Mal J Nutr 31(3): 399-412, 2025

Knowledge, attitude, and practice towards probiotic supplements among Malaysian adults: A cross-sectional survey

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ABSTRACT

Introduction: The use of probiotic supplements is increasingly prevalent due to their recognised benefits extending beyond gut health. However, data on the knowledge, attitude, and practice (KAP) towards probiotic supplements among Malaysian adults remain limited. This study aimed to assess KAP towards probiotic supplements among Malaysian adults. **Methods:** A cross-sectional online survey using a self-administered 23-item questionnaire was conducted from February to May 2024 among conveniently sampled Malaysian adults. **Results:** A total of 428 participants completed the survey. Mean knowledge and attitude scores were 5.77 out of 12 and 18.54 out of 25, respectively. Most respondents (65.9%) demonstrated poor knowledge, while 45.1% exhibited positive attitudes. A significant moderate positive correlation (r=0.64) was observed between knowledge and attitude. Probiotic supplement use was reported by 14.5% of respondents, with pharmacies being the primary source of purchase and social media the main information source. Digestive health (82.3%) was the most common reason for use. **Conclusion:** Knowledge about probiotic supplements and their health benefits among Malaysian adults is inadequate. Despite this, many expressed a willingness to learn more. There is an urgent need for widespread, evidence-based education on probiotics, emphasising the role of healthcare providers, particularly pharmacists, in enhancing public awareness and informed use.

Keywords: attitudes, dietary supplements, health knowledge, practice, probiotics

INTRODUCTION

Probiotics are "live microorganisms which, when administered in adequate amounts, confer a health benefit on the host" (FAO/WHO, 2021). Preclinical and clinical studies have highlighted the strain-specific benefits of probiotics in managing gastrointestinal disorders, including antibiotic-associated diarrhoea, traveller's diarrhoea, irritable bowel syndrome, and ulcerative colitis (Mishra & Acharya, 2021). Probiotics

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doi: https://doi.org/10.31246/mjn-2025-0002

have also demonstrated efficacy in reducing cholesterol levels (Wang *et al.*, 2018), restoring gut microflora, and enhancing immune function (Mishra & Acharya, 2021). Additionally, emerging evidence suggests potential benefits of probiotics in managing metabolic syndromes such as type 2 diabetes mellitus, obesity, and dyslipidaemia (Mishra & Acharya, 2021).

In addition to their therapeutic applications, probiotics enhance general health by supporting various physiological functions. Regular consumption of probiotics helps maintain a balanced gut microbiota, crucial for optimal digestive health and nutrient absorption (Mishra & Acharya, 2021). Additionally, probiotics fortify the intestinal barrier and modulate the immune system (Zheng *et al.*, 2023).

The prevalence of probiotic use has risen significantly, up to threefold at 4.5%, across diverse populations and settings due to growing awareness of its health benefits (O'Connor *et al.*, 2021). Probiotic use is particularly notable in paediatric care, where parents aim to address issues like respiratory infections and antibiotic-associated diarrhoea (Irwin, Currie & Davis, 2022). In hospital inpatients, probiotics are increasingly integrated into care as natural alternatives or adjuncts to pharmaceuticals, despite the need for more evidence of efficacy (Yi, Jernigan & McDonald, 2016).

The global demand for probiotics is projected to grow at a compound annual rate of 8% from 2023 to 2031 (Transparency Research Market, 2023). In Malaysia, although data on probiotic consumption is limited, the increasing registration of *Lactobacillus rhamnosus* supplements, ranking as the fifth most registered health supplement with a 1650% rise over the past decade, highlights a growing public interest in probiotics (Goh, 2022). Despite this increasing demand, there remains a gap in understanding how well Malaysian adults comprehend probiotic supplements, including their health benefits, precautions, and appropriate use. As new probiotic products emerge, it is crucial to assess the public's knowledge, attitude, and practice (KAP) to ensure safe and effective use of probiotic supplements.

