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ORIGINAL ARTICLE

Osteoporosis and premature ovarian insufficiency: geographic variation in clinicians' and consumers' knowledge gaps and barriers to care

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Abstract

Purpose To determine whether geographic variation exists in osteoporosis knowledge, management, and barriers to care in the setting of premature ovarian insufficiency (POI), among general practitioners (GPs) and women with POI.

Methods Australian GPs completed an online questionnaire regarding osteoporosis knowledge, barriers to care and educational preferences for managing osteoporosis in POI. Women with POI/early menopause (EM) completed an online questionnaire regarding osteoporosis knowledge, risk factors and health beliefs. Clinicians and consumers in metropolitan areas were compared to those in rural areas.

Results Of 688 GP respondents, 62.2% practised in major capital cities, 13.1% in major regional cities, 7.8% in regional centres, 8.7% in rural areas and 8.1% in remote areas. Mean ± SD osteoporosis knowledge score was 9.1 ± 1.5/13, with no difference by location. Forty-one percent of GPs reported barriers to care which varied by location. Of 316 women with POI/EM, 61.1% lived in metropolitan, 22.5% in regional, 11.7% in rural and 4.4% in remote locations. The mean osteoporosis knowledge score was 8.2 ± 3.1/20, with lower scores in women living in rural and remote versus metropolitan locations (difference − 1.3; 95% CI − 2.3, − 0.25; $p = 0.02$). Women in rural areas were less likely to use vitamin D supplements and more likely to have a family history of osteoporosis (both $p < 0.05$).

Conclusions GP knowledge gaps and specific, location-dependent care barriers for osteoporosis in POI were identified. Geographic differences in osteoporosis knowledge and risk factors exist in women with POI/EM. These factors require consideration when designing programs to improve bone health in POI.

Keywords Osteoporosis · Early menopause · Primary care · Consumer engagement

Introduction

Spontaneous premature ovarian insufficiency (POI), loss of ovarian activity before age 40 years, occurs in approximately 1% of women [1]. The prevalence of iatrogenic POI, due to surgery or medical treatment, appears to be even higher [2].

Women with POI have lower bone mineral density (BMD) than age-matched women, and bone loss is related to both the delay in diagnosis of POI and duration of oestrogen deficiency [3, 4]. Hormone replacement therapy (HRT) prevents bone loss in women with POI [5]. In women with contraindications to HRT, antiresorptive therapy may be indicated for the management of osteoporosis in POI [6].

Women consider osteoporosis a feared long-term complication of POI; however, knowledge gaps exist regarding osteoporosis, which impacts bone health-related behaviours [7, 8].

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International and national guidelines recommend DXA at the time of diagnosis of POI in all women and the use of systemic HRT for osteoporosis prevention in women without contraindications [1]. Despite this, suboptimal bone health management in POI has been reported, indicating an evidence-practice gap [9].

Geographic discrepancy in postmenopausal osteoporosis care is evident with higher hip fractures and lower treatment rates in Australian rural versus metropolitan areas [10, 11]. The reasons for this are likely multifactorial, with patient-related factors (lower health literacy, higher risk behaviours, higher cost of treatment), clinician-related factors (less confidence in managing osteoporosis) and system factors (lower availability of bone densitometry or specialist clinics).

We aimed to (i) assess general practitioners' (GPs) knowledge, barriers to care and educational needs in managing bone health in POI and to determine if geographical variation exists and (ii) assess geographic variation in the osteoporosis knowledge and health behaviours in women with POI.

Methods

General practitioners' study

An anonymous online questionnaire (survey methods) was emailed to Australian health professionals registered with Healthed, a national medical education provider, between 15 February 2018 and 15 March 2018. The study was approved by the Monash Health Human Research Ethics Committee (No. 07062A). Health professionals currently practicing as a GP or GP registrar in Australia were included in the study. Exclusion criteria were non-GP, postcode of practice not recorded, not in current clinical practice, and failure to complete at least one osteoporosis knowledge question.

