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Article

Knowledge, Attitude, and Practices toward Plastic Pollution among Malaysians

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Abstract: Excessive production, consumption and indiscriminate disposal of plastic waste cause an increasing plastic pollution with detrimental impacts on environment and human health. This study aimed to assess the level of knowledge, attitude, and practices (KAP) towards plastic pollution among Malaysians and evaluate the variation of plastic pollution related KAP among various socio-demographics. An online survey was conducted, and 294 valid responses was obtained. Descriptive statistics, KAP scoring and cross tabulation of responses were estimated. One-way analysis of variance, paired t-test and binary logistic regressions were carried out. Results showed that respondents had poor knowledge (mean 7.41 ± 1.80) and practice score (3.81 ± 1.39) across all socio-demographics. Compared to younger (18-30 years) respondents, older ones (>46 years) had higher knowledge (odds ratio, OR 4.304; $p<0.01$). However, middle aged (31-45 years) respondents reported significantly ($p<0.01$) higher attitude (OR 4.019) and practice (OR 4.056; $p<0.05$). Respondents with environmental related university education had showed higher odds about plastic pollution related knowledge (OR 10.343; $p<0.01$). Suggestions are made to undertake interventions such as environmental awareness creation, incorporating plastic pollution topics in formal and informal education, and providing recycling facilities nearby the localities for encouraging good practices towards minimizing plastic uses and pollution.

Keywords: Plastic pollution; waste management; environmental behavior; recycling

Introduction

People use plastic products widely because these are durable, inexpensive, and light weight, which resulted in mass utilization and disposal of plastic products (Heidbreder et al., 2019). Their excessive production and consumption have caused plastic pollution that impact both society and the environment (Heidbreder et al., 2019; Loh et al., 2020). For instance, annual global production of plastic has increased around 200 times from the year of 1950 to 2015 (Geyer et al., 2017). Between 1950 – 2015, about 8.3 billion metric tons of virgin plastics were produced worldwide of which 6.4 billion metric tons were used and disposed (Geyer et al., 2017). About 79% of disposed plastics were dropped in landfills followed by recycling (9%) and incineration (12%) (Geyer et al., 2017). Besides that, the recent emergence of the COVID-19 pandemic also caused an increasing usage of single-use plastics and personal protective equipment (PPE) such as gloves and face masks which also contributes to both macro- and

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micro-plastics pollution (Chowdhury et al., 2021; Leal et al., 2021; Patrício Silva et al., 2021). For instance, the production of face masks in China had increased to 116 million per day in February 2020 which was 12 times higher than that of pre-COVID-19 pandemic (Chowdhury et al., 2021).

Plastic affects the environment and human health at every stage of its lifecycle which includes extraction and transportation of raw materials, manufacturing of plastic products, usage of plastics and lastly the management of plastic wastes (Azoulay et al., 2019). The most visible impacts of plastic pollution are the ingestion, suffocation, and entanglement of plastics debris by animals (International Union for Conservation of Nature 2021). For instance, ingestion and accumulation of plastic in the gut can cause obstruction and inflammation in many organs in a wide range of living creatures (Wang et al., 2020). Furthermore, larger plastic waste can degrade into plastic fragments such as microplastics or nano-plastics and enter food chains, which results in bioaccumulation and biomagnification of toxicity at higher trophic level predators (Wang et al., 2020). These plastics fragments can enter human body through the consumption via food or water and inhalation via air (Leslie et al., 2022). Past studies also show that plastic fragments can be found in human stools (Schwabl et al., 2019), and recent research shows that microplastics are found in human blood for the first time (Leslie et al., 2022). Moreover, disposal of plastic waste in landfills and domestic burning systems can lead to climate change, air and soil pollution (Azoulay et al., 2019; Chae & An 2018). For instance, the burning of plastic waste with polyvinyl chloride (PVC) contributes to dioxin emissions and this persistent and bio-accumulative toxin can lead to air or soil pollutions (Azoulay et al., 2019).

Objectives of this study

Malaysia is one of the largest plastic production countries in the world with over 1300 of plastic manufacturers (Chen et al., 2021). It produces around 0.5-1.9 kg per capita per day of municipal wastes with plastic wastes being the second highest (24%) in composition (Afroz et al. 2017; Aja & Al-Kayiem 2014; Yusoff et al. 2018; Fauziah et al. 2021). Besides, Malaysia depends heavily on disposal of waste in landfills and domestic burning systems, which can cause an increasing plastic pollution with detrimental impacts on environment and human health. In addition, Malaysia also has very low recycling rate which is inadequate for dealing with the amount of plastic waste produced (Sreenivasan et al. 2012).

