



Osteoporosis awareness among patients in Singapore (OASIS)—a community hospital perspective

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Abstract

Summary This study examines factors associated with osteoporosis awareness and knowledge using Osteoporosis Prevention and Awareness Tool (OPAAT). Of 410 patients, majority of patients had a OPAAT score < 24 ($n = 362$, 88.3%). Lower education level (odds ratio (OR) (primary education): 3.63; OR (no formal education): 111.5; $p < 0.001$) and diabetic patients (OR: 1.67; $p = 0.003$) were associated with lower OPAAT scores.

Introduction Lack of osteoporosis awareness forms a critical barrier to osteoporosis care and has been linked with increased institutionalization, healthcare expenditures, and decreased quality of life. This study aims to identify factors associated with osteoporosis awareness and knowledge among female Singaporeans.

Methodology A cross-sectional study was conducted among adult female patients (aged 40 to 90 years old) who were admitted into Outram Community Hospital from April to October 2020. Osteoporosis awareness and knowledge were assessed using interviewer-administered Osteoporosis Prevention and Awareness Tool (OPAAT). High knowledge was defined as a OPAAT score ≥ 24 . Multivariate logistical regression analyses were used to identify predictors of low OPAAT scores.

Results Of 410 patients recruited, their mean age was 71.9 ± 9.5 years old and majority of patients had a OPAAT score < 24 ($n = 362$, 88.3%). Patients with lower OPAAT scores tended to be older (72.5 ± 9.2 vs 67.5 ± 10.1 , $p < 0.001$), attained lower education level ($p < 0.001$), and were more likely to live in public housing (92.5% vs 81.5%, $p = 0.009$). The prevalence of diabetes mellitus was higher in patients with low OPAAT scores (39.2% vs 18.8%, $p = 0.006$). After adjustment for covariates, lower education level (odds ratio (OR) (primary education): 3.63; OR (no formal education): 11.5; $p < 0.05$) and patients with diabetes mellitus (OR: 1.67; $p = 0.03$) were associated with lower OPAAT knowledge scores.

Conclusion Elderly female patients in community hospital have inadequate osteoporosis awareness despite being at risk of fractures. There is a need to address the knowledge gap in osteoporosis, especially among diabetic patients or patients with lower education.

Keywords Osteoporosis · Age-related bone loss · Knowledge · Awareness · Osteoporosis Prevention and Assessment tool · OPAAT · Community hospitals

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Introduction

Osteoporosis is defined as a systemic skeletal condition that is characterized by low bone mass and progressive microarchitectural deterioration of bone tissue, which predisposes one to increased risk of fragile bones and fractures [1]. Globally, over 200 million women suffer from osteoporosis and it results in over 8.9 million fractures annually [2–4]. With the greying populations worldwide, the incidence of osteoporosis is expected to continue rising, alongside projected increases in hip fractures by 200–300% in the next 3 decades [2].

Asia is expected to contribute to 50% of the global tally of hip fractures by 2050 [5, 6]. Notably, Singapore has the highest reported incidence of hip fractures within Asia [5, 6]. The International Osteoporosis Foundation Asian Audit showed that one in three Singaporean women over 50 years old has osteoporosis [5]. Among females more than 60 years, half and one-quarter of the population were at intermediate and high risk of developing osteoporosis, respectively [7, 8]. Unsurprisingly, it has been estimated that the costs of managing hip fractures in Singapore will reach USD\$145 million in 2050 [5, 6].

Despite its high prevalence, association with increased morbidity and mortality, osteoporosis remains underdiagnosed and under-treated [9]. Barriers which impede the delivery of optimal osteoporosis care and prevention include patient-, physician-, and healthcare system-related factors. Among patient-related factors, lack of public awareness of osteoporosis is regarded as the largest barrier to osteoporosis care, in the Asia–Pacific region [3, 10]. Importantly, higher levels of osteoporosis knowledge have been shown to correlate with greater utilization of osteoprotective practices such as exercise and calcium intake [11]. Furthermore, inadequate health literacy related to osteoporosis has been linked with higher rates of non-compliance to anti-osteoporosis treatment [12].