The questionnaire comprised 20 multiple choice questions, with the option of free text in 9 questions. Demographic information, society memberships, knowledge of guidelines, barriers to care and educational needs were collected. GPs' knowledge of osteoporosis in POI was evaluated using a 14-item questionnaire adapted from a study evaluating glucocorticoid-induced osteoporosis [12]. One question was later omitted due to ambiguity. Each statement was ranked on a 5-point Likert scale from "strongly agree" to "strongly disagree", with the additional option of "do not know". The responses "strongly agree" and "agree" and "strongly disagree" and "disagree" were grouped for analysis. The questionnaire was piloted in a group of GPs, endocrinologists and gynaecologists.

Practice location was classified by the Modified Monash Model, which categorises Australia into seven levels of remoteness (MM1 metropolitan areas, MM2 regional centres, MM3 large rural towns, MM4 medium rural towns, MM5 small rural towns, MM6 remote communities and MM7 very remote communities) [13]. We further subdivided MM1 into major capital city and major regional city.

Consumer study

Data from a previous study of women with POI or early menopause (EM, menopause < 45 years) [8] was reanalysed to assess differences based on location. A questionnaire was distributed to women with self-reported POI/EM at a tertiary hospital menopause outpatient clinic and online via support groups and registries, between 30 March 2017 and 11 April 2018. Participants were included if they had a diagnosis of POI/EM and reported their location. The questionnaire assessed demographic information, medical history, osteoporosis knowledge and beliefs based on validated tools (osteoporosis knowledge assessment tool (OKAT) [14], osteoporosis health beliefs scale [15], osteoporosis self-efficacy scale [16]). Due to ambiguity, one question from the OKAT was omitted from analysis. Geographic location was self-reported as metropolitan, regional (major country town), rural (population < 10,000) or remote (population < 5000).

Data analysis

Categorical variables were expressed as number (%) and continuous variables as mean ± standard deviation (SD). Categorical outcomes were compared using chi-square, parametric continuous outcomes were compared using ANOVA, and non-parametric continuous outcomes compared using Kruskal-Wallis. Univariable linear regression analysis was used to assess factors influencing osteoporosis knowledge score, osteoporosis self-efficacy and osteoporosis health beliefs, and multivariable linear regression was used to adjust for confounding variables. Binomial logistic regression was used to assess barriers to care by practice location, and multivariable logistic regression was used to adjust for confounders. $P < 0.05$ was considered significant. Data was analysed using Stata v15 (StataCorp LLC, TX, USA).

Results

General practitioner study

Demographics

A total of 987 responses were received, of which 688 were included for analysis of osteoporosis knowledge in POI and 646 included for analysis of barriers to care and educational needs (Fig. 1).

Demographic data are displayed in Table 1. The mean ± SD age was 50.7 ± 11.5 years, and 542 (78.8%) were female.