In Malaysia, there have been several studies on solid waste management. Some recent research investigated knowledge, attitude and practices (KAP) of Malaysians towards domestic waste management and recycling (Al-Naggar, Abdulghani & Al-Areefi 2019; Moh & Abd Manaf 2017; Zen et al., 2013), KAP towards sustainable consumption (Ahamad & Ariffin 2018), waste managements (Al-Naggar et al., 2019; Ariffin & Wan Yacoob 2017), and determinants of the behaviour and perspective of publics towards plastic management (Afroz et al. 2017; Loh et al. 2020). We found no previous research in Malaysia that assess knowledge, attitude, and practices of public towards plastic pollution. Therefore, this study was conducted with following objectives:

- To assess the level of knowledge, attitude, and practices (KAP) towards plastic pollution among Malaysians, and
- To understand the socio-demographic factors that influence respondents' perception on plastic pollution related KAP.

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It is anticipated that findings of this would provide useful information for waste management authorities to take actions towards reducing plastic pollution in the country.

Materials and Methods

Knowledge, Attitude and Practices (KAP) study

KAP study was originally used to assess family planning and population studies in the 1950s (Ahamad & Ariffin 2018). It is a representative tool used to measure the extent of a known situation for a specific population such as their knowledge gaps, cultural beliefs, and behavioral patterns (World Health Organization, 2014). This also allows us to identify their current needs, problems, and challenges which helps to set plans or implement interventions priorities and make decisions. Besides that, the KAP study allows us to deepen the understanding of commonly known KAP factors that influence behavior (World Health Organization, 2014). KAP is now often used in environmental studies (Ahamad & Ariffin 2018; Ariffin & Wan Yacoob 2017) and is important in mitigating plastic pollution as understanding the knowledge, attitude and practices of public towards plastic pollution can help to understand more about their immediate surroundings, respect environmental issues so that local authorities can proceed with segmentation and channel marketing efforts effectively (Afroz et al., 2017).

Data collection approach

An online survey was conducted to understand the KAP among the residents of Malaysia aged 18 years and above towards plastic pollution. A structured questionnaire was developed for this study based on our prior experience and following Afroz et al. (2017); Azoulay et al. (2019); Charitou et al. (2021); Chen et al. (2021) and Soares et al. (2021b). The draft questionnaire was reviewed by three researchers and pre-tested with 10 respondents. Based on the feedbacks, some questions were added or eliminated and rephrased for clarity. The final questionnaire consisted of 33 multiple choice questions in four sections: (1) socio-demographic information, (2) knowledge of plastic pollution, (3) attitude towards plastic pollution, and (4) practices towards plastic pollution (Table S1). The questionnaire was prepared in English.

Study population of this study was both Malaysian and non-Malaysian residents living in Malaysia during the study period and aged 18 years and above. A Google form link was shared through email and social media platforms such as Facebook, Messenger, WhatsApp, Instagram, and Telegram. Respondents were asked to share the link with friends and relatives. The form was available from November 29, 2021 to February 15, 2022. A total of 302 responses were collected.

This study was reviewed and approved by the University of Nottingham Malaysia Science and Engineering Research Ethics Committee (Application Identification Number: CKKC151121). Participation in this survey was voluntary, anonymous, and respondents were informed that they could withdraw from the study at any time. Respondents' online consent was ensured with the following statement: "I read the brief information on study objectives and provide my consent to participate in the survey".

Data analysis

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Among 302 responses, there were only nine non-Malaysians, which we excluded from the data analysis due to low in number and thus the final total respondents were 294. Descriptive statistics (frequency and percentage), KAP scoring and cross tabulation of responses were estimated. For KAP scoring, 1 mark was given when respondents answered the question correctly/ "yes", 0.5 was given when they answered "maybe/ sometimes" and 0 mark was given when they answered the questions wrongly/ "no". As for cross tabulation of KAP status, an 80% cut point was used to determine good and poor status. One-way analysis of variance (ANOVA) and paired t-test were conducted to assess the relationship between KAP scores and socio-demographic factors of respondents. Besides that, binary logistic regression analyses were conducted to assess the association between the explanatory variables (i.e., socio-demographic factors and knowledge status) and dependent variables (i.e., KAP status, attitude and practice variables). The coding for binary regression was 1 equal to "yes" or correct answer and 0 equal to "no", "maybe", "sometimes" or wrong answer. Odds ratio (OR) with 95% confidence interval (CI) was used to assess the strength of association with $p<0.05$.