The levels affecting osteoporosis-related knowledge are known to vary across countries, study designs, and types of study participants recruited [13, 14]. For example, a study in Pakistan showed that only 8% of participants had a good level of osteoporosis knowledge [13, 14]. In contrast, a study conducted in China showed that the overall osteoporosis awareness was 67.8% [14]. In Singapore, the last household survey conducted 20 years ago showed that only half of females above 45 years were aware of osteoporosis [15] while a small pilot study among 56 female nurses showed that majority (94.6%) of them had good knowledge of osteoporosis and its risk factors [15]. More recently, a local primary care study showed that more than half of patients had low osteoporosis knowledge [16]. Pertaining to determinants of osteoporosis knowledge, there

exist socio-demographic and cross-cultural differences similarly. For example, in the USA, patients who were of African or Asian ethnicity tended to have lower knowledge compared to their White counterparts [17]. Other factors which have been linked with better osteoporosis knowledge include higher education level, higher physical activity level, higher socio-economic status, prior BMD measurement, and osteoporosis treatment [10, 12, 15, 16, 18, 19].

With advances in medical care and increasing consumption of medical knowledge from non-traditional media, e.g., social media in the recent years, their impact on osteoporosis knowledge in the local population remains unclear. There is also paucity of data related to the levels of and unique factors associated with poor osteoporosis knowledge among female patients residing in community hospital. Hence, this study aims to evaluate the level of and factors associated with poor osteoporosis-related knowledge among females in community hospital. The findings from this study will enable healthcare administrators to better understand determinants of poor osteoporosis-related knowledge and facilitate the development of policies and programs to target patients with high risk of developing osteoporosis as well as patients residing in community hospitals.

Methodology

Study design and inclusion and exclusion criteria

A cross-sectional study was carried out among adult female patients (aged 40–90 years old) who were admitted to Outram Community Hospital (OCH) between April 2020 and October 2020. The lower limit of 40 years old was utilized as the study wanted to evaluate osteoporosis knowledge among younger female adults and that the onset of initial bone loss in osteoporosis starts in the fourth decade of life [20]. Outram Community Hospital is one of the three flagship community hospitals under the Singapore Health Services, the largest healthcare cluster in Singapore. It provides step-down medical services such as rehabilitative and sub-acute medical care for patients who are discharged from acute hospitals [21].

For inclusion in this study, eligible patients were required to have an Abbreviated Mental Test (AMT) score ≥ 7 . Uncommunicative patients and patients with AMT score ≤ 6 were excluded (17). Consecutive sampling was utilized for patient recruitment. Informed consent from recruited patients. Singhealth Centralised Institutional Review Board (CIRB) approval (CIRB Ref: 2020/2245) was obtained.

Osteoporosis Prevention and Awareness Tool (OPAAT)

The OPAAT is a 30-item instrument which assesses awareness and knowledge related to osteoporosis [22]. Items within the tool cover three key themes related to osteoporosis which are, namely, (1) osteoporosis in general; (2) consequences of untreated osteoporosis; and (3) osteoporosis prevention [22]. Each correct answer is awarded 1 point with a maximum score of 30. An OPAAT score of 24 or greater is defined as high osteoporosis-related knowledge, as per the developer of the tool. The English and Malay versions of the tool have been validated for use [22].

As a significant proportion of the study population were expected to speak only Mandarin, the OPAAT was translated into Chinese language via forward-translations and back-translations. This was performed by a native Chinese healthcare professional who was bilingual in English and Chinese. Another independent bilingual healthcare professional assisted in identifying and resolving inadequate expressions or discrepancies of the translation. Thereafter, another independent translator whose mother tongue is English and had no knowledge of the questionnaire was tasked to perform the back-translation to English. Pre-testing and cognitive interviewing with 10 female patients were conducted before finalizing the translated version.