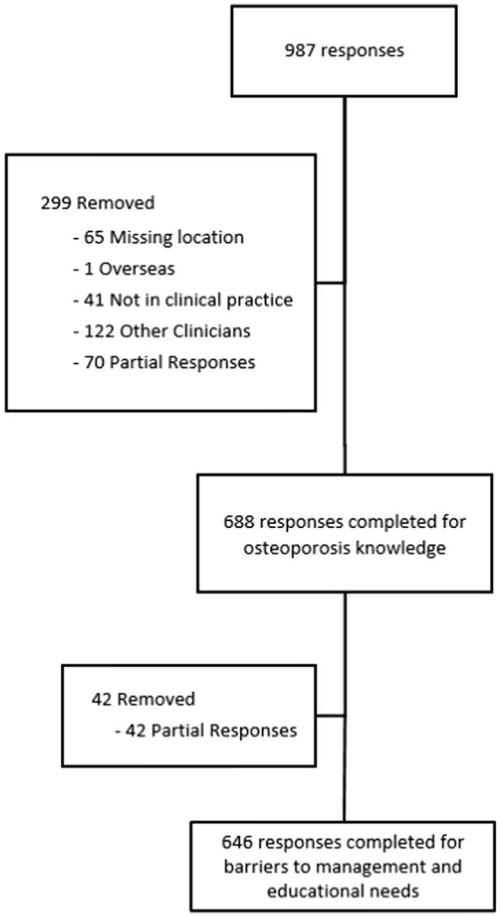

Fig. 1 Participants included in general practitioner study

Most respondents (428, 62.2%) practised in major capital cities, 90 (13.1%) in major regional cities, 54 (7.9%) in regional centres, 48 (7.0%) in large rural towns, 12 (1.7%) in medium rural towns, 46 (6.7%) in small rural towns, 8 (1.2%) in remote communities and 2 (0.3%) in very remote communities. MM3-4 (large and medium rural towns) and MM5-7 (small rural and remote communities) were combined into "rural areas" and "remote areas", respectively, for analyses due to the small number of respondents. The different practice locations differed by sex and state (Table 1).

The majority (> 90%) of respondents were not a member of either a menopause society or a bone/osteoporosis society. Most respondents (98%) managed < 10 patients with POI per week.

Knowledge

Most GPs (499, 72.5%) self-reported they were knowledgeable regarding osteoporosis in POI but needed to learn more, 123 (17.9%) self-reported they were completely/very knowledgeable, 59 (8.6%) self-reported they knew nothing and needed to learn more, and 7 (1.0%) stated it is not within their area of practice. Self-assessed knowledge did not differ by practice location.

The mean ± SD osteoporosis knowledge score was 9.1 ± 1.5/13 items, with a range of 3–13. Univariable and multivariable linear regression analysis, adjusted for age, sex, training status and state, showed no difference in osteoporosis knowledge based on practice location (Supplementary Table 1). Male GPs had a small but significantly lower score compared to females (difference − 0.3; 95% CI − 0.6, − 0.1; $p = 0.02$). Most questions (10/13) were answered correctly by > 50% of respondents (Table 2), but three questions were answered correctly by < 20% of respondents. Significantly fewer GPs in rural locations (MM3-4) compared with other locations answered the question "Fracture risk calculators (FRAX / Garvan) can be used in women <40 years with POI" correctly, with only 5% answering this correctly. This difference remained significant after adjusting for age, sex, training status and state ($p = 0.01$) (Supplementary Table 2).

Only 51% of respondents were aware of guidelines for managing osteoporosis in POI; 200 GPs (29.1%) said they use the guidelines and have no problem applying them, while 165 (24.0%) had difficulty applying guidelines, thought guidelines needed improvement or did not find them helpful. Guidelines used by GPs included International Menopause Society, Medical Journal of Australia and International Osteoporosis Foundation (IOF) (Supplementary Fig. 1).

Barriers to care

Barriers to care for osteoporosis in POI were reported by 265 (41.0%) of respondents. After adjusting for age, sex and training status, ten barriers, over a range of different areas, remained significantly different by practice location (Table 3).

GP educational needs

The preferred method for obtaining information about managing bone health in women with POI was via a conference (161, 24.9%), followed by websites (Osteoporosis Australia, Australian Menopause Society) and then written material (medical magazine, email/E news or journal article (Supplementary Fig. 2). Most topics were considered either extremely or very important, by > 90% of respondents to include in educational information provided to GPs regarding managing osteoporosis in POI (Supplementary Fig. 3).

