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Knowledge, attitude regarding osteoporosis, dietary calcium intake and food sources of calcium among Chinese young adults in Klang Valley, Malaysia

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Abstract

Background Osteoporosis is a major public health issue with huge socioeconomic implications. Adequate knowledge and a positive attitude regarding osteoporosis with sufficient dietary calcium intake are important to prevent osteoporosis, especially in young adults. Nonetheless, data on the knowledge and attitude regarding osteoporosis, dietary calcium intake and its food sources among the high-risk population, including Malaysian Chinese are limited.

Objective The study aimed to determine the knowledge and attitude regarding osteoporosis, dietary calcium intake, and food sources of calcium among young Malaysian Chinese.

Methods A total of 130 Malaysian Chinese aged 18 to 26 years living in Klang Valley were recruited. Knowledge and attitude regarding osteoporosis were assessed using the Osteoporosis Prevention and Awareness Tool (OPAAT) and Osteoporosis Health Belief Scale (OHBS). Dietary calcium intake and food sources were obtained from a 7-day diet history.

Results Participants had low knowledge regarding osteoporosis (48.8% ± 16.6), but moderate knowledge (53.2% ± 17.9) regarding preventive measures of osteoporosis. The median dietary calcium intake was 546 mg/day and only 6.2% of the participants achieved the Recommended Nutrients Intake (RNI). There was a discernible weak positive correlation between knowledge and dietary calcium intake ($r = 0.192$, $p = 0.029$).

Conclusion Young Malaysian Chinese adults exhibited low knowledge about osteoporosis and reported inadequate dietary calcium intake. Thus, there is a need for community-based health education programs focusing on osteoporosis awareness among Malaysian young adults.

Keywords Osteoporosis · Knowledge · Attitude · Calcium intake · Malaysian Chinese young adults

1 Introduction

Osteoporosis is a skeletal metabolic disease with a reduction of bone quality and density resulting in an increased risk of bone fracture [1]. Globally, more than 8.9 million fractures are caused by osteoporosis annually and is predicted to affect approximately 200 million people [2]. In Malaysia, the overall incidence of hip fracture among individuals aged 50 and above is 90 per 100,000 population [3]. The Asian Federation of Osteoporosis Societies reported that by 2050 Malaysia is projected to have the highest increase in the number of hip fractures (3.55-fold), from 6000 to nearly 21,000 [4]. A hip fracture can diminish the quality of life and increase mortality rates, thereby exacerbating both social and economic

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burdens within the nation [5]. In addition to non-modifiable factors such as genetics, modifiable risk factors include environmental influences and physical activity where dietary calcium intake remains a crucial determinant of bone health. Osteoporosis is one of the preventable fracture risks, strongly linked with good nutrition and adequate calcium [6, 7]. It is crucial to ensure adequate calcium intake for individuals below 30 years old as sufficient calcium intake contributes to the accrual of bone mass, a process that concludes after the age of 30, leading to subsequent bone mass depletion [8].

The recommended calcium intake for young Malaysian adults is 1000 mg/day [9]. However, young Malaysians only consume about half of the requirement [10]. This is despite the availability of calcium-rich food in the Malaysian diet such as anchovies, sardines, milk, almonds, watercress, and tofu [9]. Even though the intake of calcium is poor, Malaysians are deemed to generally have moderate knowledge and attitudes regarding osteoporosis [11, 12]. However, in the Malaysian Chinese population who are reported to have the highest prevalence of osteoporosis and hip fracture incidence, there is limited data on their calcium food source and their knowledge and attitude on osteoporosis [13, 14]. Therefore, this study aims to determine the knowledge and attitude regarding osteoporosis, dietary calcium intake, and food sources of calcium among Chinese young adults in Klang Valley, Malaysia.

2 Methods

2.1 Research design

This cross-sectional study was conducted from January 2020 to March 2020. The study received ethical approval from the International Medical University—Joint Committee of Research and Ethics Committee [BDN I-2019 (17)]. All experiments were performed in accordance with relevant guidelines and regulations. The calculation of sample size was performed using Pearson's correlation coefficient with the level of significance = 5%, power = 80%, and r-value of 0.23, the sample size calculated was 146 [11, 15]. Participants were recruited from residential houses, eateries, universities, and religious centers situated in Klang Valley, Malaysia using a convenience sampling method.

