Article

Prevalence and Predictors of Osteoporosis Among the Chinese Population in Klang Valley, Malaysia

Shaanthana Subramaniam ¹, Chin-Yi Chan ¹, Ima-Nirwana Soelaiman ¹, Norazlina Mohamed ¹ ,
Norliza Muhammad ¹, Fairus Ahmad ², Mohd Rizal Abd Manaf ³, Pei-Yuen Ng ⁴,
Nor Aini Jamil ⁵ and Kok-Yong Chin ^{1,*}

¹ Department of Pharmacology, Faculty of Medicine, Universiti Kebangsaan Malaysia, Cheras, Kuala Lumpur 56000, Malaysia; shaanthana_bks@hotmail.com (S.S.); chanchinyi@gmail.com (C.-Y.C.); imasoel@ppukm.ukm.edu.my (I.-N.S.); azlina@ppukm.ukm.edu.my (N.M.); norliza_ssp@ppukm.ukm.edu.my (N.M.)

² Department of Anatomy, Faculty of Medicine, Universiti Kebangsaan Malaysia, Cheras, Kuala Lumpur 56000, Malaysia; apai.kie@gmail.com

³ Department of Community Health, Faculty of Medicine, Universiti Kebangsaan Malaysia, Cheras, Kuala Lumpur 56000, Malaysia; mrizal@ppukm.ukm.edu.my

⁴ Faculty of Pharmacy, Universiti Kebangsaan Malaysia, Kuala Lumpur 50300, Malaysia; pyng@ukm.edu.my

⁵ School of Healthcare Sciences, Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Kuala Lumpur 50300, Malaysia; ainijamil@ukm.edu.my

* Correspondence: chinkokyong@ppukm.ukm.edu.my; Tel.: +603-9145-9573

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Abstract: The prevalence of osteoporosis is forecasted to escalate in Malaysia with an increasing elderly population. This study aimed to analyze the prevalence and the risk factors of osteoporosis among middle-aged and elderly Chinese Malaysians. Three hundred sixty seven Malaysian Chinese aged ≥ 40 years in Klang Valley, Malaysia, were recruited. All subjects completed a structured questionnaire comprised of demographic details, medical history, diet, and lifestyle practices. Body anthropometry and bone mineral density measurements were also performed. The relationship between bone health status and risk factors was determined using multivariate logistic regression. Fifteen-point-three percent of the overall study population and 32.6% of those aged ≥ 71 years had osteoporosis. The prevalence of osteoporosis among women (18.9%) was higher than men (11.5%). The significant predictors of osteoporosis were age, body weight, and low monthly income. Lean mass, low education level, and being underweight predicted osteoporosis in women. Lean mass was the only significant predictor of osteoporosis in men. Overall, 15.3% of the Malaysian Chinese aged ≥ 40 years from Klang Valley, Malaysia, had osteoporosis. Osteoporosis was associated positively with increased age and low monthly income and negatively with body weight. Therefore, osteoporosis preventive strategies targeting Chinese elderly from a low socioeconomic background is necessary.

Keywords: bone mineral density; calcium; exercise; osteoporosis; osteopenia; sex

1. Introduction

Osteoporosis is one of the emerging non-communicable diseases worldwide. The ultimate outcome of osteoporosis is fragility fractures, mainly at the spine, hip, and wrist. The escalating morbidity and mortality due to fragility fractures cause a substantial healthcare burden on individuals, families, and society [1]. Globally, 21 million men and 137 million women had a high probability of osteoporotic fracture in the year 2010, and 55% of them were from Asia [2]. Half of all hip fractures in the world will occur in Asia by 2050 [3]. The population aged over 50 years in Malaysia is expected to increase from 5.3 million in 2013 to 13.9 million in 2050 [4]. Apart from that, an updated hip fracture

projection in Asia revealed that Malaysia will experience a 3.55-fold increase in hip fracture incidence by 2050 compared to 2018 [5].

