 254 nm from a UVP portable lamp in a Cole-Parmer UV viewing cabinet, to enhance the compound's visibility. The spots were circled with a pencil, and the R_f value was calculated. The procedure was repeated with different mobile phase which were hexane: ethyl acetate (3:7). A glass sprayer containing an anisaldehyde-sulfuric acid reagent was used to perform the chemical derivatization. The plate was dried at 100°C using a Bosch heat gun until the visible compound could be detected.

2.4. Preliminary qualitative analysis

The qualitative analysis (Chakraborty et al., 2010; Shaikh & Patil, 2020) was carried out to detect the presence of alkaloids and phenolics in each extract of guava leaves. For the test for alkaloid, two ml of Dragendorff's reagent was added to a few ml of filtrate by the side of the test tube. A prominent yellow particulate could indicate a positive result. Meanwhile, the extract (50 mg) was dissolved in 5 ml of distilled water, to detect the presence of phenolic compounds. Then, a few drops of 5% ferric chloride solution were added to the solution. A dark green or bluish black colour would indicate the presence of phenolic compounds.

3. RESULTS AND DISCUSSION

3.1. Percentage of yield extract

The yield of extracts was shown in Table 1. The percentage yield was calculated based on 10 g of the sample powder used in the extraction and the mass of crude extracts. The amount obtained from methanol, chloroform and hexane extracts were 3.75 g, 2.75 g, and 4.08 g respectively, in which hexane provided the highest yield.

Table 1. The percentage yield of *P. guajava* leaves extracts.

Solvent	Weight of the extract (g)	Percentage yield (% w/w)
Methanol	1.53	15.30
Chloroform	0.98	9.80
Hexane	1.35	13.50

3.2. Thin Layer Chromatography (TLC) screening of *P. guajava* leaves

It is noted that the TLC data on the *Psidium* extract was not available in the national online monograph (Globinmed, 2022). Nevertheless, Metwally et al., (2011) provided a guideline on a typical chromatographic pattern of the ethyl acetate extract of the guava leaf. The compound separation could be achieved by utilising quercetin (labelled as S) Figure 3) in the TLC examination. The silica gel plate was subjected to a middle polar system with ethyl acetate : methanol : water : acetic acid (100:2:1:4 drops) as the developing solvent. Meanwhile, the ammonia was used as the revealing reagent. In this experiment, five mobile phases were tested to achieve a good resolution in moving the compounds in the extract via capillary action. The use of hazardous benzene as the TLC solvent could be avoided (Sarkar et al., 2011). The results of each mobile phases tested were shown in Table 2.

Finally, hexane: ethyl acetate (7:3) and hexane: ethyl acetate (3:7) were used as the mobile phases as they showed better results for polar and non-polar compounds, as compared to the rest of the mobile phases. Quaternary acidified solvent system for the TLC (Shirke et al., 2023) was not adapted in this study. Figure 4 showed that the derivatization of the TLC plate by using anisaldehyde–sulfuric acid reagent provided the fingerprints of the investigated samples, that were not seen under UV light (254 nm). This reagent produced a result in which the compound is more pronounced. There were six to seven identified spots in methanol, hexane, and chloroform extracts, on the TLC plate of hexane: ethyl acetate (7:3), after spraying with anisaldehyde–sulfuric acid. On the other hand, for the TLC plate of hexane: ethyl acetate (3:7), four to five spots were identified in methanol, chloroform, and hexane extracts, after the TLC plate was introduced to the sulfuric anisaldehyde. The Rf value for standard quercetin in hexane: ethyl acetate (7:3) and (3:7) are 0.07 and 0.80, respectively.

Table 2. The mobiles phases for TLC screening.

Solvent mixtures	Ratio (v/v)	Observation
Hexane: ethyl acetate	8:2	Good separation but it is less distinctive.
Chloroform: methanol	7:3	This mobile phase causes streaking on TLC plate which may be due to the concentrated sample.
Methanol: hexane	1:1	This mobile phase cause smearing upward.
Hexane: ethyl acetate	7:3	Excellent and more distinctive separation for non-polar compounds.
Hexane: ethyl acetate	3:7	It is more polar, and it shows good separation for polar compounds.

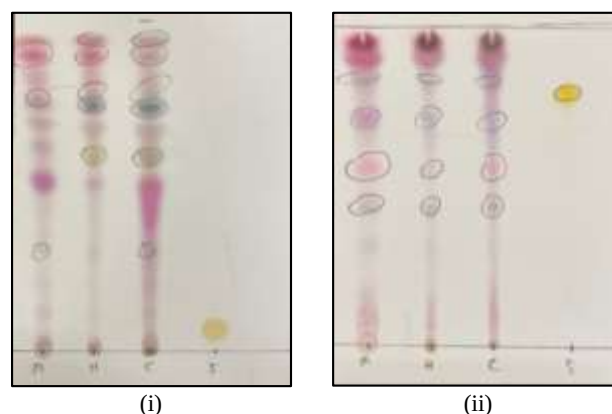


Figure 3: The TLC profile of *P. guajava* leaves extract, using sulfuric anisaldehyde as the staining reagent. Two mobile phases were used, (i) hexane: ethyl acetate (7:3) and (ii) hexane: ethyl acetate (3:7).

Based on Figure 4, the TLC plate using hexane: ethyl acetate (7:3), which was sprayed with anisaldehyde–sulfuric acid, showed the presence of carbohydrate and polyols, as the spots appeared as pink/red for all extracts. Furthermore, there were blue spots on the TLC plate for all extracts, which indicated the presence of monoterpene (Gerlach et al., 2018). Spots with Rf value of 0.91, 0.89 and 0.89 in methanol, hexane and chloroform extracts, respectively indicated the presence of phytosterols. Reference marker of 0.88 has been used to conclude phytosterols on the TLC plate (Chakraborty et al., 2010). There is a presence of flavonoid, specifically quercetin, for all extracts in hexane: ethyl acetate (3:7). The spots with Rf value of 0.84, 0.84 and 0.82 in methanol, hexane

and chloroform extracts, respectively shared comparatively similar R_f value with standard quercetin, which was 0.80.

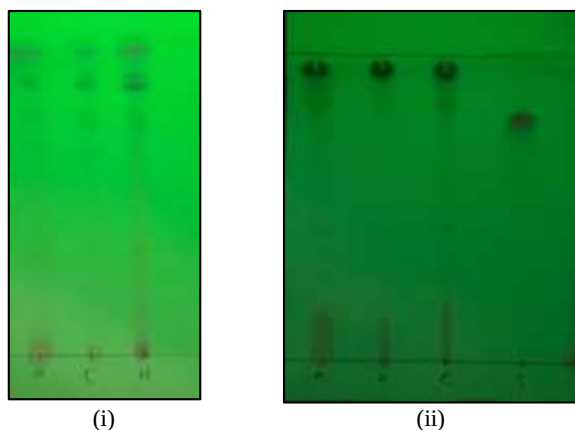


Figure 4: The chromatographic profile of *P. guajava* leaves extract, visualized under UV (254 nm). Two mobile phases were used, (i) hexane: ethyl acetate (7:3) and (ii) hexane: ethyl acetate (3:7).

Astuti et al., (2017) conducted the stability tests of the *Psidium* compounds on the High Performance Thin Layer Chromatography (HPTLC) plate and in solution. Based on the HPTLC, the guava leaves extract is stable on the plate and in methanolic solution because there were no differences in the zone intensity, no disappearing zones and no new zones could be observed. Tiwari et al. (2021) was also in agreement that HPLC method is reproducible and selective for the estimation of four bioactive compounds, including quercetin (Figure 2), gallic acid, eugenol and β -sitosterol in *P. guajava* extracts. Quercetin-3-*O*-sulfate is the major compound from the *P. guajava* ethanol extract and was isolated from this plant for the first time (Nguyen et al., 2023), under neutral condition. However, the isolation of quercetin-3-*O*-sulfate could not be summarised. The TLC eluting mixtures in this study was not parallel to that quintet solvent system of ethyl acetate – formic acid – acetic acid – water – methanol (50: 2: 2: 5: 2), to order to detect quercetin-3-*O*-sulfate (R_f = 0.53) (Nguyen et al., 2023). The polarity of quercetin-3-*O*-sulfate may not suit the nonpolar condition of the mobile TLC environment in here. These work could be another guide in experimenting LC of the *Psidium* components in the future.

3.3. Preliminary qualitative analysis

All extracts were tested with a Dragendorff's reagent and 5% ferric chloride solution, to detect the presence of alkaloid and phenolic compounds. Based on Table 3, only methanol extract showed positive results for alkaloid and phenolics. In test for alkaloid, methanol extracts showed positive result due to its colour changes from greenish black to prominent yellow. This indicated the presence of alkaloid. Meanwhile, in test for flavonoid, the addition of 5% ferric chloride solution showed positive results in methanol extracts by the appearance of bluish black colour, which indicated the presence of phenolic

compounds. However, chloroform and hexane extracts showed negative results for both alkaloid and phenolics.

Table 3. The phytochemical screening of guava extracts.

Extracts	Alkaloid	Phenolic compound
Methanol	+	+
Chloroform	-	-
Hexane	-	-

+ = present; - = absent

4. CONCLUSION

P. guajava leaves were successfully extracted through maceration by using methanol, chloroform, and hexane. The TLC solvent systems consisted of hexane: ethyl acetate (7:3) and (3:7), which manifested the best separation of compounds. The phytochemical screening of methanol, chloroform, and hexane extracts revealed the presence flavonoids, terpene, alkaloids, carbohydrates, and phenolic compounds by positive reaction with the respective test reagents. The analysis showed the presence of phytoconstituents in methanol and chloroform. The result of the study could be useful for the description and additional information for the plant's monograph.

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RESEARCH ARTICLE

Computer Vision Syndrome (CVS) among secondary school students in Selangor

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Abstract:

Computer Vision Syndrome (CVS) is a group of ocular and vision-related symptoms that manifest after prolonged digital device usage. With increasing use of digital devices especially among teenagers, this study aimed to investigate the prevalence of CVS among secondary school students in Selangor and their level of awareness about this condition. In this cross-sectional study, CVS-Q (Computer Vision Syndrome Questionnaire) (Seguí et al., 2015) was distributed both online and offline to secondary school students in Selangor. The questionnaire included demographic information, general and ocular health conditions, and questions on CVS to determine their awareness about the condition and symptoms of CVS that they have experienced. A total of 202 students, aged between 13 and 18 years, 72.3% of whom were females participated in the study. About 50% of the total participants were reported to have CVS. The most prevalent symptoms experienced by the students were headache (69%) and itchy eyes (69%), followed by burning sensation (60%) and watery eyes (59%); whereas seeing halos around objects (24%) was found to be the least reported symptoms experienced by them. 18.8 % of the participants claimed that they were aware of CVS. The chi-square test revealed that CVS was associated with gender ($\chi^2 (1) = 8.01, p = 0.005$) with females being associated with higher CVS scores. The prevalence of CVS among secondary school students in Selangor is considerably high, with higher CVS symptoms found in female participants. A low level of awareness of CVS warrants health education on this matter among this population.

Keywords: Computer Vision Syndrome (CVS), Digital Eye Syndrome (DES), Eyestrain, Headache, Secondary School Students

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1. INTRODUCTION

American Optometric Association (AOA) defined Computer Vision Syndrome (CVS) as a group of ocular and vision-related problems that occur due to prolonged use of digital devices such as computers, tablets, cell phones, and e-readers (AOA, 1996). This has been suggested to manifest after more than four hours of continuous use of digital devices such as computers (Irmayani et al., 2020; Blehm et al., 2005). Computers and other digital devices usage require the eye to work harder compared with printed materials. Therefore, increased reliance on digital devices, including computers and smartphones in this digital era, has resulted in increased visual demand, which eventually makes more people susceptible to CVS symptoms. According to Blehm et al. (2005), ocular complaints commonly experienced by computer users include eyestrain, burning sensation, eye fatigue, eye irritation, ocular redness, blurry vision and dry eye sensation. These symptoms may be exacerbated by glare, non-ergonomic workstation setup, poor room illumination, improper computer brightness, and uncorrected refractive

error (Torrey, 2003). Additionally, CVS symptoms can also be accompanied by non-ocular symptoms such as headaches, shoulder pain, neck pain, and back pain (Blehm et al., 2005).

Although CVS is more commonly reported among adults, few studies have reported that children are also susceptible to CVS and can experience similar symptoms after prolonged use of computers and digital devices (Kozeis, 2009). In fact, they might be more susceptible to CVS than adults due to less awareness about this condition and the use of less ergonomic workstations that are usually designed for adults. A study in China reported that three-quarters of school children from grade 1 until grade 12 (aged between 6 to 18 years old) experienced CVS symptoms during the Covid-19 pandemic (Li et al., 2021). In addition, similar findings were found in a study conducted among senior high school students in East Java, Indonesia, whereby 87.2% of the students were reported to experience CVS symptoms, particularly dry eye (Loebis et al., 2021). The increased use of digital devices among children and adolescents may lead to tremendous lifestyle changes and an alarming incidence of

visual problems associated with prolonged use of the devices (Ichhpujani et al., 2019). The CVS can reduce work productivity as it requires someone to take frequent breaks when doing a task or else would cause discomfort that may affect one's quality of life. Therefore, increasing the use of digital devices among children and adolescents may pose a public health burden by impacting children's quality of life and possibly their learning process in the long run.

Currently, in Malaysia only the prevalence of CVS among university students and working adults have been reported, while CVS among school children particularly teenagers has not been reported. Therefore, this study aimed to investigate the prevalence of CVS among secondary school students in Selangor and their awareness of the condition. The findings will give a better insight into CVS among secondary school students and determine whether health education on this issue is needed.

2. MATERIALS AND METHODS

2.1 Study design and sample population

A cross-sectional study was carried out among secondary school students in Selangor. Based on a sample size calculation using Raosoft software, for a 95% confidence interval with 5% error, the sample size required for the study was 385 subjects. Participants were recruited via the non-probability selective purposive sampling method. An advert was distributed through various social media platforms to reach the potential participants. All participants were Malaysian secondary school students in Selangor, aged between 13-18 years old with a minimum of three hours of daily exposure to any digital devices including laptops, desktops, tablets or handphones. This criterion has been set to ensure that all participants have access to digital devices prior to taking part in the CVS questionnaire. However, participants with active corneal diseases and a history of ocular surgery were excluded from the study, as these factors can intensify the ocular dryness symptoms and influence their responses to CVS questionnaires (Denoyer et al, 2015; Hardten, 2008).

2.2 Materials

Data were collected using a questionnaire that can be divided into the following sections: (i) demographic information including information on daily usage of digital devices, (ii) medical and ocular health information including medication intake, (iii) questions on awareness of CVS, and (iv) CVS symptoms experienced by the participants which was adopted from CVS-Q (Segui et al, 2015). In section 1 (i), the socioeconomic status was divided into three categories which were B40, M40 and T20. These categories refer to the

bottom 40%, middle 40%, and top 20% of the household income distribution in Malaysia, where the thresholds may vary depending on location. In section 3 (iii), participants were asked whether they have heard about CVS before (yes or no) and what measures can be taken to prevent CVS. A 'yes' to this question indicates participants were aware of CVS.

Computer Vision Syndrome Questionnaire (CVS-Q)

Questions in Section 4 (iv) of the questionnaires were adopted from CVS-Q (Segui et al, 2015) to determine the prevalence of CVS among the participants. The original questionnaire was developed in English, which was then translated into Malay language and validated in a pilot study (Cronbach's Alpha >0.7). In this section, participants were asked to indicate the frequency of having CVS symptoms with the response options of "never", "occasionally", "often or always" which were scored as 0, 1 or 2 respectively. If they reported experiencing the symptoms (the answer option of 1 or 2), they were asked to rate the intensity of the symptoms as either "moderate" or "intense" with a score of 1 or 2 respectively.

The CVS score for each symptom was then calculated by multiplying the frequency with the symptoms (frequency X intensity). Scores for 16 symptoms were summed up to get the total CVS score. A total CVS score of six or more (≥ 6) was considered as having CVS.

2.3 Procedures

This study was conducted both online and offline where Google Form was used to create the online version of the questionnaire, while the printed version was distributed to several secondary schools around Shah Alam. Consent and assent forms were attached together with the questionnaire for both online and offline methods which were filled in by all participants and their parents before answering the questionnaire. The study was conducted in accordance to the Declaration of Helsinki and was approved by the ethical committee of the university (FERC/FSK/MR/2022/0076).

2.4 Data analysis

Data collected were analysed using SPSS version 27.0. The data were tested for normality using the Kolmogorov-Smirnov test. Descriptive statistic was used to describe the prevalence and awareness of CVS among secondary school students. Since the CVS scores were not normally distributed ($p < 0.05$), Mann-Whitney test was used to compare the scores between upper and lower secondary school students, different genders and socioeconomic status. In addition, the associations between these factors and CVS categories were

also assessed using Pearson's Chi-square test with an alpha value set at 0.05.

3. RESULTS

A total of 202 secondary school students participated in this study, with 105 lower secondary and 97 upper secondary students. Lower secondary school students were between 13 to 15 years of age ($M = 13.91$; $SD = 0.71$), while upper secondary school students were between 16 to 18 years of age ($M = 16.98$; $SD = 0.82$). The demographic data of the participants were as follows (Table 1).

Table 1. Demographic data of participants

Demographic variables	Frequency (n=202)	Percentage (%)
Age group		
Lower secondary school	105	52.0
Upper secondary school	97	48.0
Gender		
Male	56	27.7
Female	146	72.3
Family's socioeconomic status		
B40	73	36.1
M40	100	49.5
T20	29	14.4
School		
Government	193	95.5
Private	9	4.5
Duration of daily digital devices use		
<5 hours	52	25.7
≥5 hours	150	74.3

The mean duration of daily digital devices use was 8.09 hours ($SD = 5.30$). The most frequently used device was mobile phone (88%) followed by tablet (5%), laptop (4%) and desktop (3%). Out of the 202 participants, only 38 (18.8 %) of them have heard of CVS before, while 137 (67.8%) participants knew that limiting the screentime will help to reduce CVS. Among the 38 participants who were aware of CVS, majority of them were from lower secondary (57.9%) and were female (84.2%) students.