The inclusion criteria were Malaysian Chinese aged 18 to 26 years who can read and write in English. Individuals who had previous history of fractures, individuals with conditions that affect bone metabolism such as bone metabolism-related disorders, hyper/hypothyroidism, hyper/hypoparathyroidism, hyper/hypocalcemia, metabolic bone diseases (Paget's disease, osteogenesis imperfecta, osteomalacia, rickets), treatments (hormone-replacement therapy, sex hormone deprivation therapy, thiazide diuretics, anticonvulsants, antidepressants, glucocorticoids, thyroid supplements), and individuals who were currently practicing special diets such as vegetarianism were excluded from the study [16]. Informed consent was obtained from all study participants before they participated in the study.

2.2 Study instruments

A self-administered sociodemographic questionnaire was developed by the authors after a process of literature review to obtain the sociodemographic details of the participants. The data obtained include date of birth, gender, education level, marital status, employment status, monthly income, as well as family history of osteoporosis.

2.2.1 Knowledge regarding osteoporosis

The participants' knowledge of osteoporosis was assessed using the Osteoporosis Awareness and Prevention Tool (OPAAT) questionnaire, which has been validated in Malaysia [17]. The questionnaire consisted of 30 items, which included knowledge of osteoporosis (11 items), consequences of untreated osteoporosis (5 items), and osteoporosis preventive measures (14 items). The choices of "true", "false", or "don't know" were given for each item and a single mark was allocated for each accurate response. No marks were given for inaccurate answers and "don't know". The maximum score for OPAAT is 30. The marks were converted into percentages using the formula maximum score / 30 *100%. The scores were then classified into levels of knowledge in the low (≤ 50%), moderate (51–69%), and high (≥ 70%) categories.

2.2.2 Attitude regarding osteoporosis

The attitude of the participants regarding osteoporosis was determined using the Osteoporosis Health Belief Scale (OHBS), which comprises a total of 42 items in seven subscales. The subscales are, namely; perceived susceptibility (items 1–6), perceived seriousness (items 7–12), exercise benefits (items 13–18), calcium benefits (items 19–24), exercise barriers (items 25–30), calcium barriers (items 31–36), and health motivation (items 37–42) [18].

A five-point Likert scale was adopted in this questionnaire, from 1 = strongly disagree to 5 = strongly agree. However, the reverse points were given for negatively worded items (items 25–36). The maximum score for OHBS is 210. The scores were converted into percentages using the formula total scores obtained / 210 *100%. The scores were then classified into low (≤ 50%), moderate (51–69%) and high (≥ 70%).

2.2.3 7-Day diet history, diet analysis, food sources

The 7-day diet history was conducted through a face-to-face interview by researchers trained by dietitians. The participants were required to report the usual amount, frequency as well as types of food or beverages consumed in seven days. The researchers used food portion album and common household measurement tools to enable accurate measurement of food portions consumed by participants. The dietary intake was analysed manually using a Microsoft Office Excel spreadsheet by referring to several references in descending order: Singapore Energy and Nutrient Composition of Food Database, Nutrient Composition of Malaysian Foods, food nutrition labels, United States Department of Agriculture (USDA) Food and Nutrient Profile Database, Hong Kong government publication, other websites, and Taiwan Food Composition Database [19–23]. The reported food items were classified into 18 main food groups and 65 sub-food groups based on the rationale of the ingredients contributing to the calcium content, the quantity of the ingredients contributing to the calcium content, the similarity in main ingredients constituting the food products, the similarity in nutrient composition and consensus.

2.3 Statistical analysis

The statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) version 25. Descriptive data were used to present the sociodemographic data, knowledge and attitude regarding osteoporosis, dietary calcium intake, and food sources of calcium of the participants. The normality of the data was evaluated using Kolmogorov–Smirnov test. An Independent t-test was used to compare the means of gender and family history of osteoporosis with knowledge and attitude regarding osteoporosis. Both Mann Whitney U test and Kruskal Wallis test were performed to analyse the difference between sociodemographic categories and dietary calcium intake depending on the normality levels. The comparison of the means of education level, employment status and monthly income with knowledge and attitude regarding osteoporosis was done using One-way ANOVA. Pearson's correlation (r) was used to analyse the correlation between age and knowledge and attitude regarding osteoporosis. Meanwhile, Spearman's rank correlation coefficient was used to determine the association between age, dietary calcium intake, knowledge and attitude regarding osteoporosis. A p value of < 0.05 was considered as significant.