Socio-demographic and clinical variables collected

A separate standardized questionnaire was used to collect data related to the socio-demographic and clinical characteristics of patients. Socio-demographic data such as age, marital status, ethnicity, educational level, and employment status were collected. For clinical variables, information such as patient's history of fragility fracture, bone mineral density (BMD) measurement, and medical conditions were extracted. OSTA score and FRAX score of the patients were computed to assess patients' risk of osteoporosis and fractures. Lastly, details related to participants' source of osteoporosis knowledge and preferred mode of bone health education were collected.

Sample size computation

Using estimates from a study by Saw et al. which showed that 58% of female Singapore citizens were aware of osteoporosis and factoring 10% of patients with incomplete data, 410 patients was the minimum number of patients required, after applying the Cochran formula $[n = (Z_{0.95})^2 P(1 - P)/D^2]$.

Statistical analysis

Descriptive statistics were used to summarize the characteristics of the study population. Continuous variables were reported as mean \pm standard deviation or number (percentage). To evaluate differences in the characteristics of patients with low and high OPAAT scores, Student's *t*-test was used for continuous variables while chi-square or Fisher's exact test was used for categorical variables. To identify factors associated with OPAAT knowledge scores, multivariate logistical regression was performed. Socio-economic which included patients' age, working status, education level, housing type, smoking status, alcohol status, preferred speaking and reading languages, and clinical comorbidities were entered in the regression model, after checking for collinearity and interactions. All statistical analyses were performed using the STATA software, Version 16.0 (STATA corporation, College Station, Texas). A two-tailed *p*-value < 0.05 was considered statistically significant.

Results

Characteristics of the study population

Table 1 shows the baseline socio-demographic characteristics of patients. The mean age of patients was 71.9 ± 9.5 and majority of patients were of Chinese ethnicity ($n = 354$, 96.3%). Most of the patients stayed in public housing ($n = 374$, 97.2%) and received primary to secondary education ($n = 268$, 65.4%).

With regard to the clinical characteristics of patients (Table 2), majority of the study population did not have a prior diagnosis of osteoporosis ($n = 304$, 74.2%). Among 106 patients with known osteoporosis (25.8%), about 73.6% of them ($n = 78$) received osteoporosis treatment. Approximately one-third of patients (36.8%) had diabetes while only 2.2% of patients had rheumatoid arthritis.

Characteristics of patients with low and high OPAAT scores

Within the study population, most patients had low OPAAT scores ($n = 362$, 88.3%) while 48 patients had high knowledge scores.

Patients with low OPAAT scores tended to be older (72.5 ± 9.2 vs 67.5 ± 10.1 , $p < 0.001$), attained lower education qualifications ($p < 0.001$), and were more likely to live in public housing (92.5% vs 81.5%, $p = 0.009$)