Results

Socio-demographic characteristic of respondents

Female were dominant (72.4%) in the survey and majority of the respondents (75.5%) belonged to 18-30 years age range (Table 1). More than 75% respondents had university level education and were students (60.2%). Dominance of younger age (18-30), university level education, and students as respondents revealed that they were active in social media and willing to volunteer in online surveys. Among respondents, 17% had environmental-related university education.

Table 1. Socio-demographic distribution of respondents.

Variables	Frequency (n = 294)	Percentage (%)
Gender		
Male	81	27.6
Female	213	72.4
Age range (years)		
18 – 30	222	75.5
31 – 45	37	12.6
Above 46	35	11.9
Highest education level		
Up to secondary schooling	21	7.1
Pre-university	50	17.0
University (Environment related subjects)	50	17.0
University (Non-environment related subjects)	173	58.8
Occupation		
Jobs in government and private sectors	63	21.4
Professional	17	5.8
Students	177	60.2

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Others (business, homemaker, retired & unemployed)	37	12.6

Assessment of KAP responses

On the knowledge side, 62.2% respondents stated that plastics are made from fossil fuels (Table S2). Majority of the respondents were aware that plastic pollution can affect the environment and human health at every stage of its lifecycle (94.2%) as well as the negative impact of incineration of plastic wastes (95.6%). However, almost half of the respondents were not aware that discarded plastic will cause harmful effect on organisms (47.3%). Majority of the respondents were aware that some cosmetic products contain plastic as an ingredient (75.2%). Less than half of the respondents (42.5%) knew that plastic can degrade into plastic fragments and more than half of them (57.1%) did not know that plastic bags take more than 10 years to degrade. Nonetheless, most respondents (70.7%) understood that plastic fragments can accumulate in food chain and be consumed by human. More than 50% respondents had no idea that microplastics can be inhaled through air. Many respondents (42.6%) were not aware of proportion of plastic wastes within municipal solid wastes of Malaysia. To 68.4% respondents, Malaysia is one of the top ten countries with mismanaged plastic waste in the world.

On the attitude side (see Table S3), it showed that majority of the respondents agreed that plastic pollution is the topmost environmental problems (n = 248; 84.4%) and the plastic pollution is severe in Malaysia (n = 254; 86.4%). Majority of them also agreed that Malaysia government has insufficient effort in reducing plastic pollution (n = 215; 73.1%). Furthermore, majority of the respondents agreed that public has the responsibility in reducing the plastic pollution in Malaysia (n = 267; 90.8%), an increase in public's awareness can help in mitigating plastic pollution (n = 254; 86.4%) and littering or mismanagement of plastic wastes can cause plastic pollution (n = 273; 92.9%). More than half of the respondents agreed that the taxation on single-use plastics is an appropriate action in reducing plastic uses (n = 180; 61.2%). Then, half of the respondents had a positive attitude towards banning the single-use plastics in Malaysia (n = 150; 51.0%) and stopping the use of single-use plastics in their daily life (n = 152; 51.7%). Majority of the respondents agreed that plastic that ends up in landfills or the ocean can harm human health and the environment (n = 272; 92.5%).

On practice side (see Table S4), one-third of respondents had the practice of separating plastic waste from other household wastes (n = 98; 33.3%), one-third of them did not have this practice (n = 91; 31.0%) and one-third of them did it sometimes (n = 105; 35.6%). Around half of the respondents do plastic recycling but there were around 23% (n = 67) who do not have this practice at home and around 26% (n = 76) of them do recycling sometimes. Then, more than half of the respondents (n = 199; 67.7%) had the practice of using reusable bag for groceries shopping and around 28% (n = 82) who occasionally use it for groceries shopping. Less than half of respondents (n = 139; 47.3%) have the practice of using reusable container for takeaways, around 37% (n = 108) who occasionally use it for takeaways and only 9% (n = 27) of respondents did not use container for takeaways. There were around 42% (n = 122) and 47% (n = 137) of respondents who frequently and occasionally purchase plastic-made

products respectively and only 12% (n = 35) who did not frequently purchase plastic-made products. Moreover, half of the respondents (n =

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153; 52.0%) did not participate in any plastic pollution related campaigns but there were 28% (n = 83) of them participate occasionally and around 20% (n = 58) of them had the practice to participate awareness campaigns.