Figure 1 shows percentage of participants reporting each CVS symptom. 167 (82.7%) of the students had at least one symptom of CVS. Three most common symptoms experienced by the students were headache (69%), itchy eyes (69%) and burning sensation (60%) while the least common symptom was halos (24%).

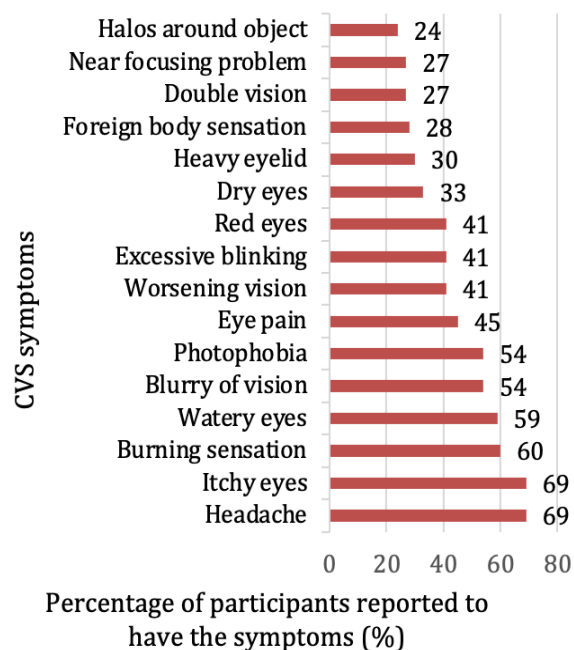


Figure 1. CVS symptoms reported by participants.

Based on the total CVS scores ($M = 6.08$; $SD = 4.83$), 50% ($n=101$) of the participants were considered as having CVS. Mann-Whitney test was used to compare CVS score between students who were aware of CVS ($Mdn = 7$; $IQR = 7$) and those who have not heard about CVS before ($Mdn = 5$; $IQR = 7$). Results showed no significant difference in CVS scores between the two groups ($z = -0.786$, $p\text{-value} = 0.433$).

CVS scores were also compared between lower and upper secondary students using Mann-Whitney test. Results showed that the CVS score between lower secondary ($M = 5.40$; $SD = 4.54$) and upper secondary ($M = 6.81$; $SD = 5.04$) school students missed the significance with the upper secondary students had a slightly higher scores ($u = 4302$, $p = 0.056$). On the other hand, Mann-Whitney test showed a significant difference in CVS scores between gender, with a higher CVS score found in female ($Mdn = 7$; $IQR = 7$) compared with male participants ($Mdn = 3.50$; $IQR = 9$) ($z = -2.933$, $p\text{-value} = 0.003$).

CVS score was also compared between three different groups of family's socioeconomic status using the Kruskal-Wallis test. No significant difference was found in CVS scores between different socioeconomic groups (Table 2).

Table 2. Total CVS score between different socioeconomic status

Family's socioeconomic status	n	Median (IQR)	χ^2 statistic (df)*	p-value*
B40	73	5.00 (8)	0.771 (2)	0.680
M40	100	6.50 (8)		
T20	29	5.00 (6)		

Note. *Kruskal-Wallis test was used to compare CVS scores between groups.

Additionally, Chi-square test showed that the only variable associated with CVS categories was gender ($\chi^2 (1) = 8.01$, $p = 0.005$), with females associated with a higher CVS score. There was no significant association found between CVS categories and age groups ($\chi^2 (1) = 0.972$, $p = 0.324$), family's socioeconomic status ($\chi^2 (2) = 1.35$, $p = 0.510$), and awareness of CVS ($\chi^2 (1) = 2.07$, $p = 0.150$).

Moreover, the associations between awareness of CVS with age, gender and family's socioeconomic status were also tested using the Chi-square test. Results showed no association between awareness of CVS with age ($\chi^2 (1) = 0.66$, $p = 0.418$), and family's socioeconomic status ($\chi^2 (2) = 3.44$, $p = 0.179$). However, the association between awareness of CVS and gender was approaching significant, with females being slightly more aware of CVS ($\chi^2 (1) = 3.33$, $p = 0.068$). Pearson's correlation coefficient test also showed no significant correlation between CVS score and hours spent on digital devices ($r = 0.05$, $p = 0.479$) as well as age ($r = -0.05$, $p = 0.717$).

4. DISCUSSION

The study aimed to determine the prevalence of CVS among secondary school students in Selangor and their awareness of CVS. Results showed half of the participants were considered as having CVS, with a higher CVS score obtained among female participants. In addition, female students were more aware of CVS compared to male students.

The prevalence of CVS seems to be varied with different occupations and the nature of work. A study by Assefa et al. (2017) reported that the prevalence of CVS among computer-based bank workers in Gondar was 73% which was somewhat similar to another study among computer office workers in Sri Lanka (67.4%) (Ranasinghe et al., 2016). A similar percentage was also found among university administrative staff in Malaysia, with 63% of the sample reported to have CVS (Zainuddin & Isa, 2014). A higher prevalence of CVS was reported among university students in Jordan (94.5%) (Gammoh, 2021), Saudi Arabia

(97.3%) (Altalhi et al., 2020) and Malaysia (89.9%) (Reddy et al., 2013). However, our study involving secondary students reported a slightly lower prevalence of CVS compared to the earlier studies, possibly due to the duration of daily screentime, which was much shorter and less intensive among secondary school students compared to office workers and university students.

On the other hand, a recent study among secondary school students of a similar age range in Thailand showed a higher prevalence of CVS (70.1%) (Seresirikachorn, 2022) compared to our study. This may be attributed to the timeline when the study was conducted in Thailand, which was earlier during the Covid-19 pandemic. During that time, the duration of digital devices usage per day was still relatively higher due to implementation of online learning instead of physical classes. In contrast, our study was conducted post-Covid period, where majority of the physical educational activities have gone back. Despite a slightly lesser prevalence of CVS among the students due to a shorter daily screentime, the findings of more than 50% prevalence of CVS indicates majority of the secondary school students are at risk of having ocular health problems if this issue is not addressed.

Among the symptoms reported, headache and itchy eyes were the most common CVS symptoms experienced by the participants. This was in agreement with studies reported in other countries such as Saudi Arabia (Al Tawil et al., 2020), Tokyo (Sen & Richardson, 2007) and India (Bali et al., 2007) where the prevalence of headache was relatively high compared to other symptoms reported by their study populations. There are multiple factors contributing to headaches when using digital devices which include short viewing distance that increases accommodation demand and the constant change in accommodation due to poor edge resolution. Altogether, these will make the eyes work harder, putting extra stress on the extraocular muscle which eventually lead to headaches (Ranasinghe et al., 2016).

Regarding factors associated with CVS symptoms, our results demonstrated that only gender has an association with CVS categories with a higher prevalence found in females compared to males, which was similar to those reported in previous studies (Rahman & Sanip, 2011; Agbonlahor, 2019). This gender difference may be attributed to the non-ergonomic setting for female users and the possible influence of hormonal changes in female students. Females usually have a shorter stature and arm reach compared to males, therefore more likely to have a closer viewing distance and non-ergonomic position when using computers, increasing the risk of musculoskeletal problems that may contribute to increase in CVS symptoms (Mowatt, 2018). Future study can explore the underlying factors contributing to the gender difference in CVS reported in this study.

Research have shown that CVS might be associated with age differently depending on the nature of work of the study population. Some studies have reported that CVS symptoms such as dry eyes and headache were more prevalent in older age (Bigal et al., 2006; Ranasinghe et al., 2016; de Paiva, 2017), while some reported a higher prevalence of CVS in the younger group (Rahman & Sanip, 2011; Wangsan et al, 2022). This difference was driven by the duration of digital devices usage where the age group with a longer duration of usage had a higher prevalence of CVS in each study. Contrasting to the previous studies, our study showed no association between CVS and age groups. A possible reason for this was due to the age range of the sample participated in our study, which was only among secondary school students with a small age range therefore a weaker association between age and CVS score. In addition, we also found no association between the prevalence of CVS and family's socioeconomic status, suggesting the widespread use of digital devices, hence CVS across all socioeconomic levels.

Furthermore, our finding suggests that most of the secondary school students were unaware of CVS. This indicates a notable knowledge gap about CVS in the studied population. However, the absence of an association between awareness of CVS and the condition indicates that simply being aware of the condition is not sufficient to prevent CVS. This implies that health education is necessary not only to increase knowledge and understanding of CVS, but also to instill self-awareness in reducing CVS among this group. Employing a multifaceted approach to educate teenagers about CVS, such as educational campaigns at school, peer education through social stories, as well as parental involvement, would be some of the effective initiatives for this group.

Despite the additional knowledge provided by this study, it is important to note its limitations. The results obtained were only based on self-reporting symptoms by the participants with no clinical examination to rule out whether the participants have uncorrected refractive error or binocular vision anomalies that can contribute to CVS. In addition, study population was restricted to several schools around Selangor with a smaller age range, with most of them were staying at the hostel during the day. This may underestimate the prevalence of CVS among school children who were staying at home and have more access to digital devices. Moreover, the higher percentage of female respondents in this study might also contribute to the significant association between gender and CVS symptoms as mentioned earlier. Notwithstanding this, the presence of CVS in the majority of the participants is alarming, therefore warrants health education initiatives on this matter among secondary school children to ensure long-term sustainable well-being of the future generation.

5. CONCLUSION

This study provides an initial overview of CVS symptoms among secondary school students in Malaysia. CVS was found to be prevalent among secondary school students in Selangor with a higher prevalence found in females compared to male students which could potentially impact on their health and academic performance. Considering only a small percentage of the participants were aware of CVS, health education on this matter among school students is needed to spread the knowledge and awareness of CVS, as well as instilling self-awareness in practicing good habit to prevent this condition. This will help to ensure the long-term sustainable well-being of our future generation.

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RESEARCH ARTICLE

The prevalence of stillbirth due to antenatal complications (hypertension, diabetes, and anemia): A single center study in Malaysia

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Abstract: Stillbirth is a serious problem globally with approximately 2.65 million third trimester stillborn baby cases recorded around the world each year. In Malaysia, there are very limited studies on the risks of stillbirth. Thus, the objective of the study was to investigate the odds and probability of stillbirth due to antenatal complications (hypertension, diabetes and anemia) among women in Malaysia. A case-control study was undertaken at Hospital Serdang in Selangor. The sample size for the study is 367 patients who gave birth at this hospital of which 155 are stillbirths (cases) and 212 are the alive (controls). The data was collected from 2013 to 2015 based on the patient's data in the manual book and database. A descriptive analysis is conducted to know the percentage of mothers with antenatal problems with the birth of their babies. A chi-square test of independence was conducted to identify the association between antenatal complications and stillbirth. The binary logistic regression (odd ratio) is implemented to identify the risk factors of antenatal complications toward stillbirth. The results showed that most of the stillborn baby's mothers did not have any antenatal complications during pregnancy just 18.1% had hypertension, 18.7% had diabetes and 23.2% had anemia. Mothers with babies born alive showed quite similar results with only 18.9% having diabetes and 25% having anemia but a slight difference in hypertension with only 1.9%. The chi square tests of independence results concluded that only hypertension is associated with the birth of a baby. Based on the odds ratio, a mother who has hypertension during pregnancy has 11.465 times higher odds (95 CI: 3.930 to 33.445) of getting a stillborn baby compared to a mother without hypertension. Thus, pregnant women who have hypertension during pregnancy have a higher risk of having a stillborn baby. So, if hypertension is detected during pregnancy, the doctor and mother should be more careful and always monitor the progress of the baby to avoid a stillbirth.

Keywords: Stillbirth, Antenatal Complication, Malaysia

1. INTRODUCTION

World Health Organization (WHO) define stillbirth as a child dies after 28 weeks of pregnancy, either before or during birth. Stillbirth can be divided into two types which are macerated stillbirth and fresh stillbirth. Other names used for macerated stillbirth and fresh stillbirth are intrauterine death and intrapartum death. Macerated stillbirth is a death of a foetus with birthweight ($\geq 500\text{g}$), gestational age (≥ 22 weeks) and the presence of peeling of skin. Meanwhile, for fresh stillbirth, there is the absence of peeling of skin (Mother Newborn Child Mortality Registry, n.d.). Usually, for macerated stillbirth, the baby may have died during late pregnancy which means in the womb or before giving birth while fresh stillbirth is a baby that may have died during

labour or birth (Miles, n.d.). Therefore, the physical of the baby will help in estimating time of death in stillborn foetus either in the womb or during labour.

A pregnant woman should always notice if there are any changes in the movement of the baby in the womb. If the movement and reaction of the baby in the womb keep reducing, it shows a problem with your baby. The main signs of stillbirth are when there is no heartbeat and movement of the baby. Other signs of stillbirth are when the pregnant mother feel cramps, pain, and fluid loss or have bleeding from the vaginal. So, the best way is to meet the doctor, to know the progress or problem of the baby. Frequently, the doctor will check the pregnant mother's health and listen to the baby's heartbeat using heart rate monitor but if there is

no sign of a heartbeat, the doctor will do an ultrasound to confirm the death of a baby (March of Dimes, 2020).

After the doctor has already confirmed the death of the baby, the doctor will give some suggestions and options for giving birth. The suitable time and best method for delivery of a stillborn baby depend on the gestational age and medical history. From the discussion with the doctor at the hospital, the stillborn baby can be delivered normally after two weeks of death in the womb. Unfortunately, the doctor will suggest medication to induce labour to avoid a baby to degenerate in the womb and doctor can also easily identify cause of death for stillborn baby. Furthermore, most of stillborn babies are normally delivered normally compared to caesarean delivery and only in some cases which requires a baby to be delivered by caesarean such as multiple pregnancy because the doctor needs to save the other baby (Sulaiman, Othman, Razali, & Hassan, 2013).

Stillbirth is a serious issue that needs to be known especially among pregnant women. Pregnant women should always know whether they are in high or low risk in getting a stillborn baby. During pregnancy, many problems can be encountered with the early preparation and the awareness of the mother. Therefore, it is important to meet with doctors regularly to ensure that the mother and the baby are always in a good condition. When the appointment with the doctor is done regularly, the information of the progress of the baby's growth can be monitored and any problems during pregnancy can be avoided and controlled. So, an alive and healthy baby will be born and the proportion of stillborn baby can be reduced.

Stillbirth is a serious problem globally, with approximately 2.65 million third trimester stillborn baby recorded around the world each year with about 98 percent, occurring in low and medium income countries (Froen et al., 2016). The country with the lowest rate of stillbirth babies, which is about 1.3 stillbirths per 1000 total births, is Iceland while Denmark is next at 1.7 per 1000 births. The country with the worst stillbirth rate is Pakistan with 43.1 stillbirths per 1000 total births. Malaysia which stands at rank 54, with stillbirth rate of around 4 per 1000 followed very closely to Indigenous Australians and Colombia (Flenady Vicki, 2015). Identifying the risks of stillbirth can help reduce the number of stillbirths. There are very limited studies on the risks of stillbirth in Malaysia.

The objective of the study was to examine the association between antenatal complication (hypertension, diabetes, anemia) with the birth of baby (alive, stillbirth). Furthermore, to investigating odds and probability of stillbirth due to antenatal complications (hypertension, diabetes and anemia) among women in Malaysia.

2. MATERIALS AND METHODS

This is a single-setting study conducted at Hospital Serdang, Selangor, Malaysia. The duration for data collection is from 27th January 2016 until 22th April 2016.

The data is collected from years 2013 to 2015 based on the list of all patient that delivers baby at the Obstetrics and Gynaecology Unit in Hospital Serdang, Selangor. The data are focused on the alive and stillbirth baby including macerated and fresh stillbirth.

The study design use for this study is case control study. This type of design is chosen because comparison can be made between patients who deliver a stillbirth baby (cases) with patients who deliver alive baby (controls) in order to make a retrospective review to compare a risk factor in each group.

The design was used because it requires less time to complete because of the presence of the occurrence, in which at the same time, researcher can look at multiple risk factors with is lower in cost as compared to a prospective study. Furthermore, retrospective cohort study also allows the investigator to describe a population over time or obtain preliminary measures of association to develop future studies and interventions.

The data is private and confidential. Every piece of data or research that is related to public hospitals needs to be registered with the National Medical Research Register (NMRR). To get approval for NMRR, the ethics committee needs to get approval from the Medical Research Ethics Committee (MREC) and institutional approval from the head of department and hospital director in Hospital Serdang. So, the data is collected after all the procedures are completed and the NMRR Research ID-28628 is received. The data collection process began on 27th January 2016, and ended on 22th April 2016. The sample for stillbirth in the study is 155 cases. On the other hand, the sample collected randomly for alive is 212 sample. So, the sample for alive and stillbirth is 367 sample. The secondary data was used in this study and the collected data is basically about antenatal complication such as hypertension, diabetes and anemia and birth of baby. The antenatal complication is an independent variables and birth of baby is a dependent variable. Hypertension, diabetes and anemia is divided by yes and no to illustrate having and not having hypertension, diabetes and anemia but for birth of baby is assigned as alive and stillbirth baby. The conceptual framework shows the relationship between independent and dependent variables.

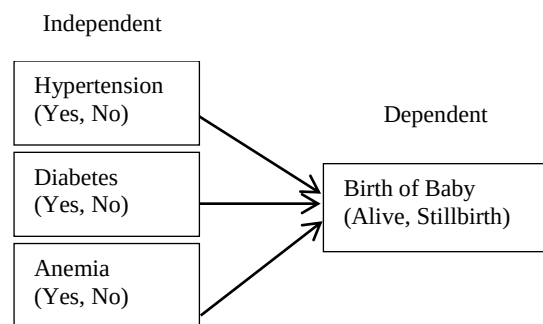


Figure 1: Conceptual Framework

It's really importance to understand the data. So, the first step is to conduct the descriptive analysis based on contingency table. Contingency table is a special type of frequency distribution table because it shows a two variable continuously and describes the relationship between several categorical variables (Agresti, 2007). In this study, variable for birth of baby and antenatal complication such as hypertension, diabetes and anemia is a categorical data and its will used contingency table to show the percentage and frequency.