In addition, the absence of clear guidelines for the appropriate use of probiotic supplements raises concerns about the public's understanding of key aspects of probiotic intake. As probiotic supplementation becomes more prevalent, it is essential for individuals to have basic knowledge about probiotics, including their definition, composition, and health benefits. Studies across various countries have reported mixed findings on KAP related to probiotics, encompassing both food and supplement forms. Previous research has primarily explored KAP towards probiotics in general, including functional foods (Ayyash *et al.*, 2021; Ida Muryany & Farina Syazwani, 2023; Stanczak & Heuberger, 2009), focusing on populations such as healthcare professionals (HCPs) (Arshad *et al.*, 2021) and students (Muchhal *et al.*, 2021; Ong *et al.*, 2023; Rahmah *et al.*, 2021; Sharma *et al.*, 2019).

However, research specifically addressing probiotics in supplement form, as distinct from probiotic-rich foods, among the general public is limited, particularly in Southeast Asia. In Malaysia, despite the increasing availability of probiotic supplements, there is a lack of population-based data on public KAP specific to these products, raising concerns about whether the public is adequately informed regarding their appropriate use. To date, no study has evaluated the public's KAP towards probiotic supplements among Malaysian adults, a group likely to be the primary

consumers. Additionally, the prevalence of probiotic supplement use among Malaysians remains unknown.

Given these gaps, this study employed the KAP framework as a structured approach to assess knowledge gaps, attitudes, and actual behaviours related to probiotic supplement consumption. The KAP model is particularly relevant for health-related research, as it provides valuable insights into behavioural patterns (Yvette & Peter, 2014). By adopting this approach, the present study aimed to assess KAP regarding probiotic supplements and determine the prevalence of use among Malaysian adults.

METHODOLOGY

Study design, setting, and participants

A cross-sectional online survey was conducted among Malaysian adults from 14 February to 31 May 2024, using convenience sampling method. Participants were required to meet the following inclusion criteria: Malaysian citizenship, age 18 years or older, and the ability to understand written information in English or Malay. Incomplete responses were excluded. For this study, probiotic supplements were defined as probiotics in pharmaceutical forms, such as tablets, capsules, liquids, or powders, excluding probiotic foods. Ethical approval for the study was obtained from the Research Ethics Committee of Universiti Teknologi MARA (REC [PH]/UG/103/2024 [MR]).

Sample size calculation

The sample size for this study was calculated using the Raosoft sample size calculator (Raosoft, 2004). Based on a 5% margin of error, a 95% confidence interval, a 50% response distribution, and approximately 23 million Malaysian adults, the recommended sample size was 385 participants. To account for potential incomplete responses, an additional 10% (n=43) was included, resulting in a final target sample size of 428 participants.

Survey instrument development and validation

A 23-item questionnaire was developed in English to assess the KAP of Malaysian adults regarding probiotic supplements. The questionnaire was adapted from a comprehensive literature review (Ayyash *et al.*, 2021; Muchhal *et al.*, 2021; Nguyen *et al.*, 2020; Ong *et al.*, 2023; Rahmah *et al.*, 2021; Sharma *et al.*, 2019; Stanczak & Heuberger, 2009) and subsequently translated into the Malay language via a forward-backward translation method, conducted by a clinical pharmacy lecturer and an English specialist lecturer. Discrepancies in wording or meaning were reconciled to ensure semantic equivalence.

The questionnaire comprised four sections. The first section gathered socio-demographic data, including age, gender, race, residential area, education level, employment status, and monthly income. The second section assessed knowledge of probiotics through 12 items addressing their definition, common probiotic bacteria, dosage forms, acid tolerance, health benefits, and precautions. Respondents selected “yes», “no” or “not sure” for each item, with one point awarded for correct answers. The third section evaluated attitudes towards probiotics using a five-item, five-point Likert scale (1 = strongly disagree to 5 = strongly agree), with all statements reflecting positive attitudes. The maximum attainable score in this section was 25. The fourth section examined practices related to probiotic use, including consumption within the past 30 days, frequency of probiotics used, dosage forms, reasons for use, and sources of purchase and information. This six-item practice section comprised

one yes/no question, one multiple-choice question, and four checkbox questions. For scoring, respondents who consumed probiotic supplements were awarded one mark. For items concerning the reason for taking probiotic supplements, dosage forms, and the source of purchase, one mark was allocated for any selected answer options. Regarding the item on the source of information, one mark was granted if the options of doctor, pharmacist or dietitian were selected, while other options were assigned a score of zero. The frequency of probiotic supplement intake was scored on a five-point scale: 5 = daily, 4 = 2 to 6 times per week, 3 = once a week, 2 = 1 to 3 times per month, and 1 = less than once a month. The maximum attainable score for this section was 10.