3 Results

3.1 Participants recruitment

A total of 130 out of 206 participants were recruited in the study, representing a response rate of 89.0% of target participants. There was one missing 7-day diet history data. Figure 1 illustrates the flow of participant recruitment.

3.2 Participants' socio-demographic characteristics

Table 1 describes the participants' sociodemographic characteristics. Participants had a mean age of 21.6 ± 1.9 years with 59.2% being male, while 40.8% were females. Most of the participants had a tertiary education level (87.7%). Over

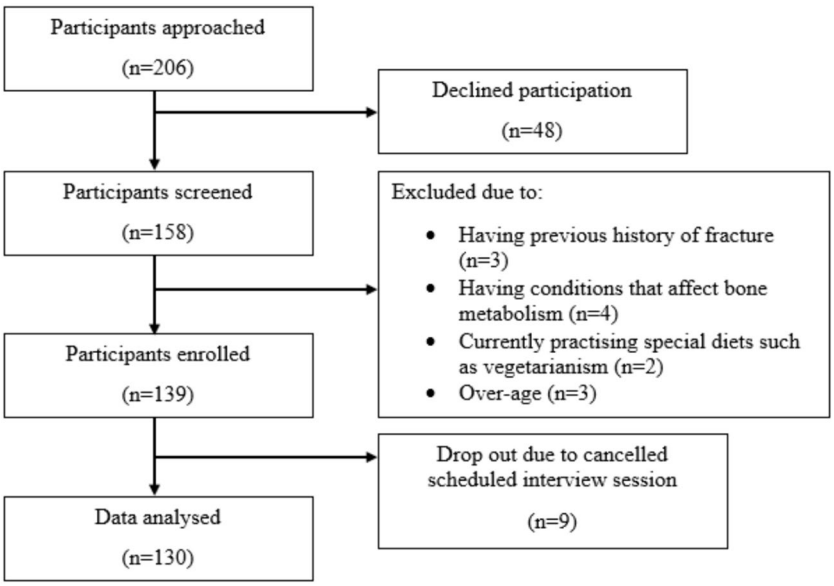

Fig. 1 Flow of participant recruitment

half were students (56.9%), followed by working individuals (36.9%) and unemployed adults (6.2%). Almost half of the participants had monthly income or pocket money of less than RM1000 (49.2%). Up to 96.9% of the participants did not have a family history of osteoporosis. All participants were single.

3.3 Knowledge regarding osteoporosis

Table 2 illustrates the number of participants (%) scores on knowledge of osteoporosis. Overall, study participants had poor general knowledge regarding osteoporosis consequences and its management. However, the study participants seem to have moderate knowledge regarding the prevention of osteoporosis itself (53.2% ± 17.9). Almost all the study participants (86.9%) knew that osteoporosis is a condition caused by weaker bone. However, they were unsure about the differences between osteoporosis and osteoarthritis. Very few (4.6%) knew the RNI for calcium but almost all (90.8%) knew that calcium supplements can help prevent osteoporosis. Majority of the participants (83.8%) were able to identify the calcium-rich food sources.

3.4 Attitude regarding osteoporosis

As shown in Table 2, the mean total score of attitudes of the participants was 68.3% ± 6.0, indicating a moderate attitude score (score 51–69%). Only 9.2% had a high perceived susceptibility to osteoporosis. More than two-thirds of the study participants agreed that regular exercise and adequate calcium intake are beneficial. Nevertheless, the participants only consumed 546 mg of calcium per day and did not meet their calcium requirement.

Figure 2 shows the percentage contribution of main food groups to the total dietary calcium intake in the study participants. Cereals/cereal products were the major sources of calcium, contributing 23% of the total dietary calcium intake, followed by milk/milk products/cheese (15%) and vegetables (13%). The sub-food groups under the cereals/cereal products include rice/grains/noodles, dishes based on cereals, bread, breakfast cereals/oats, and other grains and flour. Dishes based on cereals such as fried rice, fried noodles, dumpling noodle soup, etc. Due to the variety of dishes based on cereals, it is difficult to conclude which dish is most often consumed and has the highest calcium content. Only a minimal portion of calcium intake (7%) was attributed to supplements.