After that, the odds ratio is used to measure of the effected size, describing the strength of association or non-independent between two data values. Basically, the odds ratio was used to measure if there was an association between two variables. Furthermore, the odds ratio for a predictor is defined as the relative amount by which the odd of the outcome increase (OR greater than 1.0) or decrease (OR less than 1.0) when the value of the predictor variable is increased by 1.0 units (Montgomery, Peck, & Vining, 2012). Lastly, the Chi-Square test is conducted to examine the association between antenatal complication such as hypertension, diabetes and anemia towards birth of baby (alive and stillbirth). There is an association if the p-value less than or equal to $\alpha=0.05$ (Triola, 2004).

3. RESULTS

The table 1 shows the antenatal complication among alive and stillbirth. The results show that the stillbirth's mother did not have any antenatal complication during pregnancy such as hypertension (81.9%); diabetes (81.3%) and anemia (76.8%). The alive babies show that a mother with hypertension (98.1%), diabetes (81.1%) and anemia (75.0%) respectively.

Table 1: Antenatal Complications

Variable	Alive n (%)	Stillbirth n (%)
Hypertension		
No	208 (98.1)	127 (81.9)
Yes	4 (1.9)	28 (18.1)
Diabetes		
No	172 (81.1)	126 (81.3)
Yes	40 (18.9)	29 (18.7)
Anemia		
No	159 (75.0)	119 (76.8)
Yes	53 (25.0)	36 (23.2)

The descriptive only show the percentage of mother with antenatal complication, but using chi-square test it to know the association between stillbirth and antenatal complication. From table 2, it shows that the chi-square results for three types of antenatal complications. the result show that only hypertension is associated with stillbirth based on p-value is 0.000. The diabetes and anemia are not

associate with stillbirth because the p-value is greater than $\alpha=0.05$.

Table 2: Chi-Square Test for Associations

Determinants	Chi Square	P-value
Hypertension	29.442	0.000
Diabetes	0.001	0.969
Anemia	0.153	0.695

Using chi square test, only hypertension is associated with stillbirth. To know how much hypertension will cause a stillbirth, test for logistic regression need to be conducted to calculate the odd ratio. The odds ratio showed that a mother who has hypertension during pregnancy has 11.465 times higher odds (95 CI: 3.930 to 33.445) of getting a stillbirth baby compared to a mother without hypertension. Unfortunately, a mother who has diabetes during pregnancy has only 0.990 times lower odds (95 CI: 0.582 to 1.682) of getting a stillbirth baby compared to a mother without diabetes. Lastly, a mother who has anemia during pregnancy has only 0.908 times lower odds (95 CI: 0.559 to 1.475) of getting a stillbirth baby compared to a mother without anemia. Thus, pregnant women who have hypertension during pregnancy have a higher risk of getting stillbirth baby. The mother with diabetes and anemia showed the lower risk of getting stillbirth baby.

Table 3: Odd Ratio for Antenatal Complications

Determinants	Odd Ratio	95% Confidence Interval
Hypertension	11.465	3.930-33.445
Diabetes	0.990	0.582-1.682
Anemia	0.908	0.559-1.475

4. DISCUSSION

The descriptive analysis only can give the number of mothers with antenatal complication. Although, the most of the stillbirth mothers did not have hypertension during pregnancy yet there is still an association between hypertension and birth of baby. The odd ratio and Chi-Square test also shows that hypertension is associated and it is one of the important factor in the risk of getting stillbirth. Patel et al. (2015) supported the result in who stated that hypertension remained risk factors of having stillbirth compared to other maternal problem.

Most of the stillbirth mothers did not have diabetes during pregnancy and there is no association between diabetes and the birth of baby based on the Chi Square test and odd ratio. Hence, diabetes is not a risk factor of stillbirth. Diabetes is not an important risk because if the pregnant women make an intensive antenatal care during pregnancy, it will reduce the risk of stillbirth baby (Pattinson et al., 2011).

Most of the stillbirth mothers did not have anemia during pregnancy and thus there is no association between anemia and the birth of baby. It is contrasted with the literature

review because in developing country such Ghana, anemia was related in the increase of the risk of stillbirth (Aminu et al., 2014). The similar result from Chumak & Grjibovski (2010) found that anemia is associated with lower risk of stillbirth or women with anemia in pregnancy were less likely to have stillbirths.

4. CONCLUSION

The objective of the study is to investigate the odds and probability of stillbirth due to antenatal complications (hypertension, diabetes, and anemia) among women in Malaysia and to examine the association between antenatal complications (hypertension, diabetes, and anemia) and the birth of the baby (alive or stillbirth).

The odd ratio showed that only pregnant women who have hypertension during pregnancy have a higher risk of having a stillborn baby. The mother with diabetes and anemia showed a lower risk of having a stillborn baby.

Since hypertension is one of the risks of stillbirth, the mother should take care of their health by always monitoring their blood pressure. This is to ensure that their blood pressure reading is normal. Mothers also need to consult a doctor and follow the medication given by doctors.

Besides that, the doctor also plays an important role in raising awareness about the effects of hypertension in pregnancy, which may lead to stillbirth. The doctor needs to check the patient regularly and give suitable medication if needed.

So, hypertension has a high risk of stillbirth, so this is a serious problem that needs to be solved to avoid the increasing number of stillbirths, especially in Malaysia.

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RESEARCH ARTICLE

Methanol versus acetic acid extract effects on chicken eggshell membrane protein concentration, visualization and antioxidative potential

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Abstract:

Eggshell membrane (ESM) is a fibrous microstructure located between the eggshell's layers. ESM contains numerous protein constituents that serve its beneficial biological activities. Proteins such as ovalbumin, collagens, keratins, ovomucoid and ovocleidin-116 have been extracted from ESM. However, ESM is extremely insoluble in water and has poor stability. Solvents are often used in the extraction process; thus, this study aims to extract and compare the effect of methanol and acetic acid on proteins from chicken ESM. Findings from this study demonstrate differences in methanol compared to acetic acid in ESM protein extraction. ESM protein concentration from acetic acid (1.14 mg/ml) is slightly higher than methanol (1.01 mg/ml). The SDS-PAGE result shows both solvents can extract proteins from ESM with different bands intensity. Both solvents show moderate antioxidative activity compared to L-Ascorbic acid as a control in the FRAP assay. This study shows the potential of both solvents to extract and maintain the bioactivity of proteins from ESM. However, further purification and quantitative studies are needed to completely identify protein fragments isolated by both solvents to be used in future applications such as medicine, dentistry, and food industry.

Keywords: eggshell membrane, protein, antioxidant, ESM, SDS-PAGE, FRAP

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1. INTRODUCTION

Eggs are the most largely consumed source of protein throughout the world. The hard part of eggshells is made mostly from calcium carbonate (Rath et al., 2016). However, eggshells have several layers, including the eggshell membrane (ESM). It contains over 500 protein constituents, such as collagen, ovalbumin, glycoproteins and many more (Kulshreshtha et al., 2022). These proteins are vital to the physiology of the egg itself and contributes to the safety for the maturation process of the embryo, including the safety from inflammatory process induced by free radicals such as reactive oxygen species (ROS). Fortunately, organisms have their own ways of fighting inflammation, one of which is the presence of proteins with antioxidative potential. These proteins neutralize free radicals, eventually halting cell damage and death (Xianhai Li et al., 2020). Once hydrolyzed, peptides from food and non-food sources possess a certain degree of bioactivity (Daliri et al., 2018). Research has shown that ESM proteins are of notably high quality, and their significance has been progressively recognized by the scientific community (Zhao et al., 2019). Prominent wound-

healing properties of ESM has been well documented in literature (Xiaoyun Li et al., 2019; Wedekind et al., 2017).

The overabundance of eggshell waste often results in its disposal in landfills without pre-treatment to accelerate its decomposition (Amasuomo & Baird, 2016). In turn, this causes accumulation and, eventually, environmental spillage. Conversion of waste back into society is not something new by scientists and researchers (Shaari et al., 2018). As mentioned above, ESM contains several proteins with selected bioavailability that can be utilized and reused into various proteins, especially in the medical field. A study had successfully profiled the proteins present in ESM, however, there are differences in the extraction protein due to solvents used (Rath et al., 2016). In this research, the two most frequently utilized solvents for extractions, namely methanol and acetic acid, were employed. Methanol is a relatively popular extracting method and has even been applied in phytochemical extraction methods from plants. On the other hand, acetic acid is a gentle acid used in decalcifying the hard shell (Zhang et al., 2016). To evaluate the efficacy of the extraction methods, a preliminary protein quantification was carried out using Bradford's assay. After that, Sodium

Dodecyl Sulfate Polyacrylamide Gel Electrophoresis (SDS-PAGE) was used to separate and visualize the protein. Finally, an antioxidant power assay utilizing Ferric Ions Reducing Antioxidant Power (FRAP) was used to evaluate its antioxidative potential.

2. MATERIALS AND METHODS

2.1 Materials

Empty chicken (*Gallus gallus domesticus*) eggshells waste was obtained from restaurants and households around Puncak Alam, Selangor. Chemicals used were sodium chloride (NaCl), ethylenediaminetetraacetic acid (EDTA), sodium hydroxide (NaOH), methanol, acetic acid, Bradford reagent, bovine serum albumin (BSA), acrylamide mix, sodium dodecyl sulfate (SDS), Tris base powder, tetramethyl ethylene diamine (TEMED), ammonium persulfate, bromophenol blue, glycerol, glycine, Coomassie blue powder, 170kDa protein ladder, Millon reagent, and ninhydrin.

2.2 Eggshell Decalcification

Briefly, the eggshells were rinsed with distilled water to remove any remaining impurities, such as dirt, on their surface. Then, it was washed in 1 M NaCl and soaked for 2 hours with 100 mM EDTA at pH 8.5. The washed eggshells were left to dry at room temperature (25°C). After that, the dried eggshells were smashed quickly and stirred for 15 minutes at a solid/water ratio of 1:10 (Zhang et al., 2016). The lighter ESM floated on the water surface was collected on a sieve and separated for drying. Ten gram of ESM powder was solubilized in 200 ml NaOH. This is the “crude” ESM.

2.3 Methanol Fractionation

A method by Ahmed et al. (2017) was followed with minor modifications. Ten grams of ESM was mixed with 200 ml of 0.1% acetic acid acidified 70% methanol. The mixture was allowed to sit for 4 days at 25°C with continuous stirring. Then, it was centrifuged at 13000 rpm for 60 minutes. The precipitated ESM was taken and stored at 4°C for other experimental protocols. This is the “methanol-extracted ESM”.

2.4 Acetic Acid Extraction

The obtained ESM powder was mixed with 4M acetic acid with a ratio of 1:8 (w/v) and allowed to sit for 4 days at continuous stirring (Ponkham et al., 2011). The mixture was centrifuged at 15000 rpm for 30 minutes. The process was repeated three times. The precipitated compound was labelled as “acetic acid-extracted ESM”.

2.5 Protein Quantification

A known molecular weight Bovine Serum Albumin (BSA) was used as a protein standard to generate a standard curve for determining an unknown protein sample (0.2-1.6 mg/ml). Absorbance values were plotted 595 nm (y-axis) versus their concentration in mg/ml (x-axis). The protein samples were mixed with the Bradford reagent in a 1:1 ratio and incubated at room temperature (20-25°C) for 5 minutes in a plastic disposable cuvette. Colorimetric optical reading was taken three times (triplicate) using a spectrophotometer at 595 nm wavelength.

2.6 Sodium Dodecyl Polyacrylamide Gel Electrophoresis (SDS-PAGE)

A standard procedure was followed to visualize the proteins extracted using both methods (Rath et al., 2016). Briefly, 12% polyacrylamide gels were used to separate the proteins and 4X Laemlli's loading buffer was loaded in the ratio of 1:3 to the protein sample. The mixtures were heated on a dry heating at 95°C for 5 minutes. Loading the wells were as follows:

1. 170 kDa protein marker was used as a protein standard.
2. The control, crude, and fractionate were loaded at varying concentrations of 4, 6, 8, and 10 µg.

A 120V constant current was applied to the gel for 60 minutes until the band's ends were observed at the bottom of the gel. The gels are submerged into Coomassie Brilliant Blue R-250 solution for 3-4 hours and de-stained overnight in acidified methanol until the separated protein bands could be seen clearly. GelDoc was used to visualize the gels and each protein band was analyzed using ImageJ software.

2.7 Ferric Ions Reducing Power (FRAP) Assay

A method by Singhal et al., (2011) was followed with minor modifications. Briefly, phosphate buffer and potassium ferricyanide were added to the protein samples. The mixture was incubated in a water bath with a temperature of 50°C for 20 minutes. Then, trichloroacetic acid (TCA) was added to the mixture. It was then subjected to centrifugation at 3000 rpm for 10 minutes. The supernatant was taken and mixed with freshly prepared ferric chloride and transferred into a plastic cuvette. A spectrophotometer was used to measure its absorbance at 700 nm wavelength. Ascorbic acid (1000-50 µg/ml) was used as the standard to compare its activity.

3. RESULTS AND DISCUSSION

3.1. ESM Protein Potential

Spectrophotometric protein quantification analysis was used to quantify protein concentration using a Bradford assay

protocol. The colorimetric assay is based on the binding of protein molecules to coomassie dye stimulated by an acidic environment, resulting in a change of colour measured as absorbance. BSA was used to calculate the protein concentration of an unknown sample (Figure 1).

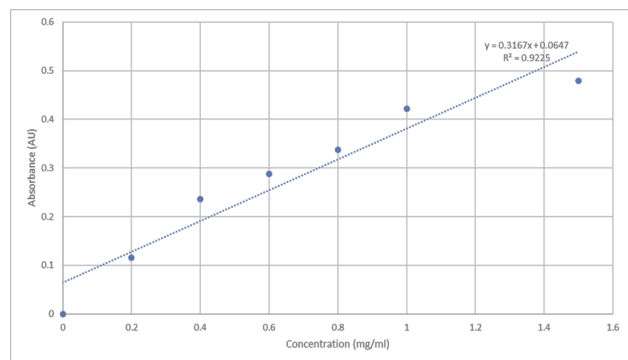


Figure 1. Graph of absorbance at 595 nm against BSA standard protein concentration (mg/ml)

Table 1. Protein concentration from different samples based on absorbance reading at 595 nm.

Sample	Δ Absorbance (mean $\pm$ S.E.M.; 595nm)	Protein Concentration (mg/ml)
Eggshell crude	0.17333 $\pm$ 0.001202	0.34
Methanol-extracted eggshell	0.18167 $\pm$ 0.003712	0.37
Acetic acid- extracted eggshell	0.19733 $\pm$ 0.002167	0.42
ESM crude	0.18700 $\pm$ 0.006928	0.39
Methanol-extracted ESM	0.38300 $\pm$ 0.000577	1.01
Acetic acid-extracted ESM	0.42544 $\pm$ 0.000242	1.14

Data are pooled for all triplicate reading and summarized as mean $\pm$ S.E.M.

Table 1 shows that both solvents protocol yielded higher protein concentrations compared to the crude ESM with acetic acid-extracted ESM being the highest with 1.14 mg/ml of protein. This result suggests that both solvents are effective for ESM proteins extraction. This finding also matches previous study which found that both methanolic and acetic acid extracts had good efficiency to detect the presence of functional protein molecules in ESM (Kumer, 2017). The principle of methanolic extraction was the solubilization which had promoted ESM solubility through chemical degradation of peptide bonds and the associated cross-

linkages (Ahmed et al., 2017). On the other hand, Husnaeni et al. (2019) suggested acetic acid reacts and hydrolysed the primary structure of the proteins. Swelling affect by pH value was one of the elements that can diminish the ability of an internal molecular structure to bind and promote protein unfolding by disrupting non-covalent bonding. The difference in molecular extraction approaches is taught to be the reason why acetic acid yielded higher protein concentration than methanol which is a much harsher solvent.

It is also notable that crude eggshell contains the least amount of extracted protein (0.34 mg/ml). This shows that proteins are more abundant in ESM than eggshells. The composition of eggshell consists primarily of calcium carbonate (CaCO_3) which is 95% and only 3.5% is an organic matrix including glycoproteins, proteins, and proteoglycans (Cordeiro & Hincke, 2011). In contrast, ESM contains 69.2% protein, 2.7% fat, 1.5% moisture, and 27.2% ash (King'ori, 2011). Furthermore, it is also high in proline, glutamic acid, glycine, and cysteine (Santana et al., 2016).

3.2. ESM Protein Expression

SDS-PAGE is a semi-qualitative technique used to separate and visualize protein mixture in any biological samples based on their size. The relative mobility of charged molecules influences protein separation in the sample. Because there is minimal resistance during electrophoresis, relatively small molecules move faster, leaving the larger molecules at the top of the gel. In this study, the electrophoretic profiles of the crude, methanol-extracted, and acetic acid-extracted ESM proteins were visualized at varying concentrations such as 4, 6, 8, and 10 μg . A 15 to 110 kD protein ladder was used as a reference for the molecular weight (MW) of separated proteins.

Both gels showed no protein bands in crude ESM sample (Figure 2 and 3). This indicates no protein was able to be extracted using the decalcification step. In contrast, methanol and acetic acid ESM extracts revealed proteins with prominent band intensity. The relative intensity of produced bands is used to estimate protein abundance. Methanol-extracted ESM showed higher protein abundance visualized by dense bands compared to acetic acid-extracted ESM. A much smaller protein at ~ 16.6 kDa was detected in the methanol-extracted ESM. In contrast, acetic acid did not manage to extract the smaller proteins. Both stained gels showed various protein bands at different molecular weights that indicates lower purity of protein samples.

This is as expected due to the absence of a purifications step and abundance of proteins present in ESM including lysozyme, polyubiquitin-B ubiquitin, ovocalyxin-36 precursor, and structural proteins such as keratins. These proteins play specific roles in the physiology of the egg itself. For instance, ubiquitin is a 76-amino-acid protein that aids in

the breakdown of a variety of cytosolic, nuclear, and ER (endoplasmic reticulum) proteins (Alves-Rodrigues et al., 1998). The ovocalyxin-36 precursor is involved in hyaluronate lyase activity while keratin, type 1 cytoskeletal is a structural constituent of the cytoskeleton in ESM (Kaweewong et al., 2013). Extensive research showed that antimicrobial proteins of ESM, such as lysozyme, defend the embryo of the egg until it produces its immunoglobulins and are also effective against viruses and some toxins (Liu et al., 2013). Concurrently, this study could not really point out all the proteins present in ESM compared to more advanced extraction and purification methods described in other literatures. It is also important to note that ESM can easily lose quality due to storage, gaseous environment, humidity, and temperature (Qiu et al., 2012).