The questionnaire's content validity was reviewed by five clinical pharmacy lecturers with expertise in health supplements and questionnaire development. All items achieved an item-content validity index of 1. In response to reviewers' feedback, terminological refinement was made to enhance clarity. Specifically, "gut microbiota" was reworded to "bacteria in the intestinal tract" and "antibiotic-associated diarrhoea" was revised to "diarrhoea caused by antibiotics". A pilot test involving 30 Malaysian adults aged 19 to 61 years old (19 females, 11 males) with educational backgrounds ranging from secondary school to a bachelor's degree was conducted to evaluate the comprehensibility of the survey. Based on participants' feedback, the term 'immunocompromised' was revised to 'weakened immune system' to ensure clarity of the item. The Cronbach's alpha coefficients for the knowledge, attitude, and practice sections were 0.859, 0.846, and 0.938, respectively, indicating strong internal consistency. The overall Cronbach's alpha was 0.899. Data from the pilot test were excluded from the final analysis.

Data collection

The questionnaire was administered via Google Forms, enabling respondents to self-complete the survey. It was distributed through various channels, including social media platforms (Facebook, Telegram, Instagram, and Twitter/X), WhatsApp, email, and researchers' networks. The first page of the form provided an introduction outlining the study objectives, highlighting the voluntary nature of participation, and obtaining informed consent before allowing respondents to proceed. Data were collected anonymously and responses were accessible only to the researchers. The survey was configured to allow only a single response per participant through Google Forms.

Statistical analysis

Data were compiled in Excel and analysed using IBM SPSS Statistics for Windows version 28.0 (IBM Corp., Armonk, New York, USA). Categorical variables were summarised as frequencies and percentages, while continuous variables were reported as mean ± standard deviation (SD). Knowledge and attitude scores were converted into percentages and categorised according to Bloom's cut-off points: good/positive (≥80%), moderate/neutral (60–79%), and poor/negative (≤59%) (Ong *et al.*, 2023). Statistical differences in knowledge and attitude across sociodemographic groups were assessed using independent *t*-tests and one-way ANOVA, with Tukey's post-hoc analysis applied where applicable. Pearson's correlation coefficient was used to examine the relationship between knowledge, attitude, and practice scores. A $p<0.050$ was considered statistically significant.

RESULTS

Sociodemographic characteristics

A total of 428 individuals participated in the study, meeting the minimum recommended sample size. The respondents' sociodemographic characteristics are summarised in Table 1. The majority were females (62.9%) and aged 18–29 years (39.7%). Most identified as Malays (64.7%) and resided in suburban areas (38.6%). In terms of education, 59.8% held a degree or postgraduate qualification. Additionally, the majority were employed (61.0%) and reported a monthly income of below RM2,560 (50.5%). Most respondents indicated no chronic medical illnesses (74.5%) and were not taking prescribed medications (79.2%).

Knowledge, attitude, and practice

The respondents' knowledge, attitude, and practice regarding probiotics are summarised in Tables 1-4. Of the 428 participants, 65.9% exhibited poor knowledge of probiotics, while 16.4% and 17.7% demonstrated moderate and good knowledge, respectively. The overall mean knowledge score was 5.77±3.51 out of 12; the overall mean attitude score was 18.54±3.72 out of 25. Most respondents recognised the definition of probiotics (79.4%) and their digestive health benefits (78.3%). However, awareness was notably lower regarding the appropriate dosage unit (27.3%), probiotics' role in cholesterol reduction (23.8%), their effectiveness in preventing antibiotic-associated diarrhoea (32.0%), and the need for caution in immunocompromised individuals (25.7%).

Regarding attitude, 45.1% of respondents demonstrated a positive attitude towards probiotics, 41.1% had a neutral attitude, and 13.8% exhibited a negative attitude. Most respondents (65.2%) acknowledged the health benefits of probiotic supplements. Additionally, 57.3% perceived probiotics as safe; 69.2% indicated willingness to take them if recommended by HCPs. Notably, 70.1% expressed interest in learning more about probiotic supplements. However, only 48.1% would recommend probiotic supplements to others.