Currently, bone mineral density (BMD) determination using dual-energy X-ray absorptiometry (DXA) remains as the gold standard in the diagnosis of osteoporosis [6,7]. According to the World Health Organization, a BMD value ≤ -2.5 standard deviations (SD) of young adult mean (or a T-score ≤ -2.5) indicates osteoporosis, while a T-score between ≤ -1.0 and > -2.5 indicates osteopenia [6]. The prevalence of osteoporosis is not well documented in Malaysia. A large retrospective study by Lee and Khir (1997) reported that the hip fracture incidence in 1996–1997 among Malaysians aged ≥ 50 years was 90 per 100,000 individuals per year. In addition, Malaysian Chinese were found to have the highest incidence of hip fractures [8]. Lim et al. reported that the prevalence of osteoporosis among postmenopausal women ($n = 514$, mean age: 51.07 ± 5.28 years) in central Malaysia was 24.1% [9]. Several small-scale studies revealed that the prevalence of osteopenia/osteoporosis in Chinese (62%) was higher compared to other ethnicities [10], and 2.7% of pre-menopausal Chinese women had osteoporosis [11]. Considering the previous evidence, Chinese are the most vulnerable ethnic group suffering from osteoporosis in Malaysia. Further investigations into the risk factors predisposing Malaysian Chinese to osteoporosis are warranted.

In Malaysia, some studies have reported the risk factors associated with osteoporosis. A local study reported that parity, habitual tea consumption, and body mass index (BMI) were the positive predictors of osteoporosis, while the duration of sleep was a negative predictor of osteoporosis among postmenopausal women aged ≥ 50 years [10]. Lim et al. (2005) found that increased age and longer years since menopause were positively associated with the occurrence of osteoporosis, while body weight, BMI, and waist and hip circumference were negatively associated with osteoporosis among healthy Malaysian women [9]. Studies involving both sexes are very limited, yet they are important because the risk factors may differ between men and women.

This study aimed to determine the prevalence and predictors associated with osteoporosis among Malaysian Chinese aged ≥ 40 years. We focused on Malaysian Chinese residing in Klang Valley because it is a densely-populated and highly-urbanized area. This study is novel because both Chinese men and women were recruited, allowing comparison of prevalence and risk factors between sexes to be made. It is among the few studies in Malaysia that uses DXA to determine the bone health of the population. The results obtained from this study would be able to show the prevalence of osteoporosis among Malaysian Chinese and the risk factors involved. The data will be useful in strategizing preventive measures to stop the progression of osteoporosis among high-risk individuals.

2. Materials and Methods

This cross-sectional study adopted the quota sampling technique to recruit community-living Malaysian Chinese subjects aged ≥ 40 years living in Klang Valley, Malaysia. Solicitation of subjects was performed from April–December 2018. Invitations with specific inclusion and exclusion criteria were sent to community centers in Klang Valley and advertised in local newspapers and radio stations. Only subjects fulfilling the inclusion criteria in Table 1 were recruited. The total number of subjects recruited in the study was 408, of which 51 were excluded from the study due to the following reasons: thiazide diuretics users ($n = 15$), glucocorticoids users ($n = 24$), receiving cancer treatment ($n = 2$), having mobility problems ($n = 4$), and did not complete the study procedures ($n = 6$). Finally, data for 367 subjects were used in the present study. Informed consent was obtained from all the subjects before their enrolment. The study was approved by the Research Ethics Committee of Universiti Kebangsaan Malaysia (approval code: UKM PPI/111/8/JEP-2017-761).

Table 1. Inclusion and exclusion criteria used for this study.

Inclusion Criteria	Exclusion Criteria
Malaysian aged ≥ 40 years	Previously diagnosed with metabolic bone diseases (Paget's disease, osteogenesis imperfect, osteomalacia, rickets)
Residing in Klang Valley, Malaysia	Diagnosed with conditions that alter bone metabolism (hypo-/hyper-calcemia, hypo-/hyper-thyroidism, hypo-/hyper-gonadism)
	Receiving therapeutic agents that alter bone metabolism (thiazide diuretics, glucocorticoids, thyroid supplements, anticonvulsants, antidepressants, osteoporosis treatment agents, etc.)
	Having mobility problems, need a walking aid, fractured six months prior to the screening date, having metal implants at the calcaneus, hip, spine, or femoral neck
	Suffered a low impact fracture after the age of 50 years