Table 1 Baseline socio-demographic characteristics of patients with OPAAT scores

OPAAT score	Low knowledge < 24 (n = 362)	High knowledge ≥ 24 (n = 48)	Overall (n = 410)	p-value
<i>Mean age (S.D)</i>	72.5 (9.2)	67.5 (10.1)	71.9 (9.5)	<0.001
<i>Age groups</i>				
< 65	69 (19.1)	17 (35.4)	86 (21.0)	0.011
65–74	133 (36.7)	19 (38.6)	152 (37.1)	
75–84	127 (35.1)	12 (25.0)	139 (33.9)	
≥ 85	33 (9.1)	0	33 (8.1)	
<i>Ethnicity</i>				
Chinese	312 (86.2)	42 (87.5)	354 (96.3)	0.603
Malay/Indian/Others	50 (13.8)	6 (12.5)	56 (13.7)	
<i>Smoking</i>				
Smoker/ex-smoker	8 (2.2)	0	8 (2.0)	0.582
Non-smoker	354 (97.8)	48 (100)	402 (98.1)	
<i>Alcohol</i>				
Yes	2 (0.6)	0	2 (0.5)	0.606
No	360 (99.5)	48 (100)	408 (99.5)	
<i>Marital status</i>				
Married	127 (35.1)	13 (27.1)	140 (34.2)	0.207
Widowed	74 (20.4)	15 (31.3)	89 (21.7)	
Single/separated/divorced	161 (44.5)	20 (41.7)	181 (44.2)	
<i>Housing</i>				
Public housing	335 (92.5)	39 (81.3)	374 (91.2)	0.009
Private housing	26 (7.5)	9 (18.8)	36 (8.8)	
<i>Working status</i>				
Full-time/part-time	78 (21.6)	17 (35.4)	95 (23.2)	0.032
Unemployed	284 (78.5)	31 (64.6)	315 (76.8)	
<i>Education level</i>				
Tertiary education and above	30 (8.3)	17 (35.4)	47 (11.5)	<0.001
Secondary school	97 (26.8)	19 (39.6)	116 (28.3)	
Primary school	143 (39.5)	9 (18.8)	152 (37.1)	
No formal education	92 (25.4)	3 (6.3)	95 (23.2)	
<i>Spoken language</i>				
English	168 (46.4)	40 (83.3)	208 (50.7)	<0.001
Mandarin	278 (76.8)	40 (83.3)	318 (77.5)	0.308
Chinese dialects	152 (42.0)	7 (14.6)	159 (38.8)	<0.001
Malay	79 (21.8)	10 (20.8)	89 (21.7)	0.876
Tamil/Hindi/Punjabi	30 (8.3)	2 (4.2)	32 (7.8)	0.317
<i>Reading language</i>				
English	128 (35.4)	32 (66.7)	160 (39.0)	<0.001
Chinese	185 (51.1)	29 (60.4)	214 (52.2)	0.225
Malay	20 (5.5)	5 (10.4)	25 (6.1)	0.183
Tamil	15 (4.1)	1 (2.1)	16 (3.9)	0.489
Illiterate	94 (26.0)	0	94 (22.9)	<0.001

Abbreviations: *S.D.*, standard deviation

(Table 1). With regard to spoken and reading language, a larger proportion of patients with low OPAAT scores spoke Chinese dialects (42% vs 14.6%, $p < 0.001$) and were illiterate (26.0% vs 0%, $p < 0.001$) (Table 1).

With regard to their clinical characteristics, the proportion of patients with known osteoporosis or patients on anti-osteoporotic treatment were comparable ($p > 0.05$) although more patients had diabetes mellitus (39.2% vs 18.8%,