As shown in Table 4, 14.5% of respondents reported consuming probiotics, with 41.9% taking them daily. The most common dosage forms were tablets (38.7%), followed by capsules (31.3%), liquids (21.0%), and powders (16.1%). Digestive health was the primary reason for use (82.3%), followed by general health (48.4%), immune support (30.6%), cholesterol reduction (12.9%), weight management (4.8%), and other reasons (4.8%). Pharmacies were the most common source of purchase for probiotics (82.3%), followed by Shopee (19.4%) and supermarkets (16.1%). Social media (61.3%), pharmacists (54.8%), and websites (43.5%) were the leading sources of information about probiotics.

Sociodemographic differences in knowledge and attitude scores

Table 1 summarises the variations in knowledge and attitude towards probiotic supplements across sociodemographic groups. Females exhibited significantly higher knowledge and attitude scores compared to males ($p<0.050$). Significant differences ($p<0.050$) were also observed based on age, race, residential area, education level, employment status, and income. Respondents aged 18–29 years and those residing in urban areas scored higher on knowledge and attitude assessments than other age groups and residents of suburban or rural areas. Individuals with degrees or postgraduate qualifications, as well as students, demonstrated higher knowledge and attitude scores than those with lower

Table 1. Sociodemographic characteristics and differences in knowledge and attitude towards probiotic supplements by sociodemographic characteristics (*N*=428)

Variables	*n (%)*	*Knowledge score†*		*Attitude score†*	
		Mean±SD	*p-value*	*Mean±SD*	*p-value*
Age (years)			<0.001§		<0.001§
18-29	170 (39.7)	7.07±3.16[a]		20.13±3.11[a]	
30-39	93 (21.7)	5.23±3.43[b]		17.95±4.13[b]	
40-49	95 (22.2)	4.64±3.36[b]		17.16±3.60[b]	
50-59	66 (15.4)	4.76±3.64[b]		17.26±3.31[b]	
60-69	4 (0.9)	7.00±4.55[ab]		19.25±2.99[ab]	
Gender			<0.001‡		<0.001‡
Male	159 (37.1)	4.60±3.33		17.61±3.65	
Female	269 (62.9)	6.47±3.43		19.10±3.66	
Race			<0.001‡		<0.001§
Malay	277 (64.7)	6.59±3.48[a]		19.38±3.48[a]	
Chinese	50 (11.7)	5.42±3.35[ab]		17.92±3.64[ab]	
Indian	39 (9.1)	3.51±2.91[b]		16.46±3.50[b]	
Sabah/Sarawak	62 (14.5)	3.84±2.64[b]		16.61±3.72[b]	
Residential area			<0.001§		<0.001§
Rural area	110 (25.7)	4.64±3.73[a]		17.36±3.98[a]	
Suburban area	165 (38.6)	5.57±3.47[ab]		18.26±3.72[ab]	
Urban area	153 (35.7)	6.81±3.10[b]		19.70±3.20[b]	
Highest education level			<0.001§		<0.001§
Secondary school or below	61 (14.3)	3.00±3.59[a]		15.43±4.26[a]	
Diploma/Certificate	111 (25.9)	4.54±2.79[b]		17.41±3.31[b]	
Degree/Postgraduate	256 (59.8)	6.97±3.21[c]		19.79±3.13[c]	
Employment status			<0.001§		<0.001§
Employed	261 (61.0)	5.07±3.52[a]		17.75±3.77[a]	
Unemployed	32 (7.5)	4.75±3.49[a]		16.84±3.00[a]	
Students	135 (31.5)	7.37±2.93[b]		18.54±3.72[b]	
Monthly income			<0.001§		<0.001§
<RM2560	216 (50.5)	5.76±3.50[ab]		18.66±3.97[a]	
RM2560 – RM5249	134 (31.3)	5.77±3.52[a]		17.68±3.42[a]	
RM 5250 – RM11819	78 (18.2)	5.42±3.54[b]		19.71±3.15[b]	
Do you have any chronic medical illness?			0.555‡		0.968‡
No	319 (74.5)	5.71±3.58		18.55±3.78	
Yes	109 (25.5)	5.94±3.29		18.53±3.56	
Do you take any prescribed medication?			0.607‡		0.298‡
No	339 (79.2)	5.73±3.57		18.45±3.82	
Yes	89 (20.8)	5.94±3.27		18.91±3.31	
Overall	428 (100)	5.77±3.51		18.54±3.72	

SD: Standard deviation

†Scores for knowledge and attitude ranged from 0 to 12 and 5 to 25, respectively.