3.5 Association between knowledge, attitude, and dietary calcium intake regarding osteoporosis and its sociodemographic factors

Table 3 depicts the comparison of knowledge and attitude regarding osteoporosis and its sociodemographic factors respectively. Students had the highest scores for all aspects of knowledge regarding osteoporosis ($p = 0.002$) and showed higher perceived benefits of calcium intake ($p = 0.013$). For attitude, a significant difference was found

Table 1 Participants' characteristics (sociodemographic and dietary intake) (n = 130)

Sociodemographic	
Variables	Mean ± SD
Age (year)	21.6 ± 1.9
Gender	n (%)
Female	53 (40.8%)
Male	77 (59.2%)
Marital status	n (%)
Single	130 (100.0%)
Education level	n (%)
Secondary	16 (12.3%)
Tertiary	114 (87.7%)
Employment status	n (%)
Unemployed	8 (6.2%)
Student	74 (56.9%)
Working	48 (36.9%)
Monthly income/pocket money	n (%)
< RM1000	64 (49.2%)
RM1000-2000	30 (23.1%)
RM 2001–5000	31 (23.8%)
RM5001-RM10.000	4 (3.1%)
> RM10.000	1 (0.8%)
Family history of osteoporosis	n (%)
Yes	4 (3.1%)
No	126 (96.9%)
Dietary intake	Mean ± SD / median (interquartile range)*
Total daily energy intake (kcal/day)	1937 ± 408
Total daily protein intake (g/day)*	81 (36)
Total daily carbohydrate intake (g/day)*	210 (75)
Total daily fat intake (g/day)*	76 (24)
Total daily dietary calcium intake*	546 (300)
% RNI of daily dietary calcium intake	57.5 ± 27.0
Percentage of participants meeting RNI	6.2%

n: 130 data were collected and analyzed for knowledge and attitude of osteoporosis. n = 129 were analyzed for daily calcium intake as there was one missing diet history. Data for age and total daily energy intake were presented as mean ± standard deviation (SD) while data for gender, marital status, education, employment status, monthly income, and family history of osteoporosis were expressed as frequency number (%). The data for total daily protein, carbohydrate, fat, and dietary calcium intake were expressed as median (interquartile range). *SD* standard deviation

between perceived barriers to calcium intake and gender ($p = 0.034$), whereby males were shown to perceive higher barriers to calcium intake. Study participants with higher monthly income demonstrated higher perceived benefits of calcium intake ($p = 0.001$), lower perceived barriers to calcium intake ($p = 0.012$), and demonstrated a higher attitude regarding osteoporosis ($p = 0.006$). No significant differences were observed in terms of attitude regarding osteoporosis with education level and family history of osteoporosis, however, a weak negative correlation was observed between age and the perceived seriousness of osteoporosis ($r = -0.197$, $p = 0.025$).

Table 2 Knowledge and attitude regarding osteoporosis (n = 130)