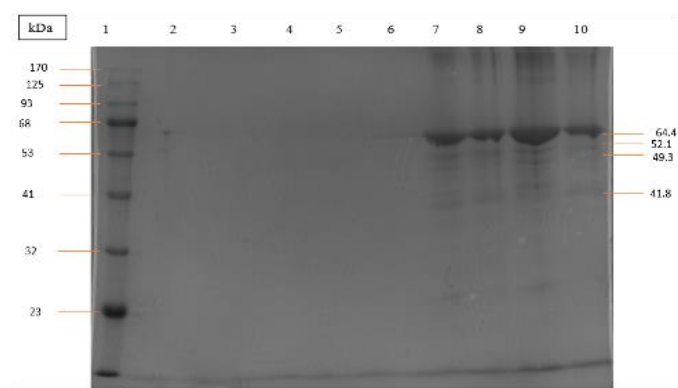


Figure 2. SDS-PAGE of the eggshell matrix protein extracted by methanol. Lane 1, protein marker; Lane 2, control (methanol); Lane 3, 4µg of crude ESM; Lane 4, 6µg of crude ESM; Lane 5, 8µg of crude ESM; Lane 6, 10µg of crude ESM; Lane 7, 4µg of methanol-extracted ESM; Lane 8, 6µg of methanol-extracted ESM, Lane 9, 8µg of methanol-extracted ESM; Lane 10, 10µg of methanol-extracted ESM.

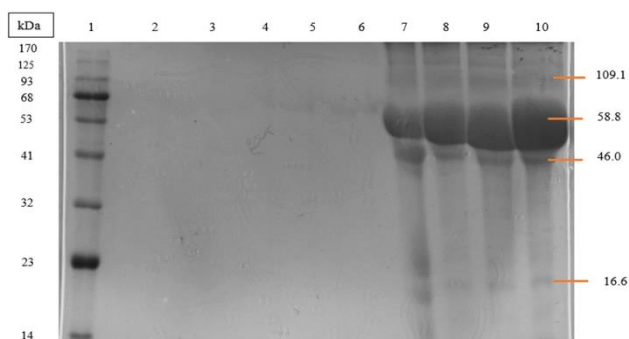


Figure 3. SDS-PAGE of the eggshell matrix protein extracted by acetic acid. Lane 1, protein marker; Lane 2, acetic acid as control; Lane 3, ESM crude 4 µg; Lane 4, ESM crude 6 µg; Lane 5, ESM crude 8 µg; Lane 6, ESM crude 10 µg; Lane 7, acetic acid extracted ESM 4 µg; Lane 8, acetic acid extracted ESM 6 µg; Lane 9, acetic acid extracted ESM 8 µg; Lane 10 acetic acid extracted ESM 10 µg.

3.3. ESM Proteins Antioxidative Potentials

Reactive oxygen species (ROS) such as superoxide anions produced by physiological metabolisms will react with proteins, DNA, and other molecules in the body. In turn, a level of oxidative damage is expected to cells and tissue (Chakrabarti et al., 2014). Accumulation of ROS and constant cellular damage will eventually cause mutations resulting in chronic disease manifestations such as cancer. Antioxidative proteins and peptides have been shown to neutralize these conditions (Shi et al., 2014). ESM is one of the greatly researched materials that possess antioxidative properties used in the field of tissue engineering.

In this study, FRAP assay was used to evaluate the antioxidant potential in methanol-extracted and acetic acid-extracted ESM (Figure 4 and 5). Its principle is based on the ability of a compound to donate an electron to free radicals to convert them to stable components which is referred to as reducing power (Jain and Anal, 2017). A known standard which is L-ascorbic acid was used to compare its antioxidative capacity. The effect of solvents on extracted ESM sample is shown in Figure 4. A dose-dependent response to its reducing power was obtained in which the highest reducing power (10%) of both methanol and acetic acid extracted ESM was at the concentration of 50 mg/ml. It can also be seen that L-ascorbic acid surpassed both extracts in every concentration used.

Based on the result, both ESM extracts showed moderate reduction of power activity against ferric ions. The notable feature of ESM as an antioxidative agent is validated. The findings from this study suggested that ESM extract could be a new functional supplement that acts as a beneficial antioxidant against oxidative stress (Shi et al., 2014).

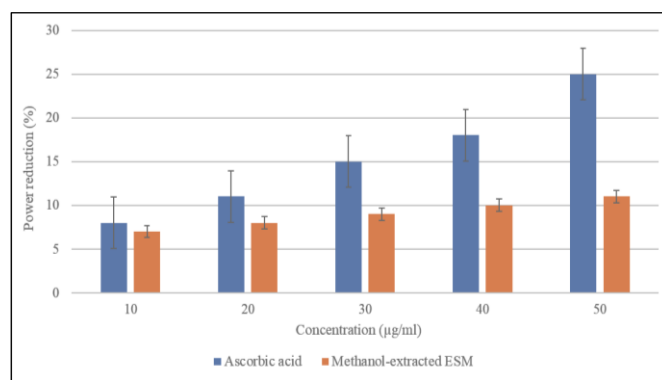


Figure 4. FRAP assay of the ESM samples extracted by methanol as compared to L-ascorbic acid as standard.

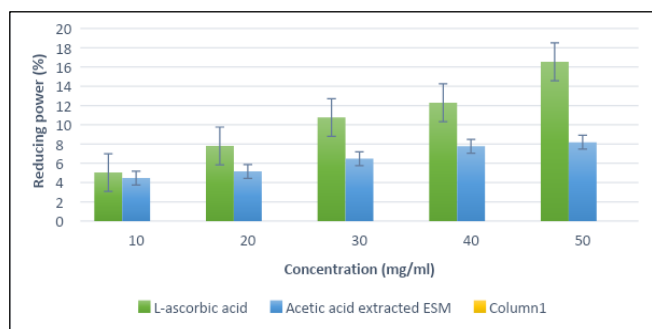


Figure 5. FRAP assay of the ESM samples extracted by acetic acid as compared to L-ascorbic acid as standard.

ROS generation typically reduces antioxidant enzymes, upregulates the MAPK signaling pathway and its associated cytokines production. When administered orally, ESM exhibits antioxidative potential by upregulating the antioxidant enzyme SOD1 and downregulating the MAPK signaling pathway and the production of proinflammatory cytokines IL-1, IL-6, and TNF- α (Sim et al., 2023).

4. CONCLUSION

ESM is a good source for a variety of biological proteins and can be used as an antioxidant. In conclusion, methanol and acetic acid are both versatile as an extraction platform solution that can extract a variety of proteins from ESM. These methods could also be applied to other eggshells or any other biological samples. From the extracted protein sample, a comprehensive study and manipulation could be done to further investigate its potential to be used as an agent of different bioactivity properties. An efficient and rapid method for solubilizing and extracting protein with a high yield was established. From this study, the ability to separate ESM from the eggshell itself successfully plays a vital role in the extraction of beneficial proteins with bioactivities. Both ESM extracts in this study show moderate antioxidative potential that could be contributed by the presence of abundant proteins found. Studies have shown hatched ESM proteins hydrolyzed into peptides reduced the level of inflammatory proteins such as ROS, matrix metalloproteinase 3 (MMP3), MMP13, and IL-6 in a hydrogen peroxide induced human chondrocytes (Zhu et al., 2022). However, advanced purification techniques are needed to purify and isolate specific protein of interest to be studied and manipulated into beneficial products.

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RESEARCH ARTICLE

Knowledge and attitude towards cervical cancer among women in the sub-urban area: A cross-sectional study

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Abstract:

Cervical cancer is preventable and curable in its early stage, but it remains the second leading cause of cancer-related deaths among Malaysian women. Therefore raising awareness is crucial to reducing cervical cancer incidence and mortality rates. This study aims to assess the knowledge and attitudes toward cervical cancer among women in a suburban area in Selangor. A cross-sectional study was conducted using convenience sampling, involving 359 women aged 21 to 60. Participants completed a self-administered questionnaire through a Google link. Results showed that approximately half of the participants had moderate knowledge of cervical cancer, 179 (49.9%), while 217 (60.4%) exhibited a favorable attitude toward cervical cancer. A significant positive relationship correlation was found between knowledge and attitude ($p < 0.05$). The findings suggest that increasing knowledge about cervical cancer can lead to more positive attitudes. Future efforts should focus on educational programs and campaigns highlighting the importance of cervical cancer screening and its symptoms to enhance awareness.

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Keywords: attitude, cervical cancer, knowledge, sub-urban, women

1. INTRODUCTION

Cervical cancer has recorded an estimated 604,127 new cases among women globally and nearly 341,831 deaths worldwide, while in Malaysia, cervical cancer ranked as the fourth most common cancer among women with 1,740 new cases and the second leading cause of death in cancer among women with 991 deaths (World Health Organization, 2020). Cervical cancer can lead to palliative care and mortality, yet it is well proved that cervical cancer can be cured if diagnosed early and treated promptly (Cubie & Campbell, 2020). In Malaysia, the rate of risk of developing cervical cancer is after 30 years of age, with the average peak age between 50- 74 years old (Azizah et al., 2016).

Knowledge about cervical cancer is pivotal in prevention, early detection, and effective disease management. Seng et al. (2018) conducted a study to investigate awareness, knowledge, and attitudes toward cervical cancer among women in Malaysia. The findings revealed that women in Malaysia still lack sufficient knowledge and general information about cervical cancer. Romli et al. (2019) found more than half of the participants did not know abnormal vaginal bleeding between periods and pain during sex were manifestations of cervical cancer. Women who had never had a Pap smear were less likely to know about cervical cancer than those who had a Pap smear (Abdullah et al., 2018). Therefore, understanding the level of knowledge

among women about cervical cancer is crucial for designing effective public health strategies and interventions to reduce the prevalence of cervical cancer.

Women's attitudes toward cervical cancer play a crucial role in determining their engagement with preventive measures, such as regular screenings and vaccination. Ajayi et al. (2021) found that women had positive attitudes toward screening and recognized its importance for early detection. Women's attitudes toward cervical cancer and Pap smear screenings are influenced by a myriad of factors, including cultural beliefs (Salehinyia et al., 2021), awareness levels (Abdullah et al., 2018), and access to healthcare services (Haas et al., 2021). Seng et al. (2018) state many women fear the pain associated with Pap smears. This fear is often based on misconceptions about the procedure, which is quick and painless for most women. According to George (2021), cultural norms and taboos surrounding reproductive health issues may shape perceptions of cervical cancer screenings, potentially impacting women's willingness to seek such services. More women have opportunities to undergo screening and take preventive measures if they acknowledge cervical cancer as a preventable and curable disease.

The relationship between the level of knowledge and attitude toward cervical cancer among women is essential to understanding the effectiveness of health education and awareness campaigns. Winarto et al. (2022) have explored this relationship to assess how knowledge impacts attitudes

and behaviors related to cervical cancer prevention and screening. The results showed that women with higher levels of knowledge about cervical cancer were more likely to have positive attitudes toward screening and prevention measures. A study conducted by Seng et al. (2018) in Malaysia revealed a positive correlation between knowledge and attitudes. Women with higher levels of knowledge about cervical cancer and vaccination demonstrated more favorable attitudes toward prevention and early detection. Pandey et al. (2021) in India explored the relationship between knowledge and attitudes toward cervical cancer screening among women. The results indicated that women with higher levels of knowledge about cervical cancer and screening had more positive attitudes and were more likely to undergo regular screening. Another study by Romli et al. (2019) found that women with a higher level of knowledge about cervical cancer were more likely to believe that they were at risk for the disease. This suggests that knowledge about cervical cancer can help women to understand their own risk and to take steps to reduce their risk.

Women living in suburban areas may have different knowledge and attitudes towards cervical cancer than women in other settings due to various factors influencing their healthcare access (Arora & Mishra, 2017), socio-cultural context (Luque et al., 2016), and community characteristics (Barnett & Vasquez, 2017). According to Abdullah et al., (2018), women in rural areas were less likely to know about cervical cancer than women in urban areas. Therefore, it is crucial to conduct research specific to suburban areas to understand women's unique knowledge and attitudes in these settings. This knowledge can inform the development of tailored interventions and educational materials that address suburban women's specific needs and challenges, ultimately improving cervical cancer awareness, prevention, and screening rates among this population. Thus the study objective is to identify knowledge and attitude toward cervical cancer among women in a suburban area in Selangor.

2. METHODOLOGY

2.1 Study design, location and sampling

A cross-sectional study was conducted among women in a sub-urban district at Selangor. The inclusion criteria were women residing in the selected sub-urban area aged 21 to 60 years old and able to comprehend either Malay or English. The sample size was calculated using the Raosoft Sample Size Calculator software with a margin of 5%, a confidence level of 95%, and a response distribution of 50%; hence, the recommended sample size was 359. Data was collected using convenience sampling and an online self-administered questionnaire was distributed through social media (Facebook, Telegram, and WhatsApp). The study received UiTM Research Ethics Committee REC/12/2021 (UG/MR/1117), and the data was encrypted to protect confidential and sensitive information.

2.2 Research instruments

The study used a structured questionnaire adopted from Mengesha et al. (2020) consisting of 3 sections. Section A is socio-demographic data including age, race, level of education, marital status, family history of cancer, and source of information regarding cervical cancer; meanwhile, Section B consists of questions about knowledge in various aspects of cervical cancer, including its meaning, risk factors, signs and symptoms, and screening. The knowledge section consisted of 27 closed-ended questions that required a yes or no response. Participants' knowledge was assessed using a scoring system where each 'yes' response earned 1 point, totaling to a maximum of 27 points for 27 questions. The scores categorized participants into three levels: 'Good Knowledge' for 22-27 points (80%-100% accuracy), 'Moderate Knowledge' for 16-21 points (60%-79% accuracy), and 'Poor Knowledge' for scores below 15 (<60% accuracy)..

In Section C, participants respond to 11 closed-ended questions about attitudes towards cervical cancer and its prevention, with 'yes' or 'no' options. Each 'yes' response earns 1 point. 'No' responses are not awarded points. The total score is calculated based on the 'yes' responses, which are then converted into a percentage for interpretation. If the participant's score meets or exceeds the mean score, it indicates a favorable attitude towards cervical cancer. The questionnaire reliability indicates Cronbach's alpha is 0.714 for knowledge and 0.77 for attitude toward cervical cancer.

2.3 Statistical analysis

The collected data was analysed using Version 26.0 of the IBM Statistical Package for the Social Sciences. Social demographic data, knowledge, and attitudes regarding cervical cancer were described using descriptive statistics. The correlation test was utilised to determine the relationship between knowledge and attitude. P-values <0.05 were considered statistically significant.

3. RESULTS

Table 1 describes the socio-demographics of 359 participants. 148 (41.2%) of women in the range 21 to 30 years old, and only 50 (13.9%) were from 51 to 60. Most of the participants were 264 (73.5%) is Malay. In terms of the level of education, 170 (47.4%) were undergraduates. The majority of the participants, 197 (54.9%), were single, and 332 (92.5%) stated that they had no family history of cervical cancer.

Table 1. Demographic characteristic

Characteristics	Frequency	Percentages (%)
Age		
21-30 years	148	41.2
31-40 years	100	27.9
41-50 years	61	17.0
51-60 years	50	13.9
Race		
Malay	264	73.5
Chinese	32	8.9
Indian	39	10.9
Others	24	6.7
Level of Education		
No formal education	5	1.4
PMR/PT3	6	1.7
SPM	78	21.7
Pre-university	79	22.0
Undergraduate	170	47.4
Master	13	3.6
PhD	8	2.2
Marital Status		
Single	197	54.9
Married	141	39.3
Divorced	21	5.8
Family History of Cervical Cancer		
Yes	27	7.5
No	332	92.5
Source of information regarding cervical cancer		
Parents	5	1.4
Classroom	44	12.3
Internet	137	38.2
Campaign	43	12.0
Mass Media (TV, Radio)	130	36.2

3.1. Knowledge of cervical cancer

Table 2 shows that most participants had moderate knowledge about cervical cancer 179 (49.9%). However, 43 (12%) participants are classified as having poor knowledge.

Table 2. Knowledge of cervical cancer

Variables	Frequency (n)	Percentage (%)
Knowledge		
Good	137	38.2
Moderate	179	49.9
Poor	43	12.0

Table 3 shows that most of the participants, 348 (96.9%), had heard about cervical cancer. The majority of participants, 302 (84.1%), understand the meaning of cervical cancer. 324 (90.3%) of them correctly identified abnormal cell growth in the cervix as cervical cancer. But 145 participants (40.4%) are unaware of the common symptoms of cervical cancer. Approximately 261 participants (72.7%) were aware of the risk factors for cervical cancer, while 57 participants (15.9%) were unaware of cervical cancer risk.