Significant differences were determined at $p<0.050$.

‡Independent *t*-test; §One-way analysis of variance (ANOVA) with Tukey's post-hoc analysis. Values within the same column with different superscript letters indicate statistically significant differences ($p<0.05$).

Table 2. Knowledge of probiotic supplements (*N*=428)

Item	*Response, n (%)*	
	Correct	*Incorrect*
Probiotics are live bacteria that provide health benefits when taken in sufficient quantities.	340 (79.4)	88 (20.6)
The most common probiotic bacteria are Lactobacillus and Bifidobacterium.	186 (43.5)	242 (56.5)
The dose of probiotic supplement is in colony-forming unit (CFU).	117 (27.3)	311 (72.7)
To be effective, probiotic supplements must be able to withstand stomach acid.	182 (42.5)	246 (57.5)
The health benefits of probiotic supplements are different according to their species.	238 (55.6)	190 (44.4)
Probiotics of the same species but different types may have different health benefits.	222 (51.9)	206 (48.1)
Probiotics may restore the natural balance of bacteria in the intestinal tract.	279 (65.2)	149 (34.8)
Probiotics are good for digestive health.	335 (78.3)	93 (21.3)
Probiotics can strengthen the body's immune system.	228 (53.3)	200 (46.7)
Some types of probiotics can prevent diarrhoea caused by antibiotics.	137 (32.0)	291 (68.0)
Some types of probiotics can reduce cholesterol level.	102 (23.8)	326 (76.2)
Probiotics intake is not recommended in people with weakened immune system.	110 (25.7)	318 (74.3)

Table 3. Attitude towards probiotic supplements (*N*=428)

Item	*Response, n (%)*				
	Strongly disagree	*Disagree*	*Neutral*	*Agree*	*Strongly agree*
Taking probiotic supplements is beneficial for health	5 (1.2)	40 (9.3)	104 (24.3)	205 (47.9)	74 (17.3)
Taking probiotic supplements is safe for health	8 (1.9)	49 (11.4)	126 (29.4)	183 (42.8)	62 (14.5)
I will consider taking probiotic supplement if it is recommended by healthcare professionals	5 (1.2)	24 (5.6)	103 (24.1)	195 (45.6)	101 (23.6)
I recommend people to take probiotic supplements	5 (1.2)	37 (8.6)	180 (42.1)	153 (35.7)	53 (12.4)
I want to know more about probiotic supplements	5 (1.2)	21 (4.9)	102 (23.8)	190 (44.4)	110 (25.7)

Table 4. Practice of probiotic supplements (*n*=62)

Item[†]	*n (%)*
Consume probiotic supplements within the last 30 days	
Yes	62 (14.5)
Frequency of probiotic supplement intake	
Daily	26 (41.9)
2 to 6 times per week	7 (11.3)
Once a week	11 (17.7)
1 to 3 times per month	7 (11.3)
Less than once a month	11 (17.7)
Form of probiotic supplements consumed[‡]	
Capsule	20 (31.3)
Tablet	24 (38.7)
Powder	10 (16.1)
Liquid	13 (21.0)
Reason for taking probiotic supplements[‡]	
General health	30 (48.4)
Digestive health	51 (82.3)
Strengthen body's immune system	19 (30.6)
To reduce body weight	3 (4.8)
To reduce cholesterol level	8 (12.9)
Others	3 (4.8)
Source of purchase for probiotic supplements[‡]	
Pharmacy	51 (82.3)
Supermarket	10 (16.1)
Grocery store	5 (8.1)
Health store/organic store	4 (6.5)
Family and friends	1 (1.6)
Shopee	12 (19.4)
TikTok	4 (6.5)
Lazada	1 (1.6)
Other online platforms (e.g., website)	7 (11.3)
Source of information about probiotic supplements[‡]	
Social media (TikTok, Instagram, and Facebook)	38 (61.3)
Internet (e.g., website)	27 (43.5)
Television	7 (11.3)
Radio	2 (3.2)
Pamphlet	5 (8.1)
Family and friends	11 (17.7)
Doctor	24 (38.7)
Pharmacist	34 (54.8)
Dietitian	9 (14.5)

[†]Practice items were asked within the past 30 days' timeline
[‡]Respondents may choose multiple answers (checkbox)

educational attainment or employment status. Higher income correlated with improved attitudes but not knowledge. Malay respondents scored higher in both knowledge and attitude than Indians and participants from Sabah or Sarawak.