Knowledge		
Aspects	n (%)	Mean score (%) ± SD
General knowledge regarding osteoporosis		
Low (0–50%)	83 (63.8%)	
Moderate (51–69%)	31 (23.8%)	43.2% ± 19.7
High (70–100%)	16 (12.3%)	
Knowledge regarding consequences of untreated osteoporosis		
Low (0–50%)	67 (51.5%)	
Moderate (51–69%)	30 (23.1%)	49.1% ± 26.3
High (70–100%)	33 (25.4%)	
Knowledge regarding prevention of osteoporosis		
Low (0–50%)	61 (46.9%)	
Moderate (51–69%)	44 (33.8%)	53.2% ± 17.9
High (70–100%)	25 (19.2%)	
Total knowledge regarding osteoporosis		
Low (0–50%)	75 (57.7%)	
Moderate (51–69%)	39 (30.0%)	48.8% ± 16.6
High (70–100%)	16 (12.3%)	
Attitude		
Aspects	n (%)	Mean score (%) ± SD
Perceived susceptibility		
Low (0–50%)	63 (48.5%)	
Moderate (51–69%)	55 (42.3%)	51.6% ± 12.8
High (70–100%)	12 (9.2%)	
Perceived seriousness		
Low (0–50%)	22 (16.9%)	
Moderate (51–69%)	56 (43.1%)	65.2% ± 13.5
High (70–100%)	52 (40.0%)	
Perceived benefits of exercise		
Low (0–50%)	3 (1.5%)	
Moderate (51–69%)	25 (19.2%)	75.8% ± 11.5
High (70–100%)	102 (78.5%)	
Perceived benefits of calcium intake		
Low (0–50%)	2 (1.5%)	
Moderate (51–69%)	34 (26.2%)	74.0% ± 11.3
High (70–100%)	94 (72.3%)	
Barriers to exercise		
Low (0–50%)	84 (64.5%)	
Moderate (51–69%)	35 (26.9%)	47.5% ± 14.3
High (70–100%)	11 (8.5%)	
Barriers to calcium intake		
Low (0–50%)	79 (60.8%)	
Moderate (51–69%)	45 (34.6%)	48.6% ± 11.1
High (70–100%)	6 (4.6%)	
Health motivation		
Low (0–50%)	17 (13.1%)	
Moderate (51–69%)	53 (40.8%)	67.4% ± 11.9
High (70–100%)	60 (46.2%)	

Table 2 (continued)

Attitude		
Aspects	n (%)	Mean score (%) ± SD
Total attitude regarding osteoporosis		
Low (0–50%)	0 (0%)	
Moderate (51–69%)	87 (66.9%)	68.3% ± 6.0
High (70–100%)	43 (33.1%)	

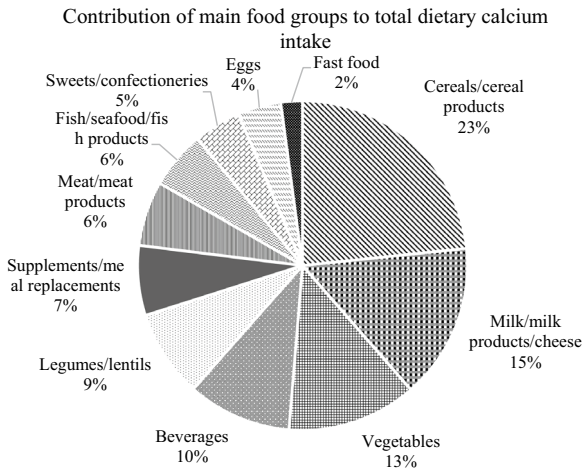

Fig. 2 Contribution of main food groups to total dietary calcium intake

3.6 Association between dietary calcium intake, knowledge, attitude, and sociodemographic factors

Based on Table 3, individuals with higher general knowledge(r = 0.206, $p = 0.019$), total knowledge scores (r = 0.192, $p = 0.029$), health motivation (r = 0.200, $p = 0.023$), and positive attitudes toward osteoporosis (r = 0.174, $p = 0.048$) may tend to have a slightly higher dietary calcium intake. The observed correlations, though statistically significant, were weak, indicating that other factors beyond knowledge, motivation, and attitude may also contribute to dietary calcium intake.

4 Discussion

Overall, this study revealed that Malaysian Chinese young adults had low levels of osteoporosis knowledge, which is in line with previous studies on osteoporosis knowledge among private university students [24], Malaysian adults [25], and Malaysian post-menopausal women [26]. This could be because most disease awareness programs in Malaysia focus on diseases such as diabetic retinopathy and cardiovascular diseases, with not much emphasis given to osteoporosis [27]. Poor knowledge of osteoporosis leads to delays in diagnosis and inadequate adoption of preventive lifestyle behaviors. Thus, it is pertinent that healthcare professionals and health authorities disseminate accurate information and encourage proactive measures about maintaining bone health in Malaysians. Even though the study participants knew that calcium helps prevent osteoporosis, they were misapprehensive that the calcium supplements can cause kidney stones, which can be a barrier to consuming calcium supplements, as suggested by Chan et al. [16].