Table 3. Subscales of knowledge regarding cervical cancer

Variables	Frequency (%)
Heard about cervical cancer	
Yes	348 (96.9)
No	11 (3.1)
Know the meaning of cervical cancer	
Yes	302 (84.1)
No	57 (15.9)
The meaning of cervical cancer	
Wound of cervix	4 (1.1)
Pain in the cervix	11 (3.1)
Abnormal growth of cells in the cervix	324 (90.3)
Swelling in the cervix	20 (5.6)
Know the risk factors for cervical cancer	
Yes	261 (72.7)
No	98 (27.3)
Knowledge on risk factors of cervical cancer	
Sexually transmitted disease	251 (69.9)
Smoking	180 (50.1)
Having multiple Sexual Partners	245 (68.2)
Poor dietary habit	244 (68.0)
Early marriage	97 (27.0)
Family history of cervical cancer	322 (89.7)
HPV (human papillomavirus) infection	287 (79.9)
Know common symptoms of cervical cancer	
Yes	214 (59.5)
No	145 (40.4)
Knowledge on the symptoms of cervical cancer	
Intra or post-coital bleeding	280 (78.0)
Bleeding after menopause	245 (68.2)
Persistent blood-stained vaginal discharge	292 (81.3)
Lower abdominal pain	320 (89.1)
Cervical cancer is preventable	
Yes	346 (96.4)
No	13 (3.6)
Cervical cancer is curable	
Yes	302 (84.1)
No	57 (15.9)
Heard about the Pap smear test	
Yes	266 (74.1)
No	93 (25.9)
If yes, where did you hear about Pap smear for the first time? (n =286)	
Relatives	24 (6.7)
Friends	23 (6.4)
Health workers	112 (31.2)
Mass media	127 (73)

Variables	Frequency (%)
How many times should a healthy woman undergo a Pap smear test?	
Only once	111 (30.7)
Two times only	91 (25.3)
At least three times and above	157 (43.7)
Know the preventive measure for cervical cancer	
Yes	241 (67.1)
No	118 (32.9)
Know the preventive measures for cervical cancer	
Using condom	207 (57.7)
Good hygiene	338 (94.2)
HPV vaccine	308 (85.8)
Pap smear	293 (81.6)
Know the screening health for cervical cancer	
Yes	260 (72.4)
No	99 (27.6)
Know the screening for cervical cancer	
By taking a piece of cervical tissue	150 (41.8)
Blood test	47 (13.1)
By taking fluids/cells of the cervix	138 (38.4)
Urine test	24 (6.7)

3.2. Attitudes toward cervical cancer

According to Table 4, more than half of the participants, 217 (60.4%), had a favourable attitude, while 142 (39.6%) had an unfavourable attitude.

Table 4. Attitude toward cervical cancer

Variables	Frequency (n)	Percentage (%)
Attitude		
Favourable	217	60.4
Unfavourable	142	39.6

Table 5 presents the findings of the attitude toward cervical cancer which 193 (53.8%) do not believe cervical cancer transmits through sexual intercourse and do not believe smoking is a risk factor for cervical cancer 146 (40.7%). Only 116 (32.3%) participants think early marriage is a risk factor for cervical cancer. In contexts of prognosis, 323 (90%) thought cervical cancer was curable.

Table 5. Subscales of attitudes towards cervical cancer

Variables	Frequency (%)	
	Yes	No
Believe having multiple sexual partners is a risk factor for cervical cancer	262 (73.0)	97 (27.0)
Believe cervical cancer is transmittable through sexual intercourse	166 (46.2)	193 (53.8)
Believe HIV positivity increases the chance of getting cervical cancer	257 (71.6)	102 (28.4)

Believe the use of the oral contraceptive pill is a risk factor for cervical cancer	168 (46.8)	191 (53.2)
Think that smoking is a risk factor for cervical cancer	213 (59.3)	146 (40.7)
Think early marriage is a risk factor for cervical cancer	116 (32.3)	243 (67.7)
Think cervical cancer is a major health problem for a female of reproductive age group (15-49 years)	295 (82.2)	64 (17.8)
Think it is possible to detect cervical cancer with early screening before symptoms appear	324 (90.3)	35 (9.7)
Think early detection of cervical cancer is good for treatment outcome	351 (97.8)	8 (2.2)
Believe cervical cancer is preventable	346 (96.4)	13 (3.6)
Think it is possible to cure cervical cancer	323 (90.0)	36 (10.0)

3.3. The relationship between knowledge and attitudes toward cervical cancer

A statistically significant, positive, and moderate correlation exists between knowledge of cervical cancer and attitudes toward cervical cancer among women's residents, as shown in Table 6.

Table 6. The correlation between knowledge of cervical cancer and attitudes toward cervical cancer

	Attitudes toward cervical cancer	
	r	P value*
Knowledge of cervical cancer	0.457	< 0.001

* p-value <0.05

4. DISCUSSION

4.1. Knowledge of cervical cancer

This study shows that participants demonstrated moderate knowledge about cervical cancer, with 179 individuals (49.9%) exhibiting this level of understanding. This knowledge score was slightly lower when compared to a similar study conducted among female healthcare workers in Hawassa, Southern Ethiopia (Dulla et al., 2017). There is a different result between both studies due to the Ethiopia study conducted among female health care workers, where most of the participants received education and were aware of cervical cancer, compared to this study selected the general women population. However, this study's findings are consistent with research from other developing countries, such as India and Nigeria, which have reported low knowledge about cervical cancer (Taneja et al., 2021; Olubodun et al., 2019). The consistency across these countries might be attributed to factors such as the lack of

population-based screening programs, ineffective mass media campaigns, or cultural barriers hindering information dissemination about cervical cancer.

This study demonstrates that the knowledge of women about cervical cancer was generally good, with a majority of the participants having heard about cervical cancer. The findings align with similar studies conducted in Uganda and Kenya, where most participants also indicated awareness of cervical cancer (Mwaka *et al.*, 2016; Gatumo *et al.*, 2018). However, the study's results contrast with a similar study in India, where poor awareness of cervical cancer was reported, with only one-quarter of the participants indicating they had heard of cervical cancer (Jha *et al.*, 2020). The discrepancy in awareness levels could be attributed to various factors, including differences between developing countries regarding healthcare infrastructure, health education initiatives, and access to information about cervical cancer and screening.

This study highlights a concerning trend where only half of the participants who had heard about cervical cancer were familiar with its clinical manifestations. This finding is consistent with a previous study conducted in Malaysia which also reported less recognition of cervical cancer signs and symptoms among the Malaysian community (Seng *et al.*, 2018). The consequences of this lack of awareness and recognition are critical, as women may only seek screening and treatment when they experience physical symptoms (Darj *et al.*, 2019). Delayed detection can result in cervical cancer being diagnosed later, reducing the chances of successful treatment and potentially leading to poorer health outcomes. There is a need for comprehensive health education campaigns that not only raise awareness about cervical cancer but also emphasize the importance of recognizing its clinical manifestations. Educating women about the early signs and symptoms can empower them to seek medical attention promptly and increase the likelihood of early detection.

4.2. Attitudes toward cervical cancer

The results of this study indicate a positive and encouraging trend in participants' attitudes toward cervical cancer. According to Romli *et al.* (2019), the majority of working women in Kedah exhibited a positive attitude toward cervical cancer screening. More than half of this study participants demonstrated a favorable attitude, reflecting an awareness of the importance of cervical cancer prevention and early detection. The findings of this study are consistent with research conducted in other countries, such as Indonesia (Winarto *et al.*, 2022), Thailand (Chang *et al.*, 2017), and Zimbabwe (Tapera *et al.*, 2019), which also reported positive attitudes towards cervical cancer screening. These similarities across diverse populations suggest that efforts to promote awareness and education about cervical cancer are yielding positive outcomes in multiple regions.

The findings from the study indicate that half of the participants do not believe that cervical cancer transmits through sexual intercourse. This is similar to Ngune *et al.* (2020) study, which indicates many young women in Kenya are unaware of cervical cancer associated with sexual intercourse. This misconception about the transmission mode is concerning, as cervical cancer is primarily caused by persistent infection with high-risk types of Human Papillomavirus (HPV), a sexually transmitted disease (World Health Organization, 2021). Furthermore, this study revealed that only 32.3% of the participants consider early marriage a risk factor for cervical cancer. Seng *et al.* (2018) also found that many Malaysian women may be unaware that an early marriage increases the risk of cervical cancer. Early age at sexual experiences was higher vulnerable to cervical cancer because of biological immaturity and hormonal in the body of a young girl (Xavier-Júnior *et al.*, 2017). The low awareness of this risk factor underscores the importance of raising awareness about the potential health consequences of early marriage, including its association with cervical cancer.

This study highlights a positive trend in the participants' attitudes towards cervical cancer, with the majority acknowledging the possibility of prevention and the potential for cure. This aligns with research conducted by Getahun *et al.* (2020) and Aweke *et al.* (2017), which also reported similar attitudes among participants regarding the preventability of cervical cancer. However, the discrepancy between participants who believed cervical cancer is preventable and those who believed it is incurable, as reported by Mengesha *et al.* (2021), warrants further investigation. By building upon the existing awareness and knowledge, healthcare professionals can work together to reduce the population's cervical cancer burden, ultimately improving women's health and well-being in the region.

The findings from this study and the supporting evidence from Seng *et al.* (2018) and Jha *et al.* (2020) highlight a concerning lack of awareness among women regarding the link between smoking and cervical cancer. The participants in this study were found to lack awareness that smoking can lead to cervical cancer, suggesting that efforts to educate women about this important risk factor are still needed. The study by Jha (2020) further emphasizes that smokers may perceive their vulnerability to cardiovascular disease as higher than non-smokers, but they do not expect the same effect on their risk of developing cervical cancer. This disparity in perception emphasized the need for targeted health education campaigns that specifically address the association between smoking and cervical cancer.

4.3. The relationship between knowledge and attitudes toward cervical cancer

This study found a positive correlation between knowledge of cervical cancer and attitudes towards cervical cancer. The findings indicate that the participant possesses a moderate knowledge level and exhibits positive attitudes

towards cervical cancer. Studies have consistently shown that individuals with higher knowledge about cervical cancer and its risk factors tend to have more positive attitudes towards preventive measures and early detection (Zaghloul et al., 2020; Nurjihan et al., 2019). Increased knowledge often leads to a greater understanding of cervical cancer's potential risks and consequences, motivating individuals to adopt healthier behaviors and seek appropriate medical care. In contrast, Rajiah et al. (2017) mentioned no correlation between knowledge and attitudes toward cervical cancer in terms of HPV vaccination among dental students in Malaysia. The results of this study are intriguing and suggest that other factors beyond knowledge alone might be influencing the attitudes toward HPV vaccination. Addressing cervical cancer requires a holistic approach that goes beyond simply increasing knowledge levels. Combining accurate information with culturally sensitive and contextually relevant interventions is essential to fostering positive attitudes and driving meaningful behavior change toward cervical cancer prevention and early detection.

4.4. Strength and limitation

The strength of this study lies in the large number of participants involved. Having a substantial sample size is advantageous as it increases the study's statistical power and generalizability of the findings. One of the limitations of this study is the use of convenience sampling which involves selecting participants based on their easy availability or accessibility, which may introduce bias into the study. Another limitation is the use of an online survey as the data collection method. While online surveys offer advantages, such as cost-effectiveness and the ability to reach a large number of participants efficiently, they also have some drawbacks. The major concern is the lack of control over the respondents' identity and the possibility of multiple submissions from the same individual (duplicate responses). Additionally, the online survey format may restrict participation to those who are digitally literate and have access to the internet. This could result in the underrepresentation of certain demographic groups, such as older adults or individuals with lower socio-economic status, leading to a potential sampling bias.

5. CONCLUSION

In conclusion, the study highlights that women in suburban areas have moderate knowledge and a favorable attitude toward cervical cancer. The participants demonstrated moderate awareness of the disease's symptoms, risk factors, and prevention methods. Moreover, the study reveals a positive and moderate correlation between knowledge and attitude towards cervical cancer. While the study provides valuable insights into women's knowledge and attitudes towards cervical cancer in suburban areas, future research could explore the factors hindering women from regular cervical cancer screenings in suburban areas. The study's findings emphasize the importance of health education and

awareness campaigns to improve knowledge and attitudes towards cervical cancer among women in suburban areas. By fostering a positive attitude towards cervical cancer prevention, healthcare professionals can work towards reducing the burden of the disease and improving women's health outcomes in suburban communities.

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RESEARCH ARTICLE

Students' belief towards COVID-19 vaccine: A challenge in reopening university

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Abstract:

Little is known about health sciences students' belief and its relation to COVID-19 vaccine uptake as vaccination program was already taken place in Malaysia. An anonymous electronic survey of health sciences students was conducted at one large Malaysian university setting. The objectives of this study were the students' beliefs and actual behaviour towards Covid-19 vaccines. Students' beliefs about COVID-19 vaccines were elicited through a series of questions about the vaccine's acceptance, the risk of COVID -19 exposure, the perceived severity of COVID -19 and their negative attitudes towards vaccination. The main outcome of the study was the students' acceptance of COVID-19 vaccines and multiple logistics regression was performed to elucidate associated factors related to COVID-19 vaccine acceptance. A total of 275 students participated in this survey. The average age of the participants was 21.9(0.9) and more than three quarters of them (82.5%) were female. Most of the respondents have completed the COVID -19 booster vaccination (82.9%), and a higher acceptance of the vaccine 4.8 (95% CI: 4.7— 4.8). Students' risk of COVID-19 exposure, perceived severity of COVID -19 and their negative attitudes towards vaccination were measured at 0.4 (95% CI:0.3—0.5), 3.8(95% CI: 3.7—4.0) and 3.2 (95% CI: 3.1—3.2) respectively. Student belief in the safety of the COVID–19 vaccine was the only significant factor in vaccine acceptance. While health sciences students reported having high acceptance and vaccine uptake, concerns about the safety of the vaccine safety remained.

Keywords: Belief, COVID-19, health-behaviour, student, vaccine

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1. INTRODUCTION

The 2019 coronavirus pandemic (COVID-19) continues to pose a public health and societal challenge worldwide (Bouza et al., 2020; Ladhani et al., 2020; Li et al., 2020; Tsai et al., 2022). In Malaysia, concerted public health efforts are being made at all levels, from local to national, to protect the population, especially those most at risk of severe illness and death (Abdul Taib et al., 2022; Jayasundara et al., 2021; Marzo et al., 2022).

As of October 2022, many universities in Malaysia, has resumed face-to-face classes after a hiatus of about 2 years. Although there are many classes that are conducted in a hybrid manner, some of them are conducted entirely face to face. The reopening of the universities and campuses brings with it new

challenges and associated risks for transmission on campuses and in the surrounding communities (Wilson et al., 2020).

Although the risk of severe health outcomes from COVID-19 is relatively low in young adults without underlying health history, university students who are in close contact with faculty members, university staff and in the community are at significantly higher risk for COVID-19 should they become infected. As we can clearly see in the US, young adults were contributing to the sharp regional increase in COVID-19 infections in the southern US in June 2020, following the opening of colleges and universities (Boehmer et al., 2020).

In the run-up to the start of the semester, universities managements have planned and implemented various COVID

-19 prevention measures and actions in case students are infected. However, as this is our first attempt to reopen the universities nationwide, there is limited evidence from the university environment to prove the impact of many specific efforts employed. Besides, we still do not know how students' belief about vaccines and how they behave because the vaccine has already been administered to the Malaysian population. Therefore, in this study we would like to investigate the students' beliefs and actual behaviour towards Covid-19 vaccines. The findings can serve as a basis for strategies and nationwide measures that could contain the spread of Covid 19 in university areas and campuses in the event of an outbreak.

2. MATERIALS AND METHODS

2.1. Design

A cross-sectional survey was conducted online among health sciences university students in Faculty of Health Sciences, Universiti Teknologi MARA (UiTM) Kampus Selangor, Bandar Puncak Alam, Malaysia (latitude N 3° 12.0456', longitude E 101° 26.8446) between September to November 2022. This faculty comprised of eight schools namely school of nursing, dietetic, medical lab technology, optometry, occupational therapy, physiotherapy, medical imaging and school of environmental health and safety. Participants were over 18 years old and currently enrolled as full-time students at UiTM. They were contacted via social media and email with invitation survey web-link to participate in this survey. The survey took less than 10 minutes to complete. Participants were encouraged to share the link with other students. The study protocol was approved by the UiTM Ethics Committee.

2.2. Sample

Instrument development and measures

The questionnaire used in this study was developed based on literature review and discussion with several faculty members. They also were asked to review the questionnaire to ensure the content validity of the survey items. Prior to distribution of the questionnaires, a pilot survey (n=30) was conducted to improve the clarity of the items and the use of wording. The data from the pilot survey was not used for further analysis and was only used to assess the face validity of the questionnaires. The final version of the questionnaire took less than 10 minutes to complete. The questionnaire was developed in English, as the lectures are mainly given in this language, and they have a good command of it. A copy of the sample questionnaire can be obtained by emailing to correspondence author.

Participants' sociodemographic characteristics were obtained by asking questions about their gender, age, smoking, scholarship status, accommodation during the academic semester and their health insurance. Study participants were also asked about their medical history by asking if they had been diagnosed with various chronic conditions and diseases. They were also asked if they had had COVID-19 related symptoms in the last 6 months and if they had received a Covid-19 vaccination.

Students' beliefs were elicited through a series of questions about the acceptance towards COVID-19 vaccine, the risk of COVID -19 exposure, the perceived severity of COVID -19 and their negative attitudes towards vaccination. Acceptance of the Covid-19 vaccine was measured by asking participants if they would take the Covid-19 vaccine when it became available. They answered this question on a five-Likert scale (1=Definitely not at all to 5=Definitely take it). The score for this item was calculated by summing the points, with a higher score representing a higher acceptance of the Covid-19 vaccine. The risk of Covid-19 exposure was asked through two items. The first item asked participants about their risk of getting Covid-19 due to work exposure, and the second item asked about their risk of getting Covid-19 due to personal exposure. Participants could choose between three response options (true, false and not sure). To assess risk exposure, each item was dichotomized into 0 (false or not sure) and 1 (true) to indicate the occurrence of exposure. A summed score was calculated, with a higher score representing a higher risk of Covid-19 exposure.

Participants were also asked about their perceived severity of Covid-19. This was assessed by participants' agreement with the statement "Covid-19 is just a flu-like disease and is generally harmless." They could choose between 1=strongly disagree and 5=strongly agree on a five-point Likert scale. The answers were then reverse coded, with a higher score representing a higher severity of Covid-19.

To ask participants about their negative attitudes towards vaccination, four questions were asked: 'Vaccines are safe', 'Vaccines have side effects', 'Vaccines contain dangerous ingredients' and 'Vaccines cause long-term harm'. Respondents rated each item on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Summated scores were formed, with a higher score indicating a higher level of negative attitudes towards vaccination.

2.3. Statistical analysis

SPSS version 21.0 (SPSS Inc., Chicago, IL) was used for data entering and data analysis. Categorical data were reported as frequencies and percentages. Prior to data analysis, data were checked for outliers and normality based on box's plot

and histogram. Numerical data were reported as mean and standard deviation for normal data however for non-normal data their median and inter quartile range were reported.