Respondents' KAP scores towards plastic pollution

Table 2 shows that overall respondents had poor average knowledge (7.41 ± 1.80, on a scale of 11) and practice score (3.81 ± 1.39, on a scale of 6) across all sociodemographic groups. Knowledge score was significantly varied among educational groups ($p < 0.01$) where environmental-related university students had the highest average knowledge score (8.08 ± 1.92) among the groups. Attitude and practice scores were significantly different across sociodemographic groups.

Furthermore, Table 3 shows that 28.9% of the respondents belonged to the "poor knowledge with poor attitude" group and 65.3% to the "poor knowledge with poor practice" group. Only 27.2% of the respondents demonstrated good knowledge while 19.4% had good attitudes and 7.5% showed good practices. Among the respondents with good knowledge, 7.8% exhibited poor attitudes and 19.7% demonstrated poor practices.

Table 2. Socio-demographic distribution of the respondents and their KAP scores.

Variables		Knowledge score ($\bar{x} \pm s$)	t / F test	P-Value	Attitude score ($\bar{x} \pm s$)	t / F test	P-Value	Practice score ($\bar{x} \pm s$)	t / F test	P-Value
Overall (mean)		7.41 ± 1.80			8.45 ± 1.26			3.81 ± 1.39		
Gender	Male	7.52 ± 1.75	0.641	0.522	8.46 ± 1.39	-0.27	0.522	3.68 ± 1.53	-0.80	0.424
	Female	7.36 ± 1.83			8.47 ± 1.09			3.82 ± 1.33		
Age	18-30	7.33 ± 1.81	0.70	0.381	8.46 ± 1.10	0.62	0.539	3.72 ± 1.37	2.64	0.073
	31-45	7.78 ± 1.65			8.63 ± 1.18			4.27 ± 1.33		
	Abobe46	7.47 ± 1.99			8.33 ± 1.60			3.69 ± 1.45		
Education	Up to Secondary	6.79 ± 1.60	4.03	0.008	8.19 ± 1.39	1.80	0.147	3.76 ± 1.18	0.81	0.491
	Pre-University	7.01 ± 1.94			8.29 ± 1.54			3.92 ± 1.23		
	University (Environment)	8.08 ± 1.92			8.76 ± 0.86			3.99 ± 1.30		
	University (Non-Environment)	7.40 ± 1.71			8.47 ± 1.10			3.69 ± 1.47		
Occupation	Jobs in government & private sectors	7.39 ± 1.95	0.50	0.684	8.29 ± 1.39	2.10	0.101	3.75 ± 1.43	0.51	0.679
	Professional	7.67 ± 1.74			8.79 ± 1.31			3.56 ± 1.67		
	Student	7.46 ± 1.79			8.56 ± 1.00			3.77 ± 1.34		
	Others	7.11 ± 1.73			8.16 ± 1.45			4.01 ± 1.41		

Table 3. Cross tabulation of good and poor attitudes and practices with respect to the participants' plastic pollution knowledge status.

	Knowledge (n) (%)

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		Good 80 (27.2)	Poor 214 (72.8)
Attitudes	Good (n) (column %) (% of total)	57 (71.2) (19.4)	129 (60.3) (43.9)
	Poor (n) (column %) (% of total)	23 (28.8) (7.8)	85 (39.7) (28.9)
Practices	Good (n) (column %) (% of total)	22 (27.5) (7.5)	22 (10.3) (7.5)
	Poor (n) (column %) (% of total)	58 (72.5) (19.7)	192 (89.7) (65.3)