Table 2 Clinical characteristics of patients with OPAAT scores

OPAAT score	Low knowledge < 24 (n = 362)	High knowledge ≥ 24 (n = 48)	Overall (n = 410)	p-value
<i>Body mass index (kg/m²)</i>				
< 18.5	34 (9.4)	9 (18.8)	43 (10.5)	0.260
18.5–22.9	118 (32.6)	14 (29.2)	132 (32.2)	
23.0–27.4	115 (31.8)	13 (27.1)	128 (31.2)	
≥ 27.5	95 (26.2)	12 (25.0)	107 (26.1)	
<i>Diabetes mellitus</i>				
Yes	142 (39.2)	9 (18.8)	151 (36.8)	0.006
No	220 (60.8)	39 (81.3)	259 (63.2)	
<i>Rheumatoid arthritis</i>				
Yes	7 (1.9)	2 (4.2)	9 (2.2)	0.014
No	355 (98.1)	46 (95.9)	401 (97.8)	
<i>Steroid use</i>				
Yes	19 (5.3)	5 (10.4)	24 (5.9)	0.337
No	343 (94.8)	43 (89.6)	386 (94.2)	
<i>Known osteoporosis</i>				
Yes	92 (25.4)	14 (29.2)	106 (25.9)	0.577
No	270 (74.6)	34 (70.8)	304 (74.2)	
<i>Osteoporosis treatment</i>				
Yes	68 (18.8)	10 (20.8)	78 (19.0)	0.734
No	294 (81.2)	38 (79.2)	332 (81.0)	
<i>Types of osteoporosis treatment</i>				
Oral bisphosphonates	58 (16.0)	8 (16.7)	66 (16.1)	0.925
SC Denosumab	14 (3.9)	3 (6.2)	17 (4.2)	0.738
IV bisphosphonate	3 (0.8)	0	3 (0.7)	0.746
SC Teriparatide	3 (0.8)	1 (2.1)	4 (1.0)	0.695
<i>Osteoporosis follow-up</i>				
Primary care	24 (6.6)	2 (4.2)	26 (6.4)	0.659
Medical specialists	39 (10.8)	6 (12.5)	45 (23.3)	
Surgical specialists	29 (8.0)	6 (12.5)	35 (20.5)	
Not applicable	270 (74.6)	34 (70.8)	304 (74.2)	
<i>OSTA</i>				
> 20	163 (45.0)	15 (31.3)	178 (43.4)	0.175
0–20	134 (37.0)	21 (43.8)	155 (37.8)	
< 0	65 (18.0)	12 (25.0)	77 (18.8)	
<i>BMD results</i>				
Osteoporosis	75 (20.7)	12 (25)	87 (21.2)	0.433
Osteopenia	31 (8.6)	6 (12.5)	37 (9.0)	
Normal	7 (1.9)	2 (4.2)	9 (2.2)	
Not available	249 (68.8)	28 (58.3)	277 (67.6)	
<i>FRAX for hip fracture</i>				
3% or more	234 (64.6)	22 (45.8)	256 (62.4)	0.011
< 3%	128 (35.4)	26 (54.2)	154 (37.6)	
<i>FRAX for major osteoporotic fractures</i>				
20% or more	130 (35.9)	9 (18.8)	139 (33.9)	0.018
< 20%	232 (64.1)	39 (81.3)	271 (66.1)	
<i>Presence of fragility fracture</i>				
Yes	138 (38.1)	15 (31.3)	153 (37.3)	0.428

Table 2 (continued)

OPAAT score	Low knowledge < 24 (n = 362)	High knowledge ≥ 24 (n = 48)	Overall (n = 410)	p-value
No	224 (61.9)	33 (68.8)	257 (62.7)	
<i>Previous fragility fracture</i>				
Yes	69 (19.1)	11 (22.9)	80 (19.5)	0.526
No	293 (80.9)	37 (77.1)	330 (80.5)	
<i>Current fragility fractures</i>				
Yes	94 (26.0)	6 (12.5)	100 (24.4)	0.035
No	268 (74.0)	42 (87.5)	310 (75.6)	
<i>Previous history of fall</i>				
Yes	150 (41.4)	20 (41.7)	170 (41.5)	0.976
No	212 (58.6)	28 (58.3)	240 (58.5)	
<i>Current history of fall</i>				
Yes	112 (30.9)	10 (20.8)	122 (29.8)	0.150
No	250 (69.1)	38 (79.2)	288 (70.2)	
<i>Use of walking aid prior to admission</i>				
Yes	193 (53.3)	19 (39.6)	212 (51.7)	0.074
No	169 (46.7)	29 (60.4)	198 (48.3)	

Abbreviations: *BMD*, bone mineral density; *FRAX*, fracture risk assessment; *OSTA*, Osteoporosis Self-assessment Tool

$p = 0.006$). Patients were more likely to have FRAX score for risk of hip fractures $\geq 3\%$ (64.6% vs 45.8%, $p = 0.011$), and FRAX score of $\geq 20\%$ for major osteoporotic fractures (35.9% vs 18.8%, $p = 0.018$). Importantly, more patients with low OPAAT scores presented with fragility fractures (26.0% vs 12.5%, $p = 0.035$).

Multivariate analysis for predictors of low OPAAT knowledge scores

Table 3 shows the results of the multivariate logistic regression analysis for predictors of low OPAAT scores. After adjustment for covariates, lower education level (odds ratio (OR) (primary vs tertiary education): 3.63, $p = 0.003$; OR (no formal education vs tertiary education): 11.5; $p < 0.001$) and having diabetes mellitus (OR: 1.67; $p = 0.03$) were predictive of low OPAAT scores.