Correlations between knowledge, attitude, and practice

Table 5 presents the correlations between knowledge, attitude, and practice towards probiotic supplements. A significant moderate positive correlation was identified between knowledge and attitude (r=0.64, p<0.001). A weak positive correlation was observed between knowledge and practice (r=0.34, p<0.001), as well as between attitude and practice (r=0.25, p<0.001).

DISCUSSION

This study underscores substantial gaps in KAP regarding probiotic supplements among Malaysian adults. The findings revealed that most respondents exhibited poor knowledge of probiotics, while only around one-fifth demonstrated good knowledge. Nearly half of the participants displayed a positive attitude towards probiotics. Digestive health emerged as the primary reason for consumption, with pharmacies being the most common source of purchase. These observations emphasise the limited understanding and utilisation of probiotics among the population, despite their well-documented health benefits.

Notably, the majority of respondents lacked awareness of critical aspects of probiotics, including dosage unit, strain-specific benefits, and contraindications for immunocompromised individuals. These results align with prior research, such as a study conducted in Jordan that reported a similarly low median knowledge score of 4 out of 8 (Ayyash *et al.*, 2021). A closer examination of individual knowledge items revealed notable similarities with previous studies. For instance, while many respondents were familiar with the definition of probiotics and knew that probiotics are beneficial for the digestive system, a considerable proportion lacked awareness of their benefits in managing antibiotic-associated diarrhoea (Chin-Lee *et al.*, 2014; Rahmah *et al.*, 2021; Stanczak & Heuberger, 2009). This limited understanding of the basic aspects of probiotics contrasts with the growing demand for probiotic supplements. The increasing market interest in probiotics, driven by health consciousness, appears to outpace public understanding (Chong & Teh, 2020).

Multiple contributing factors may explain the observed lack of knowledge. Firstly, consumers are often influenced by motivation, such as health maintenance, rather than detailed knowledge of probiotic products, rendering them more likely to use such products based on perceived benefits rather than informed understanding. Secondly, the

Table 5. Correlations between knowledge, attitude, and practice

Variables	*Correlation Coefficient*[†]	*p-value*
Knowledge – Attitude	0.64	<0.001
Knowledge – Practice	0.34	<0.001
Attitude – Practice	0.25	<0.001

[†]Correlation is significant at the 0.001 level (2-tailed)
Correlation interpretation: 0.00–0.10 = negligible, 0.10–0.39 = weak, 0.40–0.69 = moderate, 0.70–0.89 = strong, 0.90–1.00 = very strong

lack of stringent regulations on product labelling and health claims in Malaysia further compounds consumer confusion, underscoring the need for comprehensive public education, stricter regulatory frameworks, and evidence-based guidelines to enable informed choices (Tee *et al.*, 2021). Thirdly, the absence of consumer-friendly materials, such as layperson-orientated explanations or simplified educational content, limits the public's ability to understand the scientific information surrounding probiotics. Hence, HCPs play an important role in simplifying scientific information to a more comprehensible version for the public.

Although almost half of the respondents held positive attitudes towards probiotics, fewer than half were willing to recommend them to others, potentially due to a lack of confidence in their knowledge. Encouragingly, most participants expressed a willingness to learn more about probiotics, presenting an opportunity for HCPs to bridge knowledge gaps. Community-based workshops and pharmacist-led consultations could improve attitudes by delivering reliable, evidence-based information.