Socio-demographic factors associated with KAP scores

Elder respondents (above 46 years) had significantly ($p<0.01$) higher knowledge (by 4.304 factor) compared to younger respondents (18-30 years) (Table 4). The reason might be due more life experiences of older respondents and hence are more aware of the current situation with plastic pollution. Respondent aged between 31- 45 had reported significantly ($p<0.01$) higher attitude (OR 4.019) and practice (OR 4.056; $p<0.05$) compared to respondents aged between 18 - 30. This may be due to their higher level of acceptance of plastic pollution related measures. Compared to up to secondary level of education, respondents with environmental related university education had showed higher odds about plastic pollution related knowledge (OR 10.343; $p<0.01$). This indicates that environmental-related students have more knowledge on plastic pollution because of having pollution related curriculum in their study programs. On the other hand, respondents (retired, homemaker, unemployed and business owners) had significantly higher practice status (OR 5.25; $p<0.05$) compared to that of students, professionals and government and private sector employees.

Table 4. Binary regression of the KAP score with different sociodemographic variables of the respondents.

Variables		OR (95% CI)		
		Knowledge	Attitude	Practice
Gender	Male	1.00 (reference)	1.00 (reference)	1.00 (reference)
	Female	0.960 (0.495-1.863)	1.086 (0.598-1.974)	0.673 (0.309-1.465)
Age	18-30	1.00 (reference)	1.00 (reference)	1.00 (reference)
	31-45	2.051 (0.719-5.850)	4.019** (1.495-10.807)	4.056* (1.145-14.364)
	Above 46	4.304** (1.451-12.766)	2.316 (0.895-5.993)	1.416 (0.346-5.797)
Education	Up to Secondary	1.00 (reference)	1.00 (reference)	1.00 (reference)
	Pre-University	2.509 (0.471-13.353)	0.698 (0.221-2.202)	1.811 (0.306-10.734)
	University (Environment)	10.343** (1.992-53.690)	1.352 (0.402-4.551)	3.835 (0.648-22.693)
	University (Non-Environment)	4.110 (0.866-19.509)	0.679 (0.237-1.951)	3.017 (0.585-15.572)
Occupation	Jobs in government & private sectors	1.00 (reference)	1.00 (reference)	1.00 (reference)
	Professional	2.031 (0.619-6.661)	1.363 (0.415-4.481)	1.896 (0.395-9.101)
	Student	1.791 (0.708-4.531)	2.026 (0.944-4.351)	3.743 (0.982-14.256)
	Others	0.811 (0.280-2.351)	1.056 (0.425-2.625)	5.262* (1.473-18.794)

*Significant at 0.05 level; **Significant at 0.01 level.

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Association between attitude with socio-demographic factors and knowledge status

Respondents aged between 31 - 46 showed higher agreement (by 2.75 factor) in banning the use of single- use plastics in Malaysia (OR 2.75; p<0.05) and they were more confident in stopping the use of single-use plastics in daily life (OR 7.43; p<0.01) than respondents in other age categories (Table 5). Respondents having environmental-related university education (OR 7.46; p<0.05), pre-university education (OR 5.15; p<0.05)) and non-environment university education (OR 4.31; p<0.05) showed higher odds in stopping the use of single-use plastics in their daily life than respondents having up to secondary level education. This shows that education is important for improving plastic pollution related attitude among people. This is further confirmed when students reported higher odds towards banning the use of single-use plastics in Malaysia (OR 2.37; p<0.05). On the other hand, professionals showed significantly higher agreement that taxation on single-use plastics is an appropriate action in reducing plastic uses (OR 3.41; p<0.05). Compared to respondents with poor knowledge, respondents having good knowledge reported significantly higher agreement that plastic pollution in Malaysia is severe (OR 8.08; p<0.05) and plastic wastes in landfills can harm the environment and human health (OR 4.71; p<0.05).

Association between practice with socio-demographic factors and knowledge status

In comparison to younger ones, respondents aged between 31-45 were highly willing to separate plastic waste from their household waste (OR 4.39; p<0.05), recycle plastic waste (OR 4.16; p<0.05), use reusable bags for grocery shopping (OR 4.75; p<0.05) and participate in plastic pollution awareness campaigns (OR 6.25; p<0.05) (Table 6). Respondents having environmental-related university education were more willing to use reusable bags for grocery shopping (OR 3.65; p<0.05). Further, students showed higher odds of willingness to bring reusable bags for shopping (OR 3.39; p<0.05). On the other hand, professionals had reported higher odds of purchasing plastic products (OR 6.78; p<0.05). Respondents' knowledge showed positive practices in some cases. For examples, respondents with good knowledge had higher odds of recycling plastic waste (OR 1.75; p<0.05) and they showed lower odds of purchasing plastic made products (OR 0.24; p<0.05) than those having poor knowledge.