All subjects completed a questionnaire, which included demographic details (ethnicity, occupation, education level, parity, current menstrual status, age of menarche and menopause), medical history, intake of dairy products (milk, yoghurt, and cheese), coffee, tea, and alcohol, and lifestyle practices (smoking habits and physical activity). The subjects were classified based on household income into the bottom 40% (B40, with household income <RM 7640 or USD 1868), the middle 40% (M40, with household income RM 7640–RM 15,159 or USD 1868–USD 3707), and top 20% (T20, with household income $\geq$ RM 15,160 or USD 3707) groups according to data of the Malaysian census [12]. For the intake of dairy products and beverages, the frequency of consumption was determined. For beverages, an intake of less than one unit per week was defined as non-drinker. One unit of milk was defined as 200 mL, while one unit of coffee/tea was defined as one standard cup [13]. Those who consumed beverages or dairy products 3–4 days per week were defined as regular drinkers. A unit of alcoholic drink referred to a bottle of beer/cider, a glass of wine, or a portion of spirits/strong alcohol according to the National Health Service, U.K. [14]. Due to the low number of subjects who stopped drinking alcohol, both former drinkers and regular drinkers (3–4 days per week) were grouped as “ever drinker”. Meanwhile, those who consumed rarely (one or fewer days per month) or never consumed at all were grouped as “non-drinker”. In this study, current smokers and those who abstained from smoking within the past 12 months were grouped as “ever smoker”. As for calcium supplementation, subjects who consumed at least one tablet of calcium supplement for 3–4 days per week and took it for more than a month were considered as regular consumers.

Physical activity status of subjects was assessed using the International Physical Activity Questionnaire (IPAQ), which is freely available online [15]. The total energy expenditure was determined by the multiplication of the duration (in minutes) and the frequency (days) of walking by a factor of 3.3, moderate intensity by a factor of 4, and vigorous intensity by a factor of 8. These were converted to the metabolic equivalent of task (MET) and summed up. Subjects were categorized into inactive, minimally active, or HEPA (health-enhancing physical activity) active based on total MET score or other additional criteria [11,13].

Subjects' standing height without shoes was measured to the nearest 1 cm using a stadiometer (SECA, Hamburg, Germany). Body weight of subjects with light clothing, but without shoes was measured to the nearest 0.1 kg using a weighing scale (TANITA, Tokyo, Japan). Body mass index (BMI: kg/m^2) was calculated by dividing body weight (kg) by the square of body height (m^2). BMI was classified as underweight ($<18.5 \text{ kg/m}^2$), normal ($18.5\text{--}24.9 \text{ kg/m}^2$), and overweight ($>24.9 \text{ kg/m}^2$) for those aged <65 years [16]. Conversely, for subjects aged >65 years, a BMI $<22 \text{ kg/m}^2$ was classified as underweight, $22\text{--}27 \text{ kg/m}^2$ as normal, and $>27 \text{ kg/m}^2$ as overweight [17]. Subjects' waist circumference was measured between the lowest rib margin and the iliac crest while they maintained their standing position [18].

BMD at the lumbar spine (anteroposterior, L1–L4) and left hip, lean body mass, and fat mass were assessed using total body dual-energy X-ray absorptiometry (DXA) (Hologic Discovery QDR Wi densitometer, Hologic, MA, USA). The BMD values (in g/cm²) were converted to a T-score based on the reference values of the Singaporean Chinese population. Bone health status of the subjects was classified according to the World Health Organization (WHO) criteria into osteoporosis (T-score ≤ -2.5), osteopenia (T-score ≤ -1 and > -2.5), and normal (T-score > -1.0). The DXA measurement was performed by an experienced technologist. Daily calibration was conducted using a phantom. The short-term in vivo coefficient of variation for this device was 1.8% and 1.2% for lumbar spine and total hip, respectively.

Statistical Analysis

All statistical analyses were performed using the Statistical Package for Social Science Version 22.0 (IBM, Armonk, NY, USA). Normality of the data was determined using the Kolmogorov–Smirnov test. The relationship between osteoporosis and predictors of interest was determined using a two-step multivariate logistic regression analysis. All continuous variables were entered into the equation using the stepwise method. All dummy-coded categorical predictors (age groups, education level, physical activity status, parity, and menstrual status) were force-entered in the second step. Subjects who were normal or osteopenic were categorized as “0”, while those who were osteoporotic were categorized as “1”. The dichotomized bone health status was entered as the dependent variable in the logistic regression. The effect size of each predictor was expressed as odds ratio (OR) and 95% confidence interval (CI). A p -value < 0.05 was considered to be statistically significant.