The main outcome of the study was the students' acceptance of COVID-19 vaccines. In order to determine the factors that affect the acceptance among the student population to receive COVID-19 vaccines, multiple logistics regression was performed. At first, potential predictors for COVID-19 acceptance were screened using univariate logistic regression, and variables with $p < 0.25$ were considered in multiple logistic regression analysis. Vaccine acceptability outcome was recorded in two binary variables (acceptable [1] and not acceptable [0]), with students who responded 4 or 5 recorded as 1, while those who responded 1, 2 or 3 recorded as 0. A p -value of less than 0.05 was considered as statistically significant.

3. RESULTS AND DISCUSSION

A total of 275 students participated in this survey. The average age of the participants was 21.9(0.9) and more than three quarters of them (82.5%) were female. About half of the respondents (45.8%) received a scholarship. In addition, 35.6% reported having health insurance. The proportion of current and former smokers was 2.9% and 3.3% respectively. More than half of the respondents lived in a student residence (54.2%), followed by rented accommodation (42.2%) and accommodation with parents or family members (3.6%). Detailed demographics are presented in Table 1.

Table 1. Demographic characteristics of study participants (N=275).

Variable	N	(%)
Gender		
Male	48	(17.5)
Female	227	(82.5)
Age, Mean (SD)	21.9	(0.9)
Health insurance coverage		
Insured	98	(35.6)
Uninsured	177	(64.4)
Scholarship status		
Receiver	126	(45.8)
Non receiver	149	(54.2)
Smoking status		
Not a smoker	258	(93.8)
Ex-smoker	9	(3.3)
Current smoker	8	(2.9)
Accommodation during academic semester		
Living in hostel	149	(54.2)

Living with parents or family members	10	(3.6)
Living in rental house or apartment	116	(42.2)

The majority of the respondents have completed the COVID-19 booster vaccination (82.9%), surprisingly six (2.2%) of the respondents have not received any vaccination yet. Half of the respondents reported suffering from symptoms such as runny nose (51.6%), sore throat (50.9%) and fatigue (51.3%) in the last 6 months. Most of the respondents had not reported any chronic diseases, with less than 3% having chronic diseases, with chronic lung disease being the most frequently reported (2.9%). About 28% of respondents reported that they may be infected with COVID-19 in the last 6 months, with 55 and 49 respondents testing positive either by rapid test/serology or RT-PCR (Table 2).

Table 2. COVID-19 vaccine related information and medical history

Information	N	(%)
Have you received the influenza (COVID-19) vaccine?		
Completed booster	228	(82.9)
1 st dose vaccine	2	(0.7)
2 nd doses vaccine	39	(14.2)
Not taking any	6	(2.2)
For the past 6 months, did you experience any of these symptoms?	Yes	No Unknown
Fever more than 38°C	69(25.1)	192(69.8) 14(5.1)
Subjective fever (felt feverish)	128(46.5)	133(48.4) 14(5.1)
Chills	116(42.2)	149(54.2) 10(3.6)
Rigors	69(25.1)	195(70.9) 11(4.0)
Myalgia	109(39.6)	158(57.5) 8(2.9)
Runny nose	142(51.6)	123(44.7) 10(3.6)
Sore throat	140(50.9)	130(47.3) 5(1.8)
New olfactory and taste disorder(s)	19(6.9)	245(89.1) 11(4.0)
Fatigue	141(51.3)	126(45.8) 8(2.9)
Cough (New onset or worsening of chronic cough)	92(33.5)	172(62.5) 11(4.0)
Dyspnoea (Shortness of breath)	47(17.1)	216(78.5) 12(4.4)
Wheezing	41(14.9)	221(80.4) 13(4.7)
Difficulty breathing	30(10.9)	232(84.4) 13(4.7)
Chest pain	29(10.5)	239(86.9) 7(2.5)
Nausea or vomiting	54(19.6)	211(76.7) 10(3.6)

Abdominal pain	56(20.4)	211(76.7)	8(2.9)
Diarrhoea (loose stool/24h period)	39(14.2)	231(84.0)	5(1.8)
Have you been diagnosed with an underlying medical condition?			
Diabetes mellitus	2(0.7)	269(97.8)	4(1.5)
Hypertension	4(1.5)	268(97.5)	3(1.1)
Cardiovascular disease	1(0.4)	267(97.1)	7(2.5)
Chronic renal disease	1(0.4)	269(97.8)	5(1.8)
Chronic lung disease (asthma/emphysema/COPD)	8(2.9)	262(95.3)	5(1.8)
Disability	1(0.4)	271(98.5)	3(1.1)
Psychological/psychiatric conditions	5(1.8)	262(95.3)	8(2.9)
For the past 6 months did you ever infected with COVID-19 virus?	79(28.7)	191(69.5)	5(1.8)
If yes, did you confirm it by Positive conducting and test?			
Rapid test/serology	55		
RT-PCR	49		

In the present study, the respondents were found to have a higher acceptance of the vaccine. When asked how likely they would be to receive the vaccine COVID-19 if it were available, the acceptance rate of respondents was 4.8 (95% CI: 4.7-4.8). In addition, respondents were found to be at low risk of COVID-19 workplace or personal exposure, with a score of 0.4 (95% CI: 0.3—0.5). Their perceived severity of COVID -19 was on the higher side of the scale, with a mean score of 3.8 (95% CI: 3.7-4.0) observed, indicating a higher perception of the severity of COVID -19 (Table 3).

Table 3. Student's belief towards COVID-19 vaccine			
Acceptance towards COVID-19 vaccine	M	(SD)	(95% CI)
How likely are you to get a COVID-19 vaccine when it is available?	4.8	(0.6)	(4.7—4.8)
Risk of COVID-19 exposure	0.4	(0.0)	(0.3—0.5)
Perceived severity of COVID-19			
COVID-19 is just a flu-like disease and generally harmless	3.8	(1.2)	(3.7—4.0)
Negative attitudes toward COVID-19 vaccine, Overall Score	3.2	(0.5)	(3.1—3.2)
Vaccines are safe	4.3	(0.8)	(4.3—4.4)
Vaccines have side effects	4.1	(0.9)	(4.0—4.2)
Vaccines contain dangerous ingredients	2.2	(1.0)	(2.1—2.3)
Vaccines cause long-term harm	2.2	(1.0)	(2.1—2.3)

A negative perception of the safety and the side effects of the vaccine was observed among the study participants. Here we see that when asked about the safety of the vaccine and the side effects of the vaccine, the students gave a score of 4.3 (95% CI: 4.2—4.4) and 4.1(95% CI: 4.0—4.2) respectively. However, the study participants reported having a positive attitude when asked about the safety of the vaccine ingredients, 2.2 (95% CI:2.1— 2.3), and the long-term effect of the COVID -19 vaccines, 2.2 (95% CI:2.1— 2.3). Looking at the average overall score, participants in our study were rather negative towards the Covid-19 vaccine 3.2 (95% CI:3.1—3.2) (Table 3).

After running a multiple logistic regression to find factors related to acceptance of COVID-19 vaccine, only one variable was significant. Here it was found that a higher acceptance of the vaccine COVID-19 was observed when respondents considered the vaccine to be safe (Table 4).

Table 4. Factor associated with vaccine acceptance				
Factor	OR	(95% CI)	Wald statistics(df)	p-value
COVID-19 Vaccines are safe (B=0.786)	2.2	(1.2—4.0)	6.813(1)	0.009

In the present study, we investigated the acceptance of the COVID-19 vaccine among Malaysian university students. Since the COVID-19 vaccine has been commercially available since early 2021, the Malaysian government through the Ministry of Health has been actively involved in the voluntary vaccination of the entire Malaysian population. Compared to reports from studies conducted worldwide on population acceptance and willingness to be vaccinated against COVID-19, Malaysian health science students were among the highest as 95.3% (95% CI 92.8-92.8) of our study participants were accepting COVID 19 vaccination. Based on global studies, COVID-19 vaccine acceptability ranges from 54.8% in Russia to 88.6% in China (Lazarus et al., 2020). Our results also compared favourably with a study in the USA, where 45% of dental students and 23% of medical students were reluctant to be vaccinated against COVID -19 (Kelekar et al., 2021). The study among Cameroonian university students also showed a higher negative acceptance of vaccines (Ajonina-Ekoti et al., 2022). The higher acceptance is also shown by the fact that when the vaccine was available, only 2.2% (6 students) of the total study participants hesitated to be vaccinated. We can relate the higher acceptance to the vaccine as we could see how they look at COVID-19 is not another ordinary seasonal flu but something that need to be cautions at as shown by the higher value of severity towards COVID-19. We can also relate the higher acceptance of the Covid 19 vaccine in this study to the fact that on average respondents did not perceive the COVID-19 vaccine as ordinary flu-like

disease, but as a different kind of flu if you want to compare it to the seasonal flu we used to deal with, 3.8 (95% CI: 3.7—4.0).

Several factors could play a role in the higher acceptance of the vaccine among the study participants. It is possible that study participants studying health sciences remember that they are likely to be caring for patients who are SARS-CoV-2 positive, and they think that they need to make sure that they follow the procedures in place to protect not only themselves but also the patients they are dealing with. This result was also in agreement with a study among nursing students in the USA who were willing to be vaccinated (90%) and had a high vaccination rate (70% reported having received the first dose) (Morris et al., 2022). In the present study, we also observed that vaccine uptake among study participants was high (more than 80% received the booster dose). In Malaysia, young adults were among the last group to be vaccinated, as vaccination was first administered to medical personnel and high-risk groups such as the elderly. As when their time to be vaccinated much up to date and rigorous vaccine research have come out, can play a key role in reducing vaccination concerns among those who vaccinated last. As information became available from trusted sources, any negative views about the efficacy of COVID -19 vaccines were brought to light, so giving them better understanding of its role in preventing diseases and serious illnesses (Morris et al., 2022).

Our study population who affiliated with an academic center were more willing to receive vaccine compared to reports of vaccine hesitancy in some other population studied (Ajonina-Ekoti et al., 2022; Doyle-Campbell et al., 2022; Kelekar et al., 2021). Our findings are consistent with a study among health sciences students in Texas, where hesitancy to vaccinate was also low (Hosek et al., 2022).

Although vaccine acceptance was high, there is still a negative reaction to the Covid 19 vaccine among participants in this study, who still consider the vaccine to be unsafe and to have side effects, with the average score on both questions being quite high. However, on the questions of whether the vaccine contains dangerous ingredients and causes long-term harm, the respondents in our study have a low average score, indicating a positive side of vaccine. Looking at the average overall score, participants in our study were rather negative towards the Covid-19 vaccine. As we can see from the multiple logistic regression analysis, vaccine safety is also the only significant factor predicting vaccine acceptance in this population. In a study by Doyle-Campbell et al. (2022), it was reported that respondents who were hesitant to get vaccinated mainly justified it with concern about the long-term effects of the vaccine (85%) followed by not wanting to miss an exam/class (23%). In another study among college students

also found that vaccine hesitancy was related to concerns about the safety of the vaccine, its effectiveness and information about the vaccine (Silva et al., 2021). Interestingly, a study of university students in Lebanon even reported that hesitation to vaccinate was because the students thought the vaccine was a conspiracy (Hamdan et al., 2022). A successful immunisation program requires a multi-pronged approach, not only with the government-led health program, but also with the helpful platform of social media. As we can see, one of the biggest hurdles to overcome, especially in this population, is the widespread misinformation on the internet or social media platforms. Although participants in our study have high acceptance and uptake of Covid 19 vaccines, accessing positive messages and reliable resources can be challenging. Since the Malaysian Ministry of Health requires students to provide proof of their vaccination status before they are allowed to enter their facilities, this is probably why most of our study populations have higher vaccination rates as they need to use the facilities especially during the clinical years. However, the mandatory Covid 19 vaccination is controversial in some parts of the world (Morris et al., 2022), and we can see from our sample that despite the high vaccination rate, their attitude towards the Covid 19 vaccine is still negative.

Research on social media, which disproportionately promotes hesitant attitudes towards vaccination, shows that anti-vaccination content elicits greater user engagement, with anti-vaccination tweets 4.13 times more likely to be retweeted (Puri et al., 2020). In one study by Silva et al. (2021), it was reported that nearly 60% of study participants used social media to learn about Covid-19. Therefore, it is crucial that higher authorities in higher education and public health departments counteract the negative information about the Covid-19 vaccine by specifically using the platforms preferred by students. In addition, most of our students indicated that they were more concerned about the side effects and safety of vaccines. Therefore, programs should tailor educational messages to address these specific concerns. It can be difficult to navigate health information, especially for young adults whose health care has been organised and directed by parents and caregivers for most of their lives. Overcoming vaccine hesitancy is not one-size-fits-all, but knowing the target group and their needs is an important step. Targeted education about vaccine-preventable diseases, immunology and critical thinking, delivered through various communication channels, has been shown to reduce vaccination hesitancy and defuse vaccine misinformation (Johnson et al., 2019).

Among the strengths of the study is the large sample size in one of the largest university systems in Malaysia. We also controlled for student characteristics that might be related to student mental health and underlying chronic diseases.

Limitations of the study include the cross-sectional design, which cannot establish cause and effect or directionality. The study included more female than male participants. Finally, we did not study with an interview-based type of question, mostly asked online, so some of the items may not have been fully understood, yet all items were validated with face validity before distribution of the questionnaires. Appropriate future research considering the Health Belief Model to further explore students' beliefs about vaccination is warranted.

4. CONCLUSION

Understanding the student belief on vaccination in higher education especially among health sciences student is a critical step in slowing community spread and achieving COVID -19 immunity thresholds. Students surveyed have high acceptance and uptake of the COVID -19 vaccine. Students are willing to be vaccinated against COVID-19 provided the vaccines are proven safe.

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RESEARCH ARTICLE

Preliminary investigation of digital reading techniques and their impact on eye movement and blinking rate

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Abstract:

This preliminary study investigates the effect of four digital reading techniques on eye movement and blinking rate. A total of ten young adults (aged 18-26 years) were recruited in this preliminary investigation about the ocular impact of digital reading techniques. The inclusion criteria were best-corrected visual acuity of 6/6 and N5 (6/9 Snellen equivalent) or better for far and near, respectively. The exclusion criteria were any known vision problems and ocular diseases. Four types of digital reading techniques were studied: (1) skimming, (2) scanning, (3) intensive reading and (4) extensive reading. The ocular parameters encompass eye movements (fixation and saccadic) and blinking rate. The measurements were recorded using a Dikablis™ eye tracker. There was no significant difference among the four types of digital reading techniques in all eye movement investigations ($p > 0.05$). However, the blinking rate was the lowest during 'scanning technique' (average of 10.90 blinks per minute) and the highest during 'extensive reading' (average of 26.95 blinks per minute) (Friedman ANOVA Test = 11.35, $p = 0.03$). The eye movement patterns remain the same regardless of the types of digital reading techniques may indicate the robustness of individual visual search capability. The significant variation in blinking rate might be associated with the cognitive demand of the reading techniques. It will be interesting to investigate the ocular impact of these different digital reading techniques among school children due to the digital shift in our education system.

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1. INTRODUCTION

There is an uprising trend in the amount of exposure time for digital engagements (Bandura, 2002). Literature has consistently highlighted the negative impact of prolonged digital usage on the visual health (Adams, 2017; Atella et al., 2019; Chen & Rosli, 2022; Chindamo et al., 2019; Clark et al., 2018; Owen et al., 2010; Peper & Harvey, 2018; Rosella et al., 2019). Blue light from electronics has been linked to multiple ocular complications such as blurry vision, eyestrain, dry eye, macular degeneration, and cataracts (Bauer et al., 2013; Clark et al., 2018; Jaiswal et al., 2019). Compromised binocularity and the ocular surface are among the main visual problems associated with digital usage (Collier & Rosenfield, 2011; Golebiowski et al., 2020; Hue et al., 2014; Kwon et al., 2012; Park et al., 2014; Park et al., 2012; Phamonvaechavan, 2017; Seo, 2012). In contrast, O'Hagan et al. (2016) presented an interesting view after conducting a blue light exposure comparison study between artificial blue light exposure

emitted from digital devices (computer screens, tablet computers, laptops, and smartphones) and blue light exposures under natural environment. The blue light exposure conditions were also compared with international exposure limits. None of the digital devices assessed approached the exposure limits, even for extended viewing times. O'Hagan et al. (2016) concluded that blue light emitted from digital devices should not be a concern for public health even under extreme long-term viewing conditions. Nevertheless, they also alluded the age influence on the transmission of blue light from the cornea to the retina. They also emphasised the possibility of distress discrepancy between adults and children due to the higher transmission in children (O'Hagan et al., 2016).

Human eyes react differently to electronic and non-electronic activities (Arunthavaraja et al., 2010; Ciuffreda & Vasudevan, 2008; Lin et al., 2013). Mixed findings of accommodation adaptation were reported after electronic and non-electronic

near work (Pandian et al., 2006; Radhakrishnan et al., 2007; Cufflin & Mallen, 2008). The amplitude accommodation was unfailingly reduced after electronic tasks despite mixed outcome after printed materials. The accommodation lag surged but the accommodation facility worsened after both types of near work. Reduction in positive and negative relative accommodation was unswervingly found after electronic near task compared to mixed outcomes in printed materials. Thinning of choroidal was reported during electronic task but not in non-electronic task (Ghosh et al., 2014; Hoseini-Yazdi et al., 2021; Woodman-Pieterse et al., 2015).

Many health issues regarding electronic usage have prompted questions about the ‘what-how-why’ of the electronic device differed from the traditional printed hardcopy (Harasim, 2000; Prien et al., 2009). There is concern about the deterioration of functional vision due to near extensive work, especially in the electronic interface (Chang et al., 2015; Chu et al., 2014; Zambarbieri & Carniglia, 2012). It is interesting to examine how digital reading affects the eyes.