While the study identified a moderate positive correlation between knowledge and attitude (r=0.64), knowledge was only weakly correlated with practice. This finding is consistent with that of Rahmah *et al.* (2021) and Ong *et al.* (2023), who also reported a significant correlation between knowledge and attitude but noted limited translation into practice. This suggests that while improved understanding may foster better attitudes, it does not necessarily translate into actionable behaviours. Addressing practical barriers, such as cost, availability, and perceived relevance, is crucial to bridging this gap. Although digestive health benefits are widely recognised among respondents, other established benefits, such as preventing antibiotic-associated diarrhoea and reducing cholesterol levels, remain underappreciated. This disparity may stem from the predominant focus of advertisements on digestive health and the limited communication of additional benefits by HCPs (Nguyen *et al.*, 2020).

Sociodemographic factors significantly influenced KAP scores in this study. Female participants, urban residents, younger adults, and those with higher education levels demonstrated better knowledge and more positive attitudes, indicating disparities in access to information. This finding is consistent with previous studies (Kofoed *et al.*, 2015; Chan *et al.*, 2024) that demonstrated females and a higher education level were associated with higher use of dietary supplements. Younger respondents (aged 18–29 years) scored higher in knowledge and attitude, possibly due to greater exposure to probiotic information in digital media. The higher level of knowledge observed in females could be due to a greater engagement in health-related information-seeking behaviours. Women have been shown to be significantly associated with a higher likelihood of using the internet to obtain health information compared to men (Schmidt, Wild & Schreyögg, 2021). Therefore, tailored interventions targeting men, as well as less-educated, rural, and older individuals, are essential to promote equitable access to probiotic education.

The prevalence of probiotic supplement use in the present study was 14.5%, notably lower than rates reported in high-income countries, such as 39.4% in the United States (Nguyen *et al.*, 2020) and 37% in the United Kingdom (Dimidi *et al.*, 2019). Nearly half of the adult population in these countries reportedly consume dietary supplements (Iłowiecka *et al.*, 2022), in contrast to only 14.9% in Malaysia

(Chan *et al.*, 2024). This disparity may be attributed to heightened health awareness in high-income countries, where dietary supplement usage is notably more prevalent. Given that health awareness has been identified as a key predictor of probiotic consumption (Nguyen *et al.*, 2020), the lower usage observed in the present study may reflect gaps in public awareness on the health benefits associated with probiotics. This is supported by the present study's finding that a majority of respondents demonstrated poor knowledge of probiotics.

The relatively low prevalence observed in the current study, despite robust market growth globally and locally, underscores the need for enhanced public education, not only regarding probiotics but also in promoting broader health literacy and preventive health behaviours. Additionally, the intake of probiotic supplements might be constrained by affordability, as previous studies have indicated that cost is a significant determinant of probiotic use (Ayyash *et al.*, 2021; Chin-Lee *et al.*, 2014; Nguyen *et al.*, 2020). Furthermore, the public might be concerned about the effectiveness of probiotics and their potential side effects (Chin-Lee *et al.*, 2014). A lack of clear, evidence-based guidelines on strain-specific benefits and potential side effects could further exacerbate scepticism, particularly among populations with limited access to reliable health information.

While digestive health remains the primary reason for use, awareness of other benefits, such as immune support and cholesterol reduction, is limited. This pattern is consistent with global trends, highlighting the narrow perception of probiotics' potential among Malaysian consumers. Notably, two-thirds of respondents were willing to consider probiotic supplements if recommended by HCPs. These findings align with studies conducted in Jordan and India, where a substantial proportion, approximately 90% (Ayyash *et al.*, 2021) and 83.8% (Muchhal *et al.*, 2021), respectively, expressed similar willingness, underscoring the influential role of HCPs in guiding probiotic use. As studies have demonstrated that the majority of people use dietary supplements without consulting their physicians or pharmacists (Wahab *et al.*, 2022), HCPs should proactively offer evidence-based advice during patient care encounters, particularly regarding the safe and appropriate use of probiotic supplements.

Social media emerged as the predominant source of information (61.3%), surpassing pharmacists, raising concerns about the accuracy and reliability of shared content. This finding contrasts earlier studies from Jordan and India, where a smaller proportion of respondents relied on social media for probiotic information (Ayyash *et al.*, 2021; Muchhal *et al.*, 2021). This disparity may be attributed to the prevalent accessibility and utilisation of social media in the current digital era. Additionally, the emergence of social media as the main source of information on probiotic supplements is likely due to the proliferation of health supplement promotions on digital platforms, with consumers often presenting at pharmacies with specific products they have encountered online. This behaviour may explain the limited reliance on pharmacists for guidance, as some consumers perceive supplements as entirely safe or are unaware of the pharmacist's role in providing advice (Wahab *et al.*, 2022).