Sources and preferred sources of osteoporosis knowledge

Table 4 shows the sources and preferred sources of patients recruited within the study. The top three sources of osteoporosis-related knowledge were television/radio (34.9%), healthcare professionals (30.7%), and newspaper/other reading materials (30.0%). For the preferred sources of knowledge, majority of patients preferred healthcare professionals (64.2%), television/radio (32.2%), and newspaper/other reading materials (26.6%).

Patients with lower OPAAT scores were less likely to receive osteoporotic knowledge from healthcare talks (4.4% vs 12.5%, $p = 0.020$), newspaper/other reading materials (24.9% vs 68.8%), and internet (4.4% vs 25%, $p < 0.001$). However, a greater proportion of them preferred to received osteoporosis-related knowledge from healthcare professionals (66.9% vs 43.8%, $p = 0.002$), healthcare talks (8.3% vs 2.1%, $p = 0.006$), and family/friends/colleagues (10.2% vs 0%, $p = 0.020$). They were less likely to prefer newspaper or other readings materials as sources of osteoporosis knowledge (22.7% vs 56.3%, $p < 0.001$).

Discussion

To our best knowledge, this is the first Asian study which has evaluated osteoporosis knowledge among patients residing in community hospital. Overall, this study showed that the prevalence of low osteoporosis awareness and knowledge among elderly females in community hospital was high. Of note, the two main risk factors associated with low osteoporosis-related knowledge included lower education levels and having diabetes.

Compared to other countries such as China (67.8%) and Malaysia (87.1%), the proportion of female patients with good osteoporosis knowledge in this study was low (11.7%) [11, 14]. This was also markedly lower than the previous local study performed 2 decades ago which showed that 57.3% had good osteoporosis awareness. Potential explanations for differences in study findings

Table 3 Multivariate logistic regression for predictors of low OPAAT scores

Variables	Odd ratio	<i>p</i> -value	95% confidence interval
<i>Age</i>			
< 65	Reference group		
65–74	1.04	0.90	0.56–1.92
75–84	1.06	0.94	0.51–2.17
≥ 85	0.65	0.42	0.22–1.86
<i>Working status</i>			
Unemployed	Reference group		
Employed	1.02	0.41	0.76–1.96
<i>Education level</i>			
Tertiary education	Reference group		
Secondary education	1.38	0.37	0.68–2.78
Primary education	3.63	0.003	1.57–8.43
No formal education	11.5	< 0.001	3.67–36.16
<i>Housing</i>			
Private housing	Reference		
Public housing	0.64	0.29	0.28–1.46
<i>Diabetes mellitus</i>			
No	Reference group		
Yes	1.67	0.03	1.04–2.61
<i>Rheumatoid arthritis</i>			
No	Reference group		
Yes	1.60	0.57	0.31–8.10
<i>Smoking status</i>			
No	Reference group		
Yes	0.46	0.49	0.05–4.05
<i>Alcohol status</i>			
No	Reference group		
Yes	0.57	0.50	0.07–3.89
<i>Preferred speaking language</i>			
English	Reference group		
Mandarin	0.81	0.64	0.34–1.93
Chinese dialects	0.48	0.46	0.07–3.38
Malay	1.11	0.92	0.14–8.63
Tamil/Hindi/Punjabi	0.44	0.11	0.16–1.22
<i>Reading language</i>			
English	Reference group		
Chinese	0.81	0.64	0.34–1.93
Malay	0.48	0.46	0.07–3.38
Tamil	1.11	0.92	0.14–8.64
Illiterate	0.44	0.11	0.16–1.22

*Low knowledge < 24 was set as the base outcome group. Pseudo $R^2 = 0.12$, $p < 0.001$

could be related to the study population and type of instruments used for assessment of osteoporosis-related knowledge. Currently, there exists a multitude of instruments available to assess osteoporosis-related knowledge such as the Osteoporosis Knowledge Assessment Tool (OKAT) and Osteoporosis Questionnaire (OPQ) [23, 24]. Majority of these existing tools focused on themes related to osteoporosis treatment while the OPAAT questionnaire focuses on knowledge related to osteoporosis prevention [22]. Given the large number of items in these questionnaires which require significant amount of time to complete, there is a need for the development of an abbreviated, standardized instrument which assesses both osteoporosis prevention and treatment to facilitate quicker and more holistic assessment of osteoporosis-related knowledge.