Similar to other studies among Malaysians, the participants in this study were able to identify calcium food sources in their diets [26, 28]. However, the calcium intake could still be low due to insufficient motivation and health beliefs such as calcium intake and exercise [16]. This study showed that those with higher knowledge of osteoporosis, tend to consume more calcium. Comparatively, previous local studies, [11, 16], showed no significant correlation between osteoporosis knowledge and its prevention practices such as exposure to sunlight, coffee and tea intake, smoking, and alcohol consumption whilst the present study focuses only on dietary calcium intake.

Table 3 Comparison of knowledge, attitude, dietary calcium intake of osteoporosis and its sociodemographic factors (n = 130)

Variable	Categories	N	Mean (%) ± SD												Total daily calcium intake (mg/day)[a]
			Knowledge				Attitude								
			General	Untreated consequences	Preventive	Total	Perceived susceptibility	Perceived seriousness	Perceived benefits of exercise	Perceived benefits of calcium intake	Barriers to exercise	Barriers to calcium intake	Health motivation	Total attitude regarding osteoporosis	
Gender	Male	77	41.3 ± 19.0	47.8 ± 27.0	53.9 ± 18.4	48.3 ± 16.3	52.8 ± 13.6	65.7 ± 13.2	74.7 ± 11.1	74.0 ± 12.0	46.5 ± 15.1	50.3 ± 11.4	68.5 ± 12.4	68.4 ± 5.8	568 (273)
	Female	53	45.8 ± 20.6	50.9 ± 25.3	52.2 ± 17.2	49.6 ± 17.1	49.9 ± 11.4	64.4 ± 13.9	77.4 ± 12.2	74.0 ± 10.2	48.9 ± 13.0	46.1 ± 10.3	65.9 ± 10.9	68.1 ± 6.2	514 (339)
	p value		0.204	0.503	0.588	0.649	0.204	0.205	0.588	0.191	0.338	0.027*	0.206	0.779	0.079
Education level	Primary	0	–	–	–	–	–	–	–	–	–	–	–	–	–
	Secondary	16	38.6 ± 16.1	45.0 ± 27.8	47.3 ± 11.3	43.8 ± 11.2	53.3 ± 11.7	60.2 ± 15.4	75.2 ± 14.1	72.3 ± 10.5	48.5 ± 13.0	52.1 ± 9.7	62.9 ± 10.5	66.1 ± 6.1	473 (357)
	Tertiary	114	43.8 ± 20.1	49.7 ± 26.1	54.0 ± 18.5	49.5 ± 17.1	51.4 ± 13.0	65.9 ± 13.1	75.9 ± 11.2	74.2 ± 11.4	47.3 ± 14.4	48.1 ± 11.3	68.1 ± 11.9	68.6 ± 6.0	551 (294)
	p value		0.330	0.509	0.162	0.193	0.562	0.116	0.822	0.531	0.724	0.136	0.103	0.125	0.209
Employment status	Unemployed	8	28.4 ± 27.7	30.0 ± 26.2	33.8 ± 25.6	31.3 ± 24.9	44.6 ± 15.2	71.3 ± 15.3	72.1 ± 14.1	77.5 ± 12.4	46.7 ± 12.2	51.3 ± 10.7	61.7 ± 15.1	67.0 ± 9.8	659 (330)
	Student	74	47.4 ± 19.9	50.8 ± 23.2	56.0 ± 16.1	52.0 ± 15.0	50.9 ± 12.1	66.0 ± 13.1	77.5 ± 11.4	76.0 ± 10.5	49.4 ± 13.1	47.6 ± 10.5	67.7 ± 11.5	68.7 ± 5.4	546 (291)
	Working	48	39.0 ± 15.8	49.6 ± 29.8	52.1 ± 17.4	46.8 ± 16.6	53.9 ± 13.1	63.0 ± 13.6	73.8 ± 11.1	70.2 ± 11.4	44.7 ± 15.9	49.7 ± 12.2	68.1 ± 11.9	67.8 ± 6.3	516 (379)
	p value		0.006*	0.101	0.003**	0.002**	0.122	0.210	0.143	0.013**	0.165	0.466	0.361	0.607	0.882
Income/ pocket money (RM)	< RM1000	64	44.2 ± 21.1	46.6 ± 25.5	52.1 ± 18.2	48.3 ± 16.9	49.6 ± 12.8	67.1 ± 13.7	77.3 ± 9.7	75.9 ± 10.6	50.7 ± 12.9	49.4 ± 10.3	65.8 ± 11.8	67.9 ± 5.7	563 (274)
	RM1000-2000	30	44.2 ± 19.4	48.7 ± 23.3	53.1 ± 18.9	49.1 ± 16.7	52.8 ± 13.1	65.8 ± 13.2	76.8 ± 14.6	76.2 ± 11.1	44.3 ± 13.6	44.4 ± 12.3	70.1 ± 11.0	70.4 ± 6.1	514 (461)
	RM2001-5000	31	37.5 ± 16.4	49.7 ± 28.7	52.5 ± 16.1	46.6 ± 15.1	55.0 ± 11.9	60.3 ± 12.3	71.4 ± 11.6	68.4 ± 9.4	44.3 ± 14.8	51.8 ± 10.1	66.8 ± 11.9	66.5 ± 5.5	506 (228)
	RM5001-RM10,000	4	61.4 ± 13.6	80.0 ± 28.3	73.2 ± 12.2	70.0 ± 12.2	56.7 ± 8.2	65.8 ± 18.9	80.8 ± 5.7	76.7 ± 15.2	42.5 ± 27.9	38.3 ± 11.4	79.2 ± 15.2	74.1 ± 6.8	723 (1186)
	> RM10,000	1	45.5	80.0	64.3	60.0	26.67	73.3	66.7	43.3	56.7	60.0	66.7	56.7	506 (0)
	p value		0.182	0.107	0.225	0.105	0.070	0.220	0.122	0.001**	0.101	0.012**	0.145	0.006**	0.817
Family history of osteoporosis	Yes	4	43.2 ± 22.7	45.0 ± 30.0	58.9 ± 17.9	50.8 ± 19.7	50.8 ± 8.8	58.3 ± 6.4	85.8 ± 10.3	77.5 ± 16.1	52.5 ± 14.0	40.0 ± 6.1	64.2 ± 14.8	69.2 ± 4.9	646 (1319)
	No	126	43.2 ± 19.7	49.2 ± 58.9	53.0 ± 17.9	48.8 ± 16.6	51.6 ± 12.9	65.4 ± 13.6	75.5 ± 11.5	73.8 ± 11.1	47.3 ± 14.3	48.9 ± 11.2	67.5 ± 11.8	68.2 ± 6.1	546 (299)
	p value		0.997	0.754	0.516	0.807	0.905	0.304	0.078	0.523	0.465	0.117	0.577	0.762	0.765
Age	r		– 0.077	0.078	– 0.003	– 0.015	– 0.058	– 0.197	– 0.138	– 0.065	– 0.163	– 0.053	0.012	– 0.089	0.014
	p value		0.382	0.378	0.973	0.870	0.514	0.025*	0.119	0.465	0.052	0.548	0.895	0.316	0.876
Dietary calcium intake	ρ		0.206	0.147	0.125	0.192	– 0.055	0.100	0.108	0.165	0.085	0.048	0.200	0.174	–
	p value		0.019*	0.097	0.159	0.029*	0.539	0.257	0.224	0.062	0.329	0.558	0.023*	0.048*	–