3. Results

The mean age of the subjects was 59.14 ± 8.96 years. Out of 367 subjects, 182 (49.6%) were men, while 185 (50.4%) were women. Ninety four percent of the subjects had sedentary jobs, and 95.6% had an estimated monthly income $< \text{RM } 7640$ (USD 1868). The majority of the subjects had at least a secondary school education (Table 2).

The prevalence of osteoporosis among the subjects (40–87 years) was 11.5% for men and 18.9% for women based on their T-score. Besides that, 45.6% of men and 53.0% of women had osteopenia. The prevalence of osteoporosis was higher among older age groups, underweight subjects ($< 18.5 \text{ kg/m}^2$), and menopausal women. Specifically, 39.6% of the underweight subjects had osteoporosis compared to 13.8% of subjects with normal BMI ($p < 0.05$). More menopausal women (25.8%) suffered from osteoporosis compared to premenopausal women (4.5%). The prevalence of osteoporosis was not associated with the subjects' job, monthly income, education level, parity, dairy products intake, coffee/tea intake, and lifestyle practices (Table 3).

Stepwise multivariate logistic regression analysis (Table 4) revealed that increased age and low monthly income positively predicted osteoporosis among the subjects ($p < 0.05$), while body weight negatively predicted osteoporosis among them ($p < 0.05$). Older subjects (OR = 1.110, 95% CI: 1.060–1.162) and those with a lower monthly income (OR = 11.292, 95% CI: 2.349–54.282) had a greater risk of suffering from osteoporosis. Those with higher body weight (OR = 0.885, 95% CI: 0.840–0.933) were less likely to have osteoporosis. Sub-analysis based on sex showed that lean mass (OR = 0.9997, 95% CI: 0.9995–0.9998) negatively predicted osteoporosis among men and women. In addition, being underweight (OR = 3.543, 95% CI: 1.029–12.198) and calcium supplement intake (OR = 4.163, 95% CI: 1.274–13.606) positively predicted the occurrence of osteoporosis among women. Women with a secondary school (OR = 0.112, 95% CI: 0.021–0.589), certificate or diploma (OR = 0.062, 95% CI: 0.009–0.453), and university degree or above (OR = 0.037 95% CI: 0.003–0.437) were less likely to develop osteoporosis compared to those with a primary school education or without any formal education.

Table 2. General characteristics of the study population. B, bottom; M, middle.

Variables	Categories	Mean	Standard Deviation
	Age (years)	59.14	8.96
	Age of menarche (years)	13.12	1.79
	Age of menopause (years)	51.31	3.44
	Years since menopause (years)	10.17	7.22
Body Anthropometry	Weight (kg)	61.81	10.66
	Height (cm)	161.58	8.23
	BMI (kg/m ²)	23.59	3.25
	Body fat (%)	33.03	6.53
	Lean body mass (kg)	39.33	8.04
	Waist circumference (cm)	82.47	11.17
	N		%
Age Range (years)	40–50	71	19.3
	51–60	125	34.1
	61–70	128	34.9
	71 and above	43	11.7
Sex	Male	182	49.6
	Female	185	50.4
Marital Status	Single	33	9.0
	Married	334	91.0
Nature of Occupation	Manual	22	6.0
	Sedentary	345	94.0
Estimated Monthly Income	B40	351	95.6
	M40	16	4.4
BMI Classification	Underweight	53	14.4
	Normal	210	57.2
	Overweight	104	28.3
Highest Education Level	No formal education or Primary school	39	10.6
	Secondary school	179	48.8
	Certificate/diploma	89	24.3
	University degree or above	60	16.3
Parity	Nulliparous	34	18.4
	1–3 pregnancies	99	53.5
	More than 3 pregnancies	52	28.1
Current Menstrual Status	Pre-menopause	31	16.8
	Peri-menopause	22	11.9
	Menopause	132	71.4
Diabetes Mellitus	Yes	20	5.4
	No	347	94.6
Hypertension	Yes	74	20.2
	No	293	79.8
Hypercholesterolemia	Yes	78	21.3
	No	289	78.7
Gout	Yes	16	4.4
	No	351	95.6

Table 3. Bone health status of the study population. HEPA, health-enhancing physical activity. The bolded p-values are statistically significant.