Diabetes mellitus was shown to be associated with low osteoporosis knowledge in our study. This was similar to a study conducted in Malaysia among diabetes patients which found that only one-third of patients had high osteoporosis knowledge. Likewise, other studies performed in Pakistan and Palestine showed that majority of diabetes patients had poor osteoporosis-related knowledge [25, 26]. A potential mediating factor for diabetes mellitus and its relationship with poor osteoporosis knowledge could be due to higher prevalence of low health literacy among diabetic patients [27]. Poor health literacy has been consistently linked with poor health outcomes, lack of awareness on medical conditions, and lower uptake of preventive health behaviors and services [27]. In particular, low health literacy has also been linked with poorer glycemic control in diabetic patients [28]. With the ongoing diabetes epidemic, our study findings highlight the importance of targeting this group of patients for osteoporosis education, so as to improve their knowledge on the subject.

In this study, lower education was predictive of poorer osteoporosis-related knowledge. Similar findings have been reported in other countries where higher education levels were consistently associated with greater osteoporosis awareness and knowledge [1, 11, 16, 18, 25]. While higher osteoporosis-related knowledge is generally associated with better clinical outcomes, a study in Iran showed that more highly educated patients with greater osteoporosis knowledge often fail to utilize their knowledge to adopt osteo-preventive practices such as exercise and having adequate intake of calcium and vitamin D [25, 29]. While our study did not explore the correlation between osteoporosis knowledge and adoption of preventive strategies for osteoporosis, the study by Etemadifar MR et al. suggests that there is a potential role in educating patients with high osteoporosis knowledge on prevention of osteoporosis [29]. For patients that are less well educated, osteoporosis educational programs should be tailored to patients' literacy levels to improve their awareness of osteoporosis.

Table 4 Source and preferred source of osteoporosis knowledge

OPAAT score	Low knowledge < 24 (n = 362)	High knowledge ≥ 24 (n = 48)	Overall (n = 410)	p-value
<i>Source of knowledge</i>				
Healthcare professionals	111 (30.7)	15 (31.3)	126 (30.7)	0.934
Healthcare talks	16 (4.4)	6 (12.5)	22 (5.4)	0.020
Formal education	5 (1.4)	1 (2.1)	6 (1.5)	0.703
Newspaper/other materials	90 (24.9)	33 (68.8)	123 (30.0)	<0.001
Television/radio	125 (34.5)	18 (37.5)	143 (34.9)	0.685
Internet	16 (4.4)	12 (25.0)	28 (6.8)	<0.001
Family/friends/colleagues	101 (27.9)	8 (16.7)	109 (26.6)	0.098
Retail/sales	12 (3.3)	1 (2.1)	13 (3.2)	0.647
<i>Number of knowledge sources</i>				
0	68 (18.8)	1 (2.1)	69 (16.8)	0.002
1	150 (41.4)	16 (33.3)	166 (40.5)	
2	87 (24.0)	16 (33.3)	103 (25.1)	
≥ 3	57 (15.8)	15 (31.3)	72 (17.6)	
<i>Preferred source of knowledge</i>				
Healthcare professionals	242 (66.9)	21 (43.8)	263 (64.2)	0.002
Healthcare talks	30 (8.3)	10 (2.1)	40 (9.8)	0.006
Formal education	1 (0.3)	1 (2.1)	2 (0.5)	0.091
Newspaper/other materials	82 (22.7)	27 (56.3)	109 (26.6)	<0.001
Television/radio	135 (37.3)	15 (31.3)	150 (36.6)	0.524
Internet	20 (5.5)	16 (3.3)	36 (8.8)	<0.001
Family/friends/colleagues	37 (10.2)	0	37 (9.0)	0.020
Retail/sales	0	0	0	-
<i>Preference for osteoporosis education in community hospital</i>				
Yes	348 (96.1)	45 (93.8)	393 (95.9)	0.437
No	14 (3.9)	3 (6.3)	17 (4.2)	