An analysis of probiotic-related videos shared via social media in China showed poor overall reliability (Jiang *et al.*, 2023). This underscores the growing concern that misinformation and disinformation regarding probiotics on social media can

mislead consumers, potentially leading to inappropriate usage and adverse health outcomes. Pharmacies represent an accessible channel for intervention, given their status as the most common point of purchase. Leveraging pharmacists' expertise to deliver credible, personalised guidance can address knowledge gaps and promote evidence-based practices. Additionally, HCPs should incorporate probiotic education into routine interactions to enhance public awareness. Social media platforms must also be strategically utilised to disseminate accurate information, counter misinformation, and engage effectively with the public. By addressing these challenges, the potential contribution of probiotics to public health can be more fully realised.

This study has several limitations. The online distribution of the questionnaire led to the over-representation of younger, urban, and tech-savvy individuals, limiting the generalisability of the findings to the broader population, particularly older adults and those with limited access to digital platforms. Caution is therefore required when interpreting the results in these populations. Furthermore, as the study relied on self-administered questionnaire, recall bias may have occurred, potentially leading to inaccuracies in respondents' KAP. Building on these findings, future research should consider employing stratified random sampling to ensure a balanced inclusion of diverse demographic groups, enhancing the generalisability of the findings. Face-to-face surveys can be conducted to enhance participation from older adults and individuals with limited digital access.

Notwithstanding its limitations, this study offers valuable insights into the prevalence and KAP towards probiotic supplement use among Malaysian adults. By focusing specifically on public knowledge of probiotic supplements, the findings provided a comprehensive assessment of the key aspects necessary for their safe and effective use. This study's novelty lies in its focus on probiotic supplements within a Malaysian context, offering a detailed KAP assessment. It identified knowledge deficits, particularly in fundamental areas such as appropriate usage, safety precautions, and health benefits.

Practically, this study implies that the public should be educated on the appropriate and safe use of probiotic supplements, along with their various evidence-based health benefits. The findings can inform the development of targeted educational initiatives. Moreover, this study underscores the pivotal role of HCPs, particularly community pharmacists, who are the primary point of purchase for probiotic supplements, in educating the public and promoting safe and effective use of probiotic supplements. The results may further support policymakers and regulatory bodies in developing guidelines for the advertisement and promotion of probiotic supplements. Future research should include diverse demographic groups, particularly older and rural populations. Studies evaluating the effectiveness of tailored educational interventions are also warranted.

CONCLUSION

The findings of this study highlighted significant gaps in KAP regarding probiotic supplements among Malaysian adults. While fewer than one in five participants demonstrated good knowledge, a moderate positive correlation between knowledge and attitude was observed, suggesting that improved understanding fosters favourable perceptions. However, knowledge had a weaker link to practice, reflecting practical barriers like cost

and availability. The low prevalence of probiotic use, despite substantial health benefits, underscores the need for public education campaigns to promote informed choices. Additionally, reliance on social media as a primary information source raises concerns about misinformation, further reinforcing the need for evidence-based communication. HCPs, especially doctors and pharmacists, should proactively recommend probiotic supplements where appropriate, provide guidance on their use, and leverage digital platforms to disseminate evidence-based information. Transcending probiotic supplements, the insights from this study may serve as a reference for broader health supplement-related policies and educational frameworks.

Acknowledgment

The authors would like to thank all of the respondents for their valuable time participating in the survey. The authors would also like to thank Universiti Teknologi MARA (UiTM), Malaysia, for the approval to conduct this study.

Authors' contributions

Nik Aisyah Najwa NMS, principal investigator, conceptualised, designed, and supervised the study, prepared and reviewed the draft of the manuscript, and analysed the data; Fitrah Alia M, collected and analysed the data, and prepared the draft of the manuscript; Mohd Shahezwan AW, supervised the study, advised on data analysis, reviewed and edited the manuscript; Nur Sabiha MH & Saliha A, reviewed and edited the manuscript.

Conflict of interest

The authors declare no conflict of interests.

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