Demographic Details		Categories	Bone Health Status								p-Value
			Normal		Osteopenia		Osteoporosis		Total		
			n	%	n	%	n	%	n	%	
Age (years)	40–50	30	42.3	38	53.5	3	4.2	71	100	<0.001	
	51–60	49	39.2	65	52.0	11	8.8	125	100		
	61–70	38	29.7	62	48.4	28	21.9	128	100		
	71 and above	13	30.2	16	37.2	14	32.6	43	100		
	TOTAL	130	35.4	181	49.3	56	15.3	367	100		
Sex	Male	78	42.9	83	45.6	21	11.5	182	100	<0.05	
	Female	52	28.1	98	53.0	35	18.9	185	100		
	TOTAL	130	35.4	181	49.3	56	15.3	367	100		
Nature of Job	Sedentary	121	35.1	169	49.0	55	15.9	345	100	0.352	
	Manual	9	40.9	12	54.5	1	4.5	22	100		
	TOTAL	130	35.4	181	49.3	56	15.3	367	100		
Monthly Income	B40	121	34.5	177	50.4	53	15.1	351	100	0.123	
	M40	9	56.3	4	25.0	3	18.8	16	100		
	TOTAL	130	35.4	181	49.3	56	15.3	367	100		
Education Level	No formal education and Primary school	10	25.6	17	43.6	12	30.8	39	100	0.119	
	Secondary school	62	34.6	89	49.7	28	15.6	179	100		
	Certificate/Diploma	34	38.2	45	50.6	10	11.2	89	100		
	University degree and above	24	40.0	30	50.0	6	10.0	60	100		
	TOTAL	130	35.4	181	49.3	56	15.3	367	100		
Body Mass Index (BMI)	Underweight	9	17.0	23	43.4	21	39.6	53	100	<0.001	
	Normal	65	31.0	116	55.2	29	13.8	210	100		
	Overweight	56	53.8	42	40.4	6	5.8	104	100		
	TOTAL	130	35.4	181	49.3	56	15.3	367	100		
Parity	Nulliparous	9	26.5	22	64.7	3	8.8	34	100	0.416	
	1–3 pregnancies	27	27.3	52	52.5	20	20.2	99	100		
	More than 3 pregnancies	16	30.8	24	46.2	12	23.1	52	100		
	TOTAL	52	28.1	98	53	35	18.9	185	100		
Current Menstrual Status	Pre-menopause	17	54.8	14	45.2	0	0	31	100	<0.001	
	Peri-menopause	9	40.9	12	54.5	1	4.5	22	100		
	Menopause	26	19.7	72	54.5	34	25.8	132	100		
	TOTAL	52	28.1	98	53	35	18.9	185	100		
Reason of Menopause	Iatrogenic	1	12.5	7	87.5	0	0	8	100	0.128	
	Natural	25	20.2	65	52.4	34	27.4	124	100		
	TOTAL	26	19.7	72	54.5	34	25.8	132	100		
Dairy Intake	Regularly	42	36.8	55	48.2	17	14.9	114	100	0.930	
	Do not drink	88	34.8	126	49.8	39	15.4	253	100		
	TOTAL	130	35.4	181	49.3	56	15.3	367	100		
Coffee/Tea Intake	Regularly	108	36.5	146	49.3	42	14.2	296	100	0.441	
	Do not drink	22	31	35	49.3	14	19.7	71	100		
	TOTAL	130	35.4	181	49.3	56	15.3	367	100		
Calcium Supplement Intake	Regularly	17	26.2	35	53.8	13	20	65	100	0.182	
	Never	113	37.4	146	48.3	43	14.2	302	100		
	TOTAL	130	35.4	181	49.3	56	15.3	367	100		
Smoking Status	Ever-smoker	25	39.1	32	50.0	7	10.9	64	100	0.536	
	Never	105	34.7	149	49.2	49	16.2	303	100		
	TOTAL	130	35.4	181	49.3	56	15.3	367	100		
Alcohol Intake	Ever-drinker	58	40.8	62	43.7	22	15.5	142	100	0.180	
	Never	72	32	119	52.9	34	15.1	225	100		
	TOTAL	130	35.4	181	49.3	56	15.3	367	100		
Physical Activity status	Inactive	47	35.9	62	47.3	22	16.8	131	100	0.349	
	Moderately-active	56	35.2	85	53.5	18	11.3	159	100		
	HEPA-active	27	35.1	34	44.2	16	20.8	77	100		
	TOTAL	130	35.4	181	49.3	56	15.3	367	100		

Table 4. Predictors of bone health status of the study population. The bolded p-values are statistically significant.