With regard to age, it did not correlate with levels of osteoporosis knowledge in this study. This concurred with findings from two studies performed in the USA and Canada [30], but differed from a multi-center study in Turkey which showed an inverse relationship between age and level of osteoporosis awareness [31]. A potential reason for the differences could be due to the cognitive function of study participants as patients with moderate and severe cognitive impairment were excluded in this study. Cognitive function of patients plays an important role in one's ability to evaluate and assimilate health-related knowledge and has been postulated to contribute to the variation in osteoporosis knowledge among elderly patients [32]. This was demonstrated in a study evaluating the effectiveness of an osteoporosis education program which showed that a positive correlation between increments in osteoporosis knowledge pre- and post-intervention with cognition [33]. Another potential reason could be due to the reduced effect of age among elderly patients as majority of patients in this study were above 65 years old, similar to the age profile of female patients admitted into Singapore community hospitals [34].

With regard to sources of osteoporosis-related knowledge, this study showed that healthcare professionals and television/radio were most preferred sources by patients. In addition, majority of patients indicated support for osteoporosis education in community hospital. Given that community hospitals serve as an important port-of-call for elderly patients who require intensive rehabilitation and these patients are often at high-risk for osteoporosis, healthcare policymakers may wish consider the introduction of osteoporosis education programs for these patients during their hospitalization. A study in Korea has shown that a multi-faceted osteoporosis education program comprising of summary of osteoporosis and its risk factors, nutritional education and an exercise presentation was able to improve patients' osteoporosis knowledge and reduce their risk of osteoporosis [35]. Similar programs may be adapted for use in community hospitals locally.

Findings from this study should be interpreted with the following limitations. Due to the single-center nature of the study, the study results may not be representative of all community hospitals in Singapore. Future studies should

consider the recruitment of patients in other community hospitals to increase the generalizability of results. Additionally, the coronavirus 2019 pandemic had affected proportions of post-elective procedure admissions in one of the months of study recruitment. In response to COVID-19 circuit breaker measures, elective procedures were deferred in the month of April 2020 [36]. While recall bias was expected in this study, this was minimized by the screening of patients with potential cognitive issues by the AMT prior to patient recruitment and careful selection of administered questions. Furthermore, while the study sample is adequately powered for statistical analyses, the overall sample size was relatively small and only a small proportion of patients were below 50 years old (2.1%). With the availability of administrative databases with more patient information, larger studies should be performed in the future to allow for more detailed evaluation of osteoporosis knowledge including younger female adults. Another limitation of this study was the heterogeneity of the study population. Majority of patients were not formally with osteoporosis while most patients with osteoporosis were on anti-osteoporotic treatment. Future studies should consider performing case–control studies involving patients who suffered from fragility fractures and matched controls without fragility fractures in the community. This will facilitate the healthcare administrators to identify important osteoporosis-related knowledge gaps and aid in formulating secondary and tertiary osteoporosis prevention policies. Lastly, factors such as gender, level of physical activities, dietary consumption of calcium, and distance to community facilities which could affect osteoporosis knowledge and awareness were not studied. Future studies should consider evaluating the role of these factors in levels of osteoporosis knowledge among patients.

Conclusions

Overall, our study showed that females community hospital patients in Singapore had suboptimal knowledge related to osteoporosis, despite being at high risk of osteoporotic fractures. Important risk factors associated with lower osteoporosis-related knowledge and awareness include lower education qualifications and having T2DM. Given that low osteoporosis-related knowledge has been associated with poor clinical outcomes such as increased risk of fractures and prolonged institutionalization, greater efforts should be directed to educate these at-risk patients to improve their awareness of osteoporosis. The design of educational materials and programs should take into account patients' preferences for such knowledge which may include the use of traditional media such as newspaper, radio, and television as well as knowledge sharing by healthcare professionals.

Declarations

Conflicts of interest None.

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