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Table 5. Binary logistic regression of different variables of attitude with socio-demographic variable and knowledge status (values are odd ratio follows by 95% confidence interval in parenthesis).

Explanatory variable(s)	Plastic pollution as biggest problems	Severeness of plastic pollution in Malaysia	Government action in reducing plastic pollution	Public responsibility	Public's awareness	Littering or causes of plastic pollution	Taxation on single-use plastics	Banning the use of singles-use plastics	Plastics in landfills can harm human health	Stop the use of single-use plastic in daily life
Gender										
Male (ref)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Female	1.98 (0.95-4.13)	0.90 (0.38-2.10)	0.69 (0.35-1.36)	0.58 (0.20-1.68)	1.37 (0.62-3.03)	1.54 (0.54-4.35)	1.11 (0.62-1.99)	0.63 (0.35-1.13)	0.57 (1.67-1.92)	0.35 (0.19-0.67)
Age range (years)										
18 – 30 (ref)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
31 – 45	2.15 (0.65-1.13)	1.82 (0.46-7.12)	0.84 (0.29-2.38)	1.79 (0.38-8.52)	1.25 (0.38-4.04)	1.42 (0.31-6.57)	1.50 (0.61-3.72)	2.75 (1.11-6.86)*	3.02 (0.30-30.76)	7.43 (2.56-21.53)**
Above 46	0.91 (0.30-2.72)	0.73 (0.20-2.75)	0.70 (0.24-2.06)	2.40 (0.47-12.16)	2.37 (0.61-9.18)	2.0 (0.4-10.10)	1.62 (0.63-4.21)	1.54 (0.60-3.97)	0.52 (0.11-2.52)	1.98 (0.74-21.53)
Highest education level										
Up to secondary (ref)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Pre-university	0.71 (0.15-3.30)	1.41 (0.37-5.43)	1.87 (0.60-5.84)	1.89 (0.44-8.17)	1.21 (0.29-5.01)	0.45 (0.08-2.67)	1.12 (0.38-3.27)	1.12 (0.38-3.30)	1.31 (0.25-6.76)	5.15 (1.54-17.21)*
University (Environment)	0.54 (0.11-2.70)	3.33 (0.61-18.08)	1.41 (0.43-4.64)	6.06 (0.87-42.43)	1.02 (0.23-4.53)	0.60 (0.08-4.41)	1.67 (0.53-5.24)	1.57 (0.51-4.87)	0.88 (0.14-5.43)	7.46 (2.09-26.65)*
University (Non-environment)	0.55 (0.14-2.21)	2.02 (0.59-7.01)	1.66 (0.60-4.62)	2.91 (0.74-11.38)	1.21 (0.34-4.31)	1.34 (0.23-7.77)	1.38 (0.52-3.68)	1.17 (0.44-3.13)	2.82 (0.56-14.12)	4.31 (1.40-13.32)*
Occupation										
Jobs in government & private sectors (ref)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Professional	1.83 (0.43-7.70)	0.60 (0.13-2.86)	1.80 (0.36-9.10)	0.87 (0.08-8.97)	3.36 (0.39-29.22)	1.43 (0.14-14.34)	3.41 (0.97-12.04)*	1.81 (0.58-5.63)	5.570E7 (0.01-0.001)	1.63 (0.45-5.84)

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Student	2.41 (0.96-6.11)	1.32 (0.46-3.78)	0.72 (0.30-1.73)	0.99 (0.26-3.75)	1.59 (0.59-4.33)	2.17 (0.56-8.36)	2.67 (1.25-5.72)	2.37 (1.09-5.19)*	1.15 (0.27-4.80)	2.12 (0.94-4.79)
Others	1.39 (0.47-4.10)	1.64 (0.46-5.91)	0.71 (0.27-1.86)	0.29 (0.07-1.19)	0.58 (0.19-1.75)	0.53 (0.13-2.08)	0.94 (0.39-2.23)	1.68 (0.69-4.07)	0.53 (0.12-2.31)	1.22 (0.48-3.13)
Knowledge score										
Poor (ref)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Good	1.31 (0.60-2.84)	8.08 (1.86-35.18)*	1.86 (0.96-3.60)	1.80 (0.58-0.60)	1.23 (0.54-2.82)	2.10 (0.57-7.74)	1.27 (0.72-2.24)	0.92 (0.54-1.59)	4.71 (1.00-22.15)*	1.12 (0.64-1.99)

*Significant at 0.05 level; **Significant at 0.01 level

Table 6. Binary logistic regression of different variables of practice with socio-demographic variable and knowledge status (values are odd ratio follows by 95% confidence interval in parenthesis).