Variables	Odds Ratio (OR)	95% CI for OR		p-Value
		Lower	Upper	
Overall (among both sexes)				
Age	1.110	1.060	1.162	<0.001
Body weight	0.885	0.840	0.933	<0.001
Low monthly income	11.292	2.349	54.282	0.002
Sub-analysis among men				
Lean mass	0.9997	0.9995	0.9998	<0.001
Sub-analysis among women				
Lean mass	0.9997	0.9995	0.9999	0.002
Calcium supplement intake	4.163	1.274	13.606	0.018
Body mass index (BMI):				
Underweight vs. normal	3.543	1.029	12.198	0.045
Overweight vs. normal	0.517	0.087	3.066	0.467
Education:				
Secondary school vs. no formal education/primary school	0.112	0.021	0.589	0.010
Certificate/diploma vs. no formal education/primary school	0.062	0.009	0.453	0.006
University degree and above vs. no formal education/primary school	0.037	0.003	0.437	0.009

The odds ratio was obtained through a multivariate logistic regression model. The predictors are adjusted to each other.

4. Discussion

Osteoporosis is a skeletal metabolic disease with increasing prevalence among the ageing population. In the current study, the prevalence of osteoporosis was higher among older subjects. The prevalence of osteoporosis was 32.6% in subjects aged ≥ 71 years compared to subjects in younger age groups (4.2%, 8.8%, and 21.9% in age groups 40–50 years, 51–60 years, and 61–70 years, respectively). This was a common finding in many human epidemiological studies. A study conducted in 7163 Koreans aged above 50 years showed that 4.0% of men in their 50s were osteoporotic. The prevalence increased to 7.2% for those in their 60s, 15.1% in their 70s, and 26.7% in their 80s. The prevalence in women was 15.2%, 36.5%, 62.7%, and 85.8%, respectively [19]. A similar trend was found in 7042 Han Chinese adults (age range: 20–85 years), whereby men (21.7%) and women (59.3%) in the age group 75–79 years were reported to have the highest prevalence of osteoporosis as compared to other age groups [20]. The pooled prevalence of osteoporosis in 2016 (34.65%) in China was reported to be twice the pooled prevalence in the year 2006 (15.7%), and the study also observed that osteoporosis increased with age [21]. It was evident that age is one of the most important determinants of osteoporosis.

Women are known to be more susceptible to osteoporosis compared to men. This is due to a phase of accelerated bone loss after menopause [22,23] and a lower peak bone mass in women [24]. In this study, the prevalence of osteoporosis was 18.9% among women compared to 11.5% in men. This was in agreement with the study by Lim et al. (2005), which reported that the prevalence of spine and hip osteoporosis among 514 women (mean age: 51.07 ± 5.28 years) was 8.6% and 21.4%, respectively [9]. In the Korean population ($n = 126,269$; age range: 50–64 years), a 10-fold difference in the prevalence of osteoporosis between women (25.2%) and men (2.3%) was observed [25]. Menopausal women in our study had the highest prevalence of osteoporosis compared with premenopausal or perimenopausal women, and this was analogous to previous studies [26,27]. Lim et al. showed that the prevalence of osteoporosis in postmenopausal women (42.1%) was four-fold higher than that of premenopausal women (11.1%) [26]. Another Korean study (1547 men and 1991 women; age range 40–79 years) also found that postmenopausal women were at greater risk for osteoporosis at lumbar spine compared to premenopausal women [27]. After menopause, deprivation of estrogen will alter the composition of the mineral and organic matrix of bone tissue [28,29]. The progressive increase in bone resorption and the decrease in bone formation due to estrogen deficiency will deteriorate the microarchitecture and strength of bones [29].