n: 130 data were collected and analyzed for knowledge and attitude of osteoporosis. n: 129 were analyzed for daily calcium intake as there was one missing diet history. Low: 0–50%; Moderate: 51–69%; High: 70%-100%. The statistical significance was defined as $*p < 0.05$, $**p < 0.005$, $***p < 0.001$. [a]The total daily dietary calcium intake (mg/day) was expressed as median (IQR). For knowledge and attitude, Post-hoc analysis of ANOVA was done for education level, employment status, and income/pocket money; Independent t-test for gender and family history; Pearson correlation test for age. For dietary calcium intake, Kruskal Wallis test was done for education level, employment status, and income/pocket money; the Mann Whitney U test for gender and family history, and Spearman's rank correlation coefficient for age. The correlation and significance value were defined as rho-value (*p* value)

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The study revealed that young Malaysian Chinese adults exhibited a moderate level of attitude towards osteoporosis, aligning with findings from other studies [14, 16, 28]. Interestingly, the study identified a low perceived susceptibility to osteoporosis among this demographic, which contrasts with the moderate levels reported among middle-aged and elderly Malaysian Chinese by Chan et al. [16]. The disparities in the findings can be attributed to the likelihood that older adults possess higher awareness regarding osteoporosis which could result in higher perceived susceptibility to the disease [14]. Moreover, this study found that participants with higher monthly incomes exhibited a more favorable attitude toward osteoporosis. Similarly, a local study done among Malay adults demonstrated that individuals with lower income scored lowest in terms of attitude towards osteoporosis. This pattern appears to be influenced by the connection between higher education levels, elevated monthly income, and increased awareness of osteoporosis [29].