Explanatory variable	Separation of plastic waste	Recycling of plastic waste	Reusable bag(s) in shopping	Reusable container(s) in takeaways	Frequent purchase of plastic products	Participation in campaigns
Gender						
Male (ref)	1.00	1.00	1.00	1.00	1.00	1.00
Female	1.01 (0.55-1.87)	1.42 (0.79-2.57)	0.85 (0.45-1.60)	0.59 (0.33-1.06)	1.69 (0.64-4.52)	1.27 (0.60-2.69)
Age range (years)						
18 – 30 (ref)						
31 – 45	4.39 (1.67-11.55)*	4.16 (1.60-10.82)*	4.75 (1.70-13.30)*	1.28 (0.52-3.11)	0.88 (0.24-3.30)	6.25 (1.81-21.51)*
Above 46	1.77 (0.62-5.01)	2.49 (0.95-6.54)	1.80 (0.67-4.80)	1.02 (0.40-2.60)	0.27 (0.05-1.58)	1.94 (0.45-8.34)
Highest education level						
Up to secondary (ref)	1.00	1.00	1.00	1.00	1.00	1.00
Pre-university	1.03 (0.33-3.26)	1.34 (0.45-4.01)	1.42 (0.46-4.40)	1.11 (0.38-3.27)	0.93 (0.19-4.49)	1.87 (0.43-8.13)
University (Environment)	1.19 (0.36-3.93)	1.34 (0.43-4.24)	3.65 (1.03-12.96)*	1.58 (0.51-4.87)	0.48 (0.08-2.86)	1.02 (0.22-4.79)
University (Non-environment)	1.13 (0.40-3.20)	1.85 (0.68-5.06)	1.47 (0.53-4.14)	1.80 (0.67-4.84)	0.69 (0.15-3.06)	1.41 (0.36-5.51)
Occupation						

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Jobs in government & private sectors (ref)	1.00	1.00	1.00	1.00	1.00	1.00
Professional	1.43 (0.44-4.70)	1.30 (0.39-4.34)	0.49 (0.15-1.62)	0.44 (0.14-1.39)	6.78 (1.31-34.99)*	1.25 (0.31-5.12)
Student	1.96 (0.81-4.73)	1.67 (0.78-3.66)	3.39 (1.52-7.53)*	1.13 (0.53-2.38)	1.25 (0.34-4.53)	2.75 (0.83-9.09)
Others	1.36 (0.53-3.51)	1.48 (0.60-3.67)	2.18 (0.83-5.68)	1.51 (0.63-3.64)	3.58 (0.88-14.64)	0.77 (0.22-2.68)
Knowledge score						
Poor (ref)	1.00	1.00	1.00	1.00	1.00	1.00
Good	1.64 (0.93-2.87)	1.75 (1.00-3.06)*	1.67 (0.88-3.16)	1.43 (0.83-2.47)	0.24 (0.07-0.86)*	1.71 (0.89-3.29)

*Significant at 0.05 level

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Discussion

KAP scores

Results showed that respondents had relatively low average knowledge scores, high average attitude scores and low average practice scores across all socio-demographic groups. Elderly respondents showed higher odds of plastic pollution knowledge. It showed that respondents with higher educational level especially for those who took environmental-related subjects has higher knowledge status. Besides that, respondents aged between 31-45 years had significantly higher odds of attitude (OR4.019) and practice (OR4.056) among the age groups. This suggested that millennials are more socially conscious as they grew up with the internet and social media, are more open-minded and optimistic, and are more conscious about environment and health (Cheng 2022). Respondents that studied environmental-related subjects have better understanding towards plastic pollution as they demonstrated higher odds (OR10.343). Research reported that the respondents with higher educational level have higher knowledge towards plastic pollution (Soares et al., 2021b). Age and education are considered as a common predictor for both knowledge and environmentally significant behavior (Geiger et al., 2019).