This study also showed that the prevalence of osteoporosis was higher among underweight subjects compared to those with normal BMI or who were overweight. This was in line with a

number of previous studies [30–32]. Underweight subjects were shown to have a higher incidence of osteoporosis than those with a BMI ≥ 18.5 kg/m² among Mainland Chinese (n = 4988, aged 41–95 years). Lower BMI was found to be positively correlated with osteoporosis [30]. A cross-sectional study in Thailand (n = 4528, age ≥ 40 years) also reported that osteoporosis was most commonly found in underweight women (52.1%), followed by those with normal weight (20.3%), those overweight (15.7%), and those obese (9.4%) [31]. Greater BMI or body weight is positively associated with BMD as it imposes mechanical stress on bone, and in response, the bone mass increases to accommodate the load [33,34]. Adipose tissue also possesses aromatase enzyme, which converts androgen to estrogen, which is protective of bone [35,36]. BMI may also reflect the nutritional status of the subjects, whereby underweight subjects may be deficient in the vital nutrients to maintain bone health. The positive association between BMI and bone health has been discussed in various geographical regions and populations [37–40]. However, BMI is a poor determinant of obesity, because it is the excess fat mass that actually defines obesity rather than total body weight (or BMI) [33]. Lean mass, which is a component contributing to body weight aside from fat mass, was observed to predict negatively osteoporosis among the subjects of this study. The muscle can also exert mechanical forces on the bone and maintain its mass. It may also reflect the weight-bearing activity of the subjects, in which muscle mass and bone health are higher in those who are more active.

Intake of calcium supplement was a positive predictor of osteoporosis among women in this study. We hypothesized that this observation was caused by the fact that women susceptible to osteoporosis had initiated calcium supplementation prior to joining the study. Calcium supplements have been widely used as a pharmacological agent to prevent bone loss [41–43]. However, the calcium supplementation might not be persistent or sufficient among women in this study to produce an effect on their bone health. Thus, the relationship was not causal.

The majority of the subjects in the present study belonged to the low socio-economic group (95.6%). A lower monthly household income was found to predict osteoporosis among the subjects, especially women, in this study. This was in accordance with a previous study that reported a significant association between household income and bone health in elderly women [44]. A lower household income may imply limited access to healthcare [25,45]. Subjects with a lower income might not have the opportunities to engage with medical professionals to ensure their well-being. Besides, they might not have access to healthy food and supplements. Thus, previous studies have indicated that individuals with a lower income also had a greater risk of hip fracture [46].

Lower education level was one of the determinants of osteoporosis among women. Similar findings were reported by Alalli et al. (2010), whereby a lower education level was associated with a lower BMD and a higher prevalence of osteoporosis in Moroccan women (n = 356, mean age: 58.9 ± 7.7 years) [47]. It is postulated that subjects with lower educational background might have lower knowledge and awareness regarding osteoporosis. Hence, they are less likely to engage in osteoprotective practices. This was confirmed by another study among postmenopausal women (n = 560; mean age: 60.43 ± 7.19 years), which demonstrated that subjects with a higher education level had a better bone health status and positive practices towards bone health [48].

There are several limitations that should be considered when interpreting the data of this study. The present study was limited by its cross-sectional design. A prospective study would provide stronger evidence of causality between osteoporosis and its associated risk factors. We also did not determine the dietary and supplementation pattern of the subjects in detail; hence, the relationship between macro- and micro-nutrients and bone health was not investigated. An additional limitation includes the relatively smaller sample size involved in the study. However, to the best of our knowledge, this is the first study to report on the prevalence and predictors of osteoporosis defined by DXA among middle-aged and elderly Malaysian Chinese in Klang Valley. Other similar studies have been conducted in Malaysia, but they used quantitative ultrasonometry to determine bone health of the subjects [13,49,50].

5. Conclusions

In conclusion, the crude prevalence of osteoporosis among Malaysian Chinese aged 40 years was 15.3%, while sex-specific prevalence was 11.5% in men and 18.9% in women. The positive predictors of osteoporosis among Malaysian Chinese were age and low monthly income, while body weight was found to be a negative predictor. The identification of these risk factors has major implications for the design of early preventive programs against osteoporosis among middle-aged or elderly Chinese population in Malaysia. A special focus should be given to those with low socioeconomic status because they may not have easy access to healthcare facilities that cater to their bone health. Proper health education towards a healthy lifestyle also must be considered since it is a proactive measure to prevent osteoporosis.

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