The presented study observed that participants with higher health motivation and a more positive attitude towards osteoporosis tended to have a higher dietary calcium intake. These findings are in accordance with findings reported by Chan et al. which have shown that a positive correlation between health motivation and intake of dairy products [16]. Moreover, the Health Belief Model suggests that an individual's perception can shape their willingness to adopt recommended preventive health actions [30]. Therefore, fostering positive attitudes towards osteoporosis is crucial for promoting the consumption of adequate calcium to prevent osteoporosis [30].

Despite having high perceived benefits of calcium intake and low perceived barriers to calcium intake, the dietary calcium intake among study participants was generally below the recommended calcium intake for young Malaysian adults [Table 3], which is 1000 mg/day [9]. This is similar to the findings from other Asian countries of all ages, such as China (325 mg/day), Vietnam (506 mg/day), Japan (500 mg/day), and Korea (485 mg/day) [31–33]. The low calcium intake is related to the avoidance of milk and milk products due to the high prevalence of lactose intolerance among the Asian population [34, 35], and infrequent usage of calcium-rich milk and milk products in Asian cuisine [16, 33]. Milk is rich in calcium and its consumption was associated with higher dietary calcium intake [34]. Thus, it is not surprising to note that the primary dietary source of calcium in study participants is cereals/cereal products similar to a study from China [31]. This is likely due to the frequent consumption of rice or noodle-based staples despite their lower calcium content [19].

Nonetheless, relying solely on cereals for recommended calcium intake could be detrimental due to Malaysians' reported excessive carbohydrate consumption [36, 37]. Similarly, a study from China identified vegetables as a significant calcium source, particularly leafy varieties like Bok Choy and collard greens [31]. However, the high oxalate content in commonly consumed spinach and okra reduces calcium bioavailability among participants [38, 39]. Thus, depending solely on vegetables for sufficient dietary calcium may be less realistic. Rather than solely depending on cereals as the primary contributors of calcium in Malaysian diets, there is a critical need for education on the abundance of high-calcium local foods such as anchovies, tofu and tempeh.

One of the strengths of this study was the utilisation of a 7-day diet history in assessing the dietary calcium intake of the participants which enabled the estimation of usual dietary calcium intake over a period of time. Supplementary tools and photogenic aids were used during the interview of the 7-day diet history to minimize potential inaccuracy in the identification of portion size. In addition, free-living young adults were recruited in this study, this increases diversity and decreases potential bias related to a certain institution. As this was a cross-sectional study, the cause-effect relation of the investigated variables was unable to be determined. The present study is constrained by a relatively small sample size, which may limit the generalizability of our findings to a broader population.

5 Conclusion

In summary, this study showed that Chinese young adults in Klang Valley, Malaysia possessed a low level of knowledge and a moderate level of attitude regarding osteoporosis. Even though participants did not meet their calcium requirement, higher scores of knowledge and attitude regarding osteoporosis were correlated with higher dietary calcium intake. This study shows the significance of implementing health education programs on osteoporosis awareness, as well as the importance of calcium intake to prevent osteoporosis, among young adults in Malaysia.

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Writing—review and editing, Project administration; Yang WY: Conceptualisation, Methodology, Investigation, Supervision, Writing—review; Arasu K: Conceptualisation, Methodology, Investigation, Writing—review and editing, Supervision, Project administration, Funding acquisition.

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Data availability The data that support the findings of this study are available upon request from the corresponding author.

Declarations

Ethics approval and consent to participate The study received ethical approval from the IMU University– Joint Committee of Research and Ethics Committee [BDN I-2019 (17)]. Informed consent was obtained from all study participants prior to their participation in the study**.** All experiments were performed in accordance with relevant guidelines and regulations.

Competing interests The authors declare no competing interests.

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