Reading, as one of the important skills for all ages in obtaining knowledge and learning, has an impact on the quality of life (Rayner et al., 2001). Reading requires complex coordination of interrelated information to construct meaning from written texts (Pearson & Anderson, 1985). Reading activity can be affected by several factors such as font size, font type, field size, contrast, eye movement, and age (Chen et al., 2019). Reading involves a visual-motor system and visual information processing system (Garzia et al., 1990). The reading activity engages the processes of decoding and linguistic comprehension (Hoover & Gough, 1990; Rayner et al., 2003). When retrieving information from a text, the reader can adopt different reading techniques depending on the purposes, such as searching for information (scanning), extracting detailed information (skimming), reading for leisure (extensive) or deep comprehension (intensive). Scanning is a reading technique that quickly searches for specific information in a text (Fisher, 2016). The scanning reader needs to immerse or deeply comprehend the text thoroughly. Skimming evaluates the text for complexity, interest, and general storyline rather than searching for specific facts (Barral et al., 2014). Skimming usually looks for summaries, first and last sentences of paragraphs, bold words or stands-out text features. Skimming reader deliberately skips text that provides details, stories, data, or other elaboration. Extensive reading generally involves a rapid reading of large quantities of material or extended readings (Bell, 2001). Extensive reading aims to obtain new information with no time constraints. Intensive reading refers to thoroughly and profoundly reading through every word of a text from beginning to end (Koay, 2015). Intensive reading requires a lot of focus and great mental efforts (Macalister, 2011).

Tracing texts during reading is essential to repossess information (Tabrett & Latham, 2011; Whittaker & Lovie-Kitchin, 1993). Reading involves the visual-spatial capability

to locate words, visually identify text, and visually encode typo scripts (Pammer et al., 2004; Singleton, 2008). Eye movements help to position the eyes to text location during reading (Altangerel et al., 2006; Ishii et al., 2013). Saccades is a rapid eye movement that shifts from one point to another during reading (Millodot, 2017; Rowe, 2012). Fixation refers to several eyes paused during reading for the information processing (Ciuffreda & Tannen, 1995). Visual information originated from fixation but was incorporated spatially and temporally by the movement of saccades to form a visual perception (Schütz & Souto, 2011; Solan, 1985). Readers barely note discontinuities as the eye moves from one spot to another (Burton et al., 2015; Krieber et al., 2016). The parafoveal information from the initial fixation is unified with information from the fovea of the following fixation (Ishida & Ikeda, 1989). Previous studies on eye movement and reading techniques exhibited increased saccades and shorter fixation duration during the skimming, scanning, and extensive reading compared to the intensive reading (Loberg et al., 2019). However, the disparity was reported among those good readers. People with good reading skills reported shorter fixation durations than an average skilled reader (Ashby & Clifton Jr, 2005).

The blinking rate is closely linked to reading. Visual and ocular symptoms experienced by digital users have been reported to associate with changes in the quality of blinking and tear break-up to ensure the maintenance of the normal optical integrity (Emina, 2003; Himebaugh et al., 2009; Patel et al., 1991). Symptomatic digital users showed a reduced blinking rate (Emina, 2003; Jaiswal et al., 2019; Patel et al., 1991). In a well-controlled laboratory set-up, a significant reduction in the blinking rate was reported in the letter tracking task compared to watching movies (Himebaugh et al., 2009). The blink rate decreased in a visually demanding task (Baumstimler & Parrot, 1971; Drew, 1951; Stern & Skelly, 1984). This inverse relationship between the blink rate and the task criteria can be due to efforts to reduce the risk of losing essential information (Baumstimler & Parrot, 1971). Electronic reading has been associated with increased burning sensation, tearing, and blinking (Argilés et al., 2015; Prabhasawat et al., 2019).

The present study aimed to directly compare the four different reading techniques (scanning, skimming, intensive and extensive reading) using eye movement and blinking rate. Our study design controlled the screen luminance and text structure consistency. Eye movement and blinking rate were measured using one piece of equipment to control the time variation.

2. MATERIALS AND METHODS

Ethical approval was obtained from the UiTM Research Ethics Committee [REC/01/2020 (UG/MR/17)]. This cross-section study adhered to the declaration of Helsinki. Written informed consent was obtained prior to data collection. In this

preliminary study, ten young adults were recruited using convenient sampling. The inclusion criteria were best-corrected visual acuity of 6/6 and N5 (6/9 Snellen equivalent) or better for far and near, respectively. The exclusion criteria were any known vision problems and ocular diseases.

The data collection was done in a room size of 3x4 meters. The subject was seated on a chair, and a table was used. The chair and table height was 45 cm and 75 cm, respectively. Four types of digital reading techniques were studied under standard room illumination (400 to 500 lux) at 40cm working distance: (1) skimming, (2) scanning, (3) intensive reading and (4) extensive reading. The sequence of the four techniques was randomly determined for each subject. The washout period was 30 minutes between techniques.

The reading materials were presented in black text on a white background on a laptop [MacBook Pro Retinal Display 13.3 inch]. The contrast is about 80% quantified by luminance meter LS110 [Konica Minolta, Japan]. The luminance from the laptop was the highest setting in the display option. The ambient illumination was the standard office lighting, ranging from 400 to 500 lux, measured by Illuminance Spectrophotometer, CL-500A [Konica Minolta, Japan]. All reading materials for each reading technique were specially engendered for this research. They were prepared in Arial font type of N12 (6/24 Snellen equivalent) font size, single line spacing, the same number of sentences, approximately 500 words per page and justified alignment of the paragraphs. N12 was selected because it was commonly used in books.

Specific instruction was given to the subject for each reading technique. Each subject was given a single paragraph of text on one page for the scanning technique. All texts were in English. The subject was instructed to read the words starting with capital letters. For the skimming technique, the subject was given a collection of articles, and they were instructed to sort them out according to categories such as health, sports, history, and food. For the intensive reading investigation, the subject was given a text to read, and they needed to answer some questions about the text. For the extensive reading probe, the subject was given a few short stories (in a single paragraph on each page). The subject was instructed to read for 5 minutes at leisure.

The eye movements (fixation and saccadic) and blinking rate were recorded using a Dikablis™ eye tracker for five minutes during each type of reading technique. The eye tracker was calibrated for each reading technique to get an accurate reading. Calibration was performed before taking any measurement by adjusting the eye camera, pupil detection configuration, and calibrating the eye motion. Dikablis™ eye tracker is a head-mounted eye-tracking system used to track and experimentally analyse the glance direction and the eye movement of the subject being tested. Dikablis™ incorporates live view in the recording software and allows the recording of the blinking rate.

Statistical data analysis was performed with statistical software (SPSS software 26.0 for Windows; IBM Corp., Armonk, NY, USA). The Friedman ANOVA test was used to compare the mean score of parameters such as fixation, saccades, and blinking rate to measure the effect on visual function for each reading technique.

3. RESULTS AND DISCUSSION

The age range of the subjects was between 18 and 26 years old. Gender composition consisted of seven female and three male. All of them were university students.

The effect of digital reading techniques on fixation, saccades, and blink rate were summarised in Table 1. There was no significant difference among the four types of digital reading techniques in fixation and saccadic eye movement investigations ($p > 0.05$). However, the blinking rate was the lowest during 'scanning technique' (an average of 10.90 blinks per minute) and the highest during 'extensive reading' (an average of 26.95 blinks per minute) (Friedman ANOVA Test = 11.35, $p = 0.03$).

Table 1. The Effect of Four Reading Techniques on Eye Movements and Blinking Rate

Reading techniques	Eye movements, counts (n)		Blinking rate (Blinks per minute)
	Fixation	Saccadic	
Scanning	22.30	26.90	10.90
Skimming	21.30	20.30	22.40
Intensive	17.40	19.10	21.75
Extensive	21.00	15.70	26.95
Friedman Test	2.34	6.85	11.35
p-value	0.93	0.24	0.03

Fixation in reading is the point at which the eyes rest when reading. To measure the effectiveness of reading performance, the total number of eye fixes during the reading of the complete text was counted in this study. Less eye fixation during reading was suggested to result in a greater word intake per fixation (Vitu et al., 2001). A previous study suggested that the number of fixations is closely related to the difficulty of the reading task (Krieber et al., 2016). Reading for comprehension should require more cognitive processing and be considered more incredible difficulty. However, our findings on fixation and saccade patterns remain the same regardless of the types of digital reading techniques, which may indicate the robustness of individual visual search capability. Therefore, the characteristics of the reading texts used became really crucial. To repeatedly use the same text might help to standardize the consistency of text difficulty level across techniques. However, it might introduce other limitations such as learning effect and boredom to subjects in four experimental sessions. Our experimental settings were devised as close as possible to the typical expected reading

environments that stipulated scanning, skimming, intensive and extensive techniques. We assembled variety of texts that matched the cognitive level of our subjects. Text of equivalent length was also premeditated to reduce variant.

Our findings partially supported the previous research that reported an inverse relationship between the blink rate and the task demand (Abusharha, 2017; Baumstimler & Parrot, 1971). The blink rate concerns maintaining the normal integrity of the ocular surface (Golebiowski et al., 2020; Kim et al., 2017). Most blinks originate a cycle of secretion, dispersal evaporation, and drainage of tears (Fenga et al., 2008; Himebaugh et al., 2009), duly associated with dry eye symptoms. Surprisingly, the highest blinking rate was extensive and not intensive reading in our study. Intensive reading should give more cognitive demand than the extensive reading technique that was associated with blink inhibition (Golebiowski et al., 2020; Nakamura et al., 2010). One possible explanation is the reading passage used in our intensive task was not challenging enough to trigger more blinking. While for scanning reading, the low legibility perceived by the retinal image might influence the lower blinking rate (Golebiowski et al., 2020), which sees high eye movement counts on fixation and saccadic.

The small sample size of this preliminary study may limit the inference of the findings to the general population. A larger sample size with more complex reading passages for intensive reading technique investigation should be used in future research. Another limitation of this preliminary study was the absence of reading skill information of the participants. Longer fixation duration on low-frequency words was found in average-skilled readers compared to high-skilled readers (Ashby et al., 2005). A skilled reader showed fewer fixations per word and a total number of saccades and reduced jump distances than low-skilled readers (Krieber et al., 2016). However, our cross-over design minimised the bias. Our recommendation for future design should include reading performance evaluation of subjects. In addition, it will be interesting to investigate the ocular impact of these different digital reading techniques among school children due to the digital shift in our education system.

4. CONCLUSION

The eye movement patterns remain the same regardless of the types of digital reading techniques may indicate the robustness of individual visual search capability. The significant variation in blinking rate might be associated with the cognitive demand of the reading techniques.

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RESEARCH ARTICLE

Evaluation of the physical characteristics of *Beta vulgaris* and *Intsia bijuga* aqueous and methanolic extracts in comparison to haematoxylin stain

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Abstract:

The haematoxylin stain is universally recognised as pathology's gold-standard nuclear staining. This study evaluated and compared the pH value, and colour concentration of *Intsia bijuga* and *Beta vulgaris* extracts to that of haematoxylin. After lyophilisation, the plant material was extracted using methanol and water. Analyses were performed on the extracts' physical colour, pH, and colour concentration, and the results were compared to haematoxylin. A pH meter was used to obtain the pH value and spectrophotometric absorbance readings were taken to determine the colour concentration. The pH range for extracts of *B. vulgaris* was between 4.18 and 5.80, whereas the pH range for extracts of *I. bijuga* was between 4.46 and 4.65. There are statistically significant discrepancies ($p < 0.001$) in the pH and colour concentration analyses, as shown by the colour concentration statistical analysis. The colour properties of *I. bijuga* and *B. vulgaris* were also discussed to further enrich the understanding of their physical characteristics. In conclusion, the pH levels of the extracts were greater than those of haematoxylin. Regarding the colour concentration, the methanolic extract of *B. vulgaris* had a lower concentration than haematoxylin, while the other extracts had more significant concentrations than haematoxylin. In conclusion, the methanolic extract of *I. bijuga* shows the most significant similarity to haematoxylin in terms of its physical qualities.

Keywords: Aqueous extract, methanol extract, *Beta vulgaris*, *Intsia bijuga*, haematoxylin

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1. INTRODUCTION

Haematoxylin is one of the most excellent dyes ever created. For decades, the dye has been the gold standard for nuclei stain in pathology staining, alongside eosin in the Papanicolaou smear protocol. Due to its many advantages over any other stain, haematoxylin stains were still the primary nuclei stain. Many studies were done to find the ideal substitute for haematoxylin stain because, in the past, there have been several cases of haematoxylin shortage recorded (Dapson et al., 2010). The last case of haematoxylin shortage was reported by a few laboratories in 2008. As a result, the vendors had to offer substitutes for the nuclear stain as the availability of the stain was unpredictable. Moreover, along with its escalating price, there are also concerns that the shortage might be happening again, and there is also no way to tell how long haematoxylin production may last (Groover et al., 2009).

I. bijuga (Colebr.) Kuntze from the family *Fabaceae*, also known as the Merbau tree, is a high commercial value tree in Southeast Asia, including Malaysia. It is mainly used as materials for construction and furniture. The local communities also use Merbau for medicinal purposes to combat diseases due to its anti-microbial, anti-viral, and anti-cancer properties (Angio et al., 2022; Bradacs, 2008; Widodo et al., 2019). However, in recent years, fabric dyes have been developed from this tree. Meanwhile, *B. vulgaris* L. from the family *Amranthaceae*, also commonly known as beetroot, is a vegetable with red tapered fleshy roots. The plant is usually consumed as food and as health remedies due to its high content of fibre, nutrients, and minerals such as potassium, sodium, nitrate, vitamin C, vitamin A, and vitamin K. Research has proven that the content in beetroot possesses antioxidant and antiradical properties. It has also been shown that beetroots are helpful as natural colourant due to their high content of betalain (Alim-un-Nisa et al., 2021; Goldman & Janick, 2021; S. W. Sari et al., 2021).

Therefore, the aim of this study is to compare the physical characteristics of *I. bijuga* and *B. vulgaris* with haematoxylin as they have the potential to be developed as alternative natural nuclear staining reagent. In addition, to further enrich the understanding of the *B. vulgaris* and *I. bijuga* potential as haematoxylin alternatives, the colour properties of these two plants were discussed.

2. MATERIALS AND METHODS

2.1. Extractions

Two kg of *B. vulgaris* were peeled off. Then both peel and flesh were cut and weighed. The plants were frozen overnight under -86 °C in an ultra-low freezer before being lyophilised using a freeze dryer (SCANVAC) for three days. The small pieces of beet peel and flesh of *B. vulgaris* (Figure 1) were then weighed again and ground into powder. *I. bijuga* were also cut into smaller pieces and ground into powder as shown in Figure 2. After that, all the powders were soaked in distilled water and methanol for aqueous and methanolic extraction, respectively, for 24 hours with stirring. The extracts were then filtered using Whatman's filter paper, and the residues from the filtration were soaked again. This process was repeated until the filtrate produced was clear. The filtrates were then concentrated with a rotary evaporator. The extracts were placed in containers and labelled as demonstrated in Table 1. The extracts were all then stored at 4°C.



Figure 1: Small pieces of beet peel and flesh of *B. vulgaris*.



Figure 2: Ground powder of *I. bijuga*.

Table 1: Label of each plant extract.

Label	Extracts
Aqueous Extract 1 (AE1)	Aqueous extract of <i>B. vulgaris</i> peel
Aqueous Extract 2 (AE2)	Aqueous extract of <i>B. vulgaris</i> flesh
Aqueous Extract 3 (AE3)	Aqueous extract of <i>I. bijuga</i>
Methanol Extract 4 (ME1)	Methanol extract of <i>B. vulgaris</i> peel
Methanol Extract 5 (ME2)	Methanol extract of <i>B. vulgaris</i> flesh
Methanol Extract 6 (ME3)	Methanol extract of <i>I. bijuga</i>

2.2. pH and colour concentration measurement

In this research, the pH and colour concentrations of the extracts were analysed and compared with that of haematoxylin. The pH of the extracts and haematoxylin was measured using a pH meter. To determine the colour concentration, the absorbance of the extracts was measured at a specific wavelength of 630nm using PG Instruments T80+ UV/VIS Spectrophotometer. All results were then statistically analysed using Statistical Package for Social Sciences (SPSS) Software by one-way analysis of variance (ANOVA) and t-test.

3. RESULTS AND DISCUSSION

3.1. Extractions

In this study, the beetroots were lyophilised to prevent the degradation of the compounds present in the samples. This process allows moisture to be removed without destroying the compound in the samples, thus, increasing its shelf life. About 80 to 90% of the weight was lost after lyophilisation due to moisture loss. After the samples were soaked in the solvent and filtered, the extracts produced were concentrated using a rotary evaporator under vacuum condition. This approach enabled easy temperature regulation and reduced the risk of thermal degradation of the compounds in the sample. Additionally, this extraction method offered faster results compared to the boiling method.

3.2. pH Measurements

Table 2 shows the pH reading of the extracts and haematoxylin. All the extracts and haematoxylin exhibited acidic pH levels. Haematoxylin has the lowest pH at 2.55, while the aqueous extract of *B. vulgaris* peel has the highest pH at 5.94. All extracts showed higher pH values than haematoxylin. The second highest was *B. vulgaris* flesh methanolic extract, with an average value of 5.79. Meanwhile, *I. bijuga* methanolic extracts have the closest pH to haematoxylin, with an average value of 3.47. The methanolic extracts of *B. vulgaris* showed pH ranging from 4.18 to 4.56 and 5.77 to 5.95 for aqueous extract, as shown in Table 2. In

a previous study by Kale et al. (2018), beetroot juice showed a slightly higher pH at 6.5, while Madushan et al. (2021) reported a much higher pH of their extract which was at 7.5. Farghaly et al. (2019) stated that pH significantly influences the stability of betalain, one of the important pigments found in beetroot, with its optimal pH falling from 4 to 5. On the other hand, *I. bijuga* has pH values between 3.4 to 4.6. This result was slightly lower than the pH value reported by Malik et al. (2016), which ranges between 5 to 6.

Table 2: pH readings of haematoxylin and extracts.