Attitude, practices, and associated socio-demographic factors

Most of the respondents had a positive attitude in reducing plastic pollution in Malaysia. Single use plastic is a major source of plastic pollution in Malaysia (Cheng et al., 2021). Respondents aged between 31-46 showed higher odds (OR 2.75) towards banning single use plastics in Malaysia and they were optimistic (OR 7.43) to stop uses of these in their daily life. Zen et al. (2013) found that consumers were more supportive on banning plastic bags in the supermarkets, shopping malls and retailers but not its extension to traditional or public markets, night markets, and morning markets. Respondents with higher level of education also showed higher odds towards stopping single use plastics. Filho et al. (2021) reported that factors like educational background, and age seem to play a significant role in the level of engagement to reduce plastic usage and the actions undertaken.

Like attitude, 31-46 years old respondents were significantly and highly (by 4 to 6 factors) willing to separate, recycle and reuse plastic bags, and join in awareness creation program on plastic pollution. Students and respondents with education in environmental disciplines showed significantly higher odds with regards to use of reusable plastic bags. These findings corroborate with that of Filho et al. (2021). Afroz et al. (2017) reported that people have positive attitude towards recycling but less motivated for recycling (Afroz et al. 2017). Recycling practice itself controlled by many factors such as the convenience, social norms, moral consideration, environmental awareness, and knowledge regardless of educational level, gender, income, and age (Moh & Abd Manaf 2017). Environmental education in daily school scenarios can allow students to connect to environmental issues and develop positive attitudes, knowledge, and motivation to act (So & Chow 2019).

Respondents' good knowledge status was reflected in some of the attitudes and practices towards plastic pollution which indicate that respondents' knowledge status can influence their attitude and practices. Respondents with good knowledge were more concern about severity of plastic pollution in Malaysia (OR 8.08) and harmful effects of plastic wastes in landfills (OR 4.71). They reported to recycle plastic waste (OR 1.75) and purchase fewer plastic products (OR 0.24). De Pretto et al. (2015) reported that knowledgeable persons are more concern about environmental pollution and so engage in protective practices.

Study limitations

One of the limitations for this study is that the number of respondents was not enough to represent the whole study area, Malaysia. According to Morse (2000), at least

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400 responses are needed with ±5% of margin error for a size of population that is more than 100,000. Since only English was used in the questionnaire, responses from different races or local communities could not be recorded. Future study should also ask for respondent's living area to perform a more comprehensive analysis with different aspects. Besides that, respondents in this study were mostly students or younger generations which may not represent overall demography of Malaysia. Physical interviews with targeted respondents might be useful to minimize this limitation.

Conclusion

This study provides a general understanding of respondents' KAP towards plastic pollution in Malaysia. Findings may serve as a baseline that authorities can use for designing guidelines or strategies towards mitigating plastic pollution in the country. Results showed most respondents had poor knowledge and practice towards plastic pollution but relatively higher attitude with some significant influence of the socio-demographic factors on the KAP scores such as age, education, and occupation. To convert good attitude into practices, authorities may undertake interventions such as environmental awareness creation, incorporating plastic pollution topics in formal and informal education, and providing recycling facilities nearby the localities. Authorities may also provide incentives (e. g. nominal cash vouchers) to encourage residents' pro-environmental behaviors such as recycling and avoiding single use plastic materials.

Supplementary Materials

Table S1. Social-demographic information, knowledge, attitude and practice related questions towards plastic pollution.

Table S2. Frequency distribution of respondents' responses on knowledge-related questions towards plastic pollution.

Table S3. Frequency distribution of respondents' responses on attitude-related questions towards plastic pollution.

Table S4. Frequency distribution of respondents' responses on practice-related questions towards plastic pollution.

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Author Contribution

"Conceptualization, TKN. and KKCC; Methodology, KKCC. and TKN; Formal Analysis, JM and KKCC.; Investigation, KKCC.; Resources, TKN and KKCC.; Data Curation, JM and KKCC.; Writing – Original Draft Preparation, KKCC.; Writing – Review & Editing, TKN.; Supervision, TKN."

Data Availability Statement

The data presented in this study are available in this article

Conflicts of Interest

The authors declare no conflict of interest.

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