Extracts	1 st reading	2 nd reading	3 rd reading	Average
HX	2.55	2.57	2.53	2.55
ME1	4.18	4.20	4.20	4.29
ME2	4.54	4.54	4.56	4.55
ME3	3.46	3.48	3.46	3.47
AE1	5.94	5.92	5.95	5.94
AE2	5.80	5.77	5.80	5.79
AE3	4.63	4.60	4.65	4.63

*HX= Haematoxylin, ME1= *B. vulgaris* peel methanolic extract, ME2= *B. vulgaris* flesh methanolic extract, ME3= *I. bijuga* methanolic extract, AE1= *B. vulgaris* peel aqueous extract, AE2= *B. vulgaris* flesh aqueous extract, AE3= *I. bijuga* aqueous extract

3.3. Physical Colour and Colour Concentrations

Figure 3 shows the colour of the methanolic extracts. The physical colour of both peel and flesh *B. vulgaris* methanolic extracts seems to be retained, which is bright red, similar to the colour of the vegetable before its extractions. Meanwhile, as shown in Figure 4, the colour of the aqueous extraction of *B. vulgaris* was brown, probably due to oxidation and degradation of the compound in the extracts. On the other hand, the extraction of *I. bijuga* in both aqueous and methanol produced dark brownish colour extracts. None of the extracts resembles the physical colour of haematoxylin as seen in Figure 5. The methanolic extracts of *B. vulgaris*'s colour were much lighter than the other extracts while *I. bijuga* methanolic extracts seem to have similar concentrations with haematoxylin. However, its colour does not resemble the purple colour of that haematoxylin.

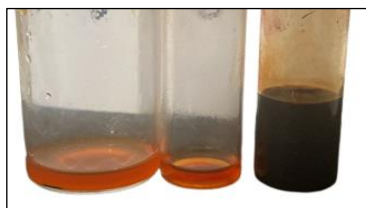


Figure 3: Physical colour of methanolic extracts (From left; *B. vulgaris* peel, *B. vulgaris* flesh, and *I. bijuga*).



Figure 4: Physical colour of aqueous extracts (From left; *B. vulgaris* peel, *B. vulgaris* flesh, and *I. bijuga*).



Figure 5: Physical colour of haematoxylin.

To determine their colour concentrations, absorbance were measured using the UV/Vis Spectrophotometer. The results were then compared with haematoxylin. As shown in Table 3, the average absorbance reading of haematoxylin recorded was 1.21. The average absorbance of ME1 was 0.400 and 0.421 for the flesh extracts. ME3 recorded the highest absorbance with an average of 2.994. Meanwhile, all the aqueous extract showed higher absorbance than haematoxylin. The absorbance for aqueous extracts of *B. vulgaris* peel, flesh, and *I. bijuga* were 2.256, 2.910, and 2.665, respectively.

ME1 showed the lowest absorbance reading, while ME3 recorded the highest reading. AE1 recorded the nearest absorbance reading to haematoxylin. The absorbance values were directly proportional to the concentration of the extracts; thus, methanolic extracts of *I. bijuga* have the highest concentration, while methanolic extracts of *B. vulgaris* have the lowest concentration. Except for ME1 and ME2, the other extracts have higher concentrations than haematoxylin. Since AE1 recorded the closest absorbance reading to haematoxylin, its colour concentration is the nearest to haematoxylin compared to other extracts. However, despite producing colour, these extracts might not be able to stain the nucleus if it does not possess the binding ability to the tissues (Veuthey et al., 2014). Thus, further research needs to be done to analyse their staining ability. In one study by Udonkang et al. (2021), beetroot dye was found to have a comparable staining ability to haematoxylin. The dye gave detailed features of the stained tissues making it promising as a haematoxylin alternative. Similarly, Obeta et al. (2022) also found that beetroot is suitable as a haematoxylin alternative as it possesses similar properties to haematoxylin.

Table 3: The absorbance reading for haematoxylin and extracts

Extracts	1 st Absorbance	2 nd Absorbance	3 rd absorbance	Average
HX	1.202	1.207	1.209	1.210
ME1	0.402	0.400	0.398	0.400
ME2	0.415	0.421	0.426	0.421
ME3	2.989	2.989	3.003	2.994
AE1	2.243	2.257	2.267	2.256
AE2	2.909	2.909	2.913	2.910
AE3	2.667	2.663	2.666	2.665

*HX= Haematoxylin, ME1= *B. vulgaris* peel methanolic extract, ME2= *B. vulgaris* flesh methanolic extract, ME3=*I. bijuga* methanolic extract, AE1= *B. vulgaris* peel aqueous extract, AE2= *B. vulgaris* flesh aqueous extract, AE3=*I. bijuga* aqueous extract

3.4. Statistical Analysis

A one-way ANOVA test was performed to compare the mean between the extracts, and the results were tabulated in Table 4. The ANOVA test shows significant differences at $p < 0.001$ for all the extracts. Meanwhile, an independent t-test was performed to compare the pH of the extracts to the haematoxylin. The statistical result showed that haematoxylin and ME3 have the slightest difference ($t = 68.750$), while AE1 has the highest difference with haematoxylin ($t = 233.086$).

Table 4: Comparison of pH of different types of extracts.

Type of dye	N	Mean (SEM)	t(df)	F ^a	P value
HX	3	2.55 (0.020)		15463.345	0.001
ME1	3	4.193(0.116)	123.250 (4)		
ME2	3	4.547 (0.116)	149.750 (4)		
ME3	3	3.467 (0.116)	68.750 (4)		
AE1	3	5.887 (0.757)	233.086 (4)		
AE2	3	5.790 (0.017)	212.108 (4)		
AE3	3	4.627 (0.025)	111.894 (4)		

*a=One way ANOVA test, t=t-test, df=degree of freedom, HX= Haematoxylin, ME1= *B. vulgaris* peel methanolic extract, ME2= *B. vulgaris* flesh methanolic extract, ME3=*I. bijuga* methanolic extract, AE1= *B. vulgaris* peel aqueous extract, AE2= *B. vulgaris* flesh aqueous extract, AE3=*I. bijuga* aqueous extract

One-way ANOVA analysis was also performed to obtain the mean concentration between all the extracts. The statistical test, as shown in Table 5, shows significant differences ($p < 0.001$) for all extracts. An Independent t-test was done to analyse the differences between the extracts and haematoxylin. AE1 has the least difference ($t = 144.486$), while AE2 has the most difference ($t = 818.095$).

Table 5: Comparison of absorbance value of extract.

Type of dye	N	Mean (SEM)	t(df)	F ^a	P value
HX	3	1.206 (0.004)		104300.877	0.001
ME1	3	0.400 (0.001)	338.588 (4)		
ME2	3	0.421 (0.003)	206.635 (4)		
ME3	3	2.994 (0.005)	349.844 (4)		
AE1	3	2.256 (0.007)	144.486 (4)		
AE2	3	2.909 (0.000)	818.095 (4)		
AE3	3	2.665 (0.001)	607.119 (4)		

*a=One way ANOVA test, t=t-test, df=degree of freedom, HX= Haematoxylin, ME1= *B. vulgaris* peel methanolic extract, ME2= *B. vulgaris* flesh methanolic extract, ME3=*I. bijuga* methanolic extract, AE1= *B. vulgaris* peel aqueous extract, AE2= *B. vulgaris* flesh aqueous extract, AE3=*I. bijuga* aqueous extract

3.5. Haematoxylin

In this study, the physical properties of the two plants mentioned were studied and compared to the properties of haematoxylin. Haematoxylin is one of the most influential and most used dyes in the world (Orchard, 2018; Avwioro, 2011). Figure 6 shows the logwood cross-section of *Haematoxylum campechianum*, the tree from which haematoxylin was originally extracted. First documented in 1502, haematoxylin was initially used as a fabric dye and as a diarrhoea treatment by the Mayan civilian (Orchard, 2018). It was also used as fabric dye to stain cotton in the 16th century and the soldiers' uniforms during the American Silver War until the Second World War (Ali et al., 2017). Haematoxylin is a colourless dye (empirical formula: $C_{16}H_{14}O_6$; C. I. 75290) that turns into haematein when oxidised, which is reddish brown (Titford, 2005). The molecular structures of both haematoxylin and hematein are shown in Figure 7 and Figure 8, respectively. This oxidation process can occur either naturally or by chemical means.



Figure 6: *Haematoxylum campechianum* logwood cross-section which is used in the production of haematoxylin (Orchard, 2018).

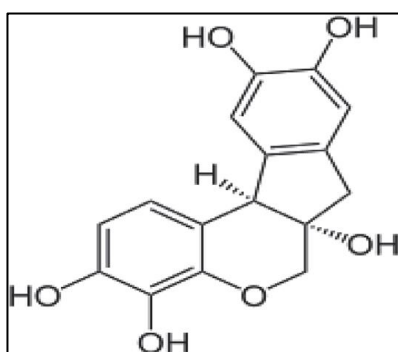


Figure 7: Haematoxylin's molecular structure before it is oxidised (Orchard, 2018).

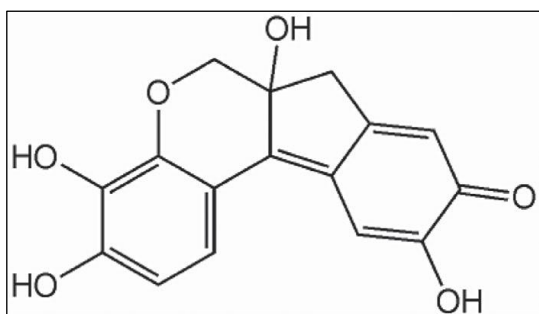


Figure 8: Hematein's molecular structure, which formed when haematoxylin oxidised (Orchard, 2018).

Historically, Bohmer was the first one to successfully make the haematoxylin stain in 1865 when he added mordant to the dye. It was Wissowzky, however, who used it first for pathology staining in 1876. Until now, haematoxylin is still the prominent nucleus stain used in cytological and histological practices.

Previous research has been done to find alternatives or substitutes for haematoxylin. One of the plant extracts that have enormous potential is roselle (*Hibiscus sabdariffa*). According to Alshamar & Dapson (2021), research on this

flower as an alternative for nuclear stains has been studied since 1976. Since then, more research has been done on different extractions and mordant of *H. sabdariffa* for formulating the plant as a stain. Although it was able to stain the cells and tissue successfully, the plant was not good enough due to the stability of its components. Research by Benard et al. (2015, 2017) reported that the aqueous extract of *H. sabdariffa* was satisfactory as a nuclear stain in histological staining of brain tissue and connective skin tissue as the stain was able to give similar colour when compared to haematoxylin. Conversely, a study by Okolie et al. (2021) found that the pH of roselle extract is acidic. Thus, it is not suitable as a nuclear stain.

Other researchers studied beetroot as a haematoxylin alternative. The plant's pigment, which is responsible for the staining properties, is betalain. Obeta et al. (2022) suggested that beetroot might possess haematoxylin-like staining properties because the nucleus was stained bluish-purple when the extracts were used as a substitute in their histological staining. On the other hand, Udonkang et al. (2018) reported that beetroot could stain cytoplasm and other components of the tissue successfully but could not successfully stain the nucleus.

3.6. *B. vulgaris* and *I. bijuga* colour properties

To further understand the colour properties of these two plants, the chemical content of the plants was reviewed. Current studies unveiled the physical colour of both peel and flesh methanolic extracts of *B. vulgaris* remains bright red, resembling the colour of the vegetable itself. In contrast, the aqueous extract of *B. vulgaris* appears brown, possibly due to oxidation and degradation of compounds.

Similarly, both aqueous and methanolic extracts of *I. bijuga* yield dark brownish extracts, distinct from the colour of haematoxylin. Various beneficial nutrients such as folate, potassium, nitrates, and vitamins C, A, and K. Hence, it is highly regarded as a healthy ingredient in culinary practices and traditional health remedies. Beetroots are one of the popular natural dyes in the market due to their high content of betalain pigments, which produce the red colour of the plant. Moreover, due to its health benefit and aesthetic value, the pigment gained popularity as a commercialised natural colourant, especially as a food colourant. Alim-un-Nisa et al. (2021) showed that the plant is a safe food colourant for candy, and the colour was retained until it was exposed to high temperature and pH. In addition, beetroot also can be used as a natural food preservative because betanin was found to be able to prevent the deterioration of some foods (Silva et al., 2021). Due to the aesthetic value that can be produced from beetroot extracts, the development of its fruit as beauty products has also been studied. Sari et al. (2021) studied beet root formulation as a blush that can show colour when applied to the skin without damaging them.

Table 6: Betalain, betacyanin, and betaxanthin content in beetroot in different studies.

Author	Compounds	Concentration (mg/g)	Beetroot parts	Method	Extraction method
(Mistriano et al., 2022)	Total Betalain	1.18 ± 0.03	Not mentioned	Spectrophotometric method	Ethanol extract
(Desseva et al., 2020)	Betacyanin	2.81 ± 0.10	Beetroot juice		Not mentioned
	Betaxanthin	1.27 ± 0.00			
(Alonzo-Macías et al., 2020)	Betanin	$30.56 \pm 0.18 - 67.50 \pm 1.28$	Not mentioned	HPLC	Methanolic Extract
(Wang et al., 2020)	Betanin	0.26	Conventionally grown root		
		0.057			Ascorbic acid extract
		0.76	Organically grown root		Methanolic extract
		0.038			Ascorbic acid extract
(Hernández-Aguirre et al., 2021)	Betalain	$3.49 \pm 0.14 - 3.65 \pm 0.25$	Beetroot waste from peel and pulp	UV-Vis spectrophotometer	Deep eutectic solvents (DES) extract
	Betacyanin	$0.23 - 0.30$			
	Betaxanthin	$0.09 - 0.14$			
(Bárta et al., 2020)	Betalain	$10.92 - 18.10$ (Before boiling) $8.75 \pm 1.05 - 15.04 \pm 0.79$ (After boiling)	Red beetroot roots	Spectrophotometric method	Ethanol extract
	Betacyanin	$4.29 \pm 0.22 - 6.95 \pm 0.21$ (Before boiling)			
	Betaxanthin	$4.29 \pm 0.22 - 6.95 \pm 0.21$ (Before boiling) $3.17 \pm 0.39 - 5.31 \pm 0.28$ (After boiling)			
	Betalain	$1.38 - 2.07$ (Before boiling) $1.16 \pm 0.13 - 1.48 \pm 0.79$ (After boiling)	Yellow beetroot roots		
	Betacyanin	$0.54 \pm 0.01 - 0.90 \pm 0.44$ (Before boiling) $0.50 \pm 0.50 - 0.72 \pm 0.72$ (After boiling)			

Betalain is one of the compounds extensively studied in beetroot and is one of the primary compounds responsible for the beetroot colour. It is the parent of two groups of pigments: betacyanin and betaxanthin. These water-soluble pigments, which exhibit red and yellow hues, can only be found in certain plant families, such as Caryophyllaceae, which

includes beetroot, pitaya, and spinach (Lembong et al., 2019; Zhao et al., 2022). The chemical structures of betaxanthin and betacyanin display a sequence of conjugation characterised by alternating double and single bonds. This conjugation is responsible for the vibrant colouration observed in these pigments (Liu, 2019).

A lot of researches has been done to study the betalain content in beetroot. Research by Mistrianu et al. (2022) found that betalain content in beetroot is 1.18 DW, while Hernández-Aguirre et al. (2021) reported slightly higher content of betalain in the *B. vulgaris* fresh weight and water extracts, which range from 3.49 to 3.99 mg/g. Similarly, Bárta et al. (2020) found almost similar betalain content in yellow beetroot powder ranging from 1.38 to 2.07 mg/g DM, while red beetroot powder showed much higher betalain content ranging from 10.92 to 18.10 mg/g DM. However, they found that the betalain content decreased by up to 30% when the powder was boiled. On the other hand, Desseva et al. (2020) studied the betalain content of beetroot juices which showed high betalain content, 2.81 mg/g of betacyanin and 1.27 mg/g betaxanthin. In addition, Wang et al. (2020) study showed that organically grown beetroot produces higher betanin content in methanolic extract (756.4 µg/g) than the conventionally grown beetroot (260.7 µg/g). The findings from these studies are summarised in Table 6.

Merbau, on the other hand, is well known for its high commercial value and mainly commercialised as construction material for house building, furnishing, panelling, and flooring. Apart from that, parts from the tree, like leaves and bark, are also utilised by local communities as traditional medicine remedies for asthma, diabetes, arthritis, liver disease, urinary diseases, and others (Widodo et al., 2019; Bradacs, 2008). Although Merbau is a well-known plant for its many uses, limited studies were found on the chemical constituent of *Intsia spp.* As mentioned by Koch et al. (2006), Hillis & Yazaki (1973) reported that the major polyphenol compound is robinetin, which was found as the yellow deposits in Merbau heartwood. Similarly, a more recent study by Sari et al. (2021) found that flavonoids are abundantly present in the plant, with robidanol and robinetin being the dominant compounds in the plant extracts.

A natural colourant from *I. bijuga* has been developed and commercialised in Indonesia, mainly used in the textile industry (Setyono, 2022). It gives a brown to reddish-brown colour when the fabric is dyed with the dye from the plant. (Rahayuningsih et al., 2022; Widyaputri, 2020). This is because the tree has reddish-brown heartwood that changes colour to dark brown or dark red when exposed to light for a period, making it attractive (Osvaldova et al., 2020).

According to Rahayuningsih et al. (2022), tannins and morins are responsible for the colour of the natural dye. Other than that, flavonoids present in the plant might also be responsible for producing the colour. Some flavonoids such as robidanol, robinetin, myricetin, naringenin, and amelopsin are also found in Merbau (Angio et al., 2022; Koch et al., 2006).

4. CONCLUSION

In conclusion, an acid solution resembling haematoxylin was obtained from the aqueous and methanolic extracts of *I. bijuga* and *B. vulgaris*. The colour intensity of the *B. vulgaris* methanolic extracts was less concentrated than the haematoxylin, as measured by the absorbance value. Meanwhile, the maximum concentration of colour is seen in methanolic extracts of *I. bijuga*. While the dark colour of *I. bijuga's* methanolic extract is most similar to haematoxylin, the bright red colour of *B. vulgaris's* methanolic extract and the brown colour of its aqueous extract were not comparable. The physicochemical features of the methanolic extract from *I. bijuga* are most similar to those of haematoxylin of all the extracts tested in this work.

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