Consumer study

All eligible respondents ($n = 316$) were included in this study as they provided location data [8]. The majority lived in a metropolitan location (193, 61.1%), 71 (22.5%) in a regional location, 37 (11.7%) in a rural location and 14 (4.4%) in a remote location. Rural and remote locations were combined

Table 1 Demographic data for GP study

	Overall $n = 688$	By practice location					
		Major capital city (MM1)	Major regional city (MM1)	Regional centre (MM2)	Rural area (MM3-4)	Remote area (MM5-7)	*P* value
n(%)	*688*	*428 (62.2)*	*90 (13.1)*	*54 (7.8)*	*60 (8.7)*	*56 (8.1)*	
Age (years) mean ± SD	50.7 ± 11.5	50.8 ± 11.8	48.2 ± 11.1	50.5 ± 11.4	51.3 ± 11.3	52.9 ± 10.3	0.73
Female n(%)	542 (78.8)	346 (80.8)	72 (80.0)	44 (81.5)	47 (78.3)	33 (58.9)	*0.007*
Practice type n(%)							0.84
Solo practitioner	88 (12.8)	60 (14.1)	9 (10.0)	6 (11.1)	5 (8.33)	8 (14.3)	
Group of 2 or more practitioners	586 (85.2)	359 (83.9	80 (88.9)	47 (87.0)	53 (88.3)	47 (83.9)	
Hospital	12 (1.74)	7 (1.64)	1 (1.11)	1 (1.85)	2 (3.33)	1 (1.79)	
Training status n(%)							
General practitioner	654 (95.1)	412 (96.3)	87 (96.7)	48 (88.9)	56 (93.3)	51 (91.1)	0.06
Registrar	34 (4.94)	16 (3.74)	3 (3.33)	6 (11.1)	4 (6.67)	5 (8.93)	
State n(%)							*< 0.001*
Australian Capital Territory	9 (1.31)	9 (2.10)	0	0	0	0	
New South Wales	265 (38.5)	155 (36.2)	49 (54.4)	7 (13.0)	30 (50.0)	24 (42.9)	
Northern Territory	5 (0.73)	0	0	2 (3.70)	0	3 (5.36)	
Queensland	96 (14.0)	46 (10.7)	22 (24.4)	14 (25.9)	6 (10.0)	8 (14.3)	
South Australia	39 (5.67)	32 (7.48)	0	0	2 (3.33)	5 (8.93)	
Tasmania	15 (2.18)	0	0	12 (22.2)	3 (5.00)	0	
Victoria	201 (29.2)	142 (33.2)	15 (16.7)	16 (29.6)	16 (26.7)	12 (21.4)	
Western Australia	58 (8.43)	44 (10.3)	4 (4.44)	3 (5.56)	3 (5.00)	4 (7.14)	

Comparison of age using ANOVA, comparison of categorical variables using Chi2. *MM* Modified Monash category, *MM1* metropolitan areas, *MM2* regional centres, *MM3* large rural towns, *MM4* medium rural towns, *MM5* small rural towns, *MM6* remote communities and MM7 very remote communities [13]

Table 2 Osteoporosis knowledge in POI by question

Question	Correct response	Correct n(%)
Osteoporosis is an important consequence of POI	Agree/strongly agree	679 (98.7)
Fracture risk calculators (FRAX/Garvan) can be used in women < 40 years with POI	Disagree/strongly disagree	128 (18.6)
Delay in diagnosis is a risk factor for low bone density in women with POI	Agree/strongly agree	653 (94.9)
Reduced bone density in women with POI is related to the degree and duration of oestrogen deficiency	Agree/strongly agree	595 (86.5)
Oestrogen containing HRT (unless contraindicated) is recommended for women with POI to maintain bone health and prevent osteoporosis	Agree/strongly agree	606 (88.1)
Oestradiol containing HRT and ethinyl-oestradiol containing oral contraceptive pills are equally effective in preventing bone loss	Disagree/strongly disagree	118 (17.2)
HRT is not a contraceptive	Agree/strongly agree	650 (94.5)
HRT should only be used for 5 years in women with POI	Disagree/strongly disagree	430 (62.5)
In those women with contraindications to HRT, bisphosphonate therapy can be considered for prevention and treatment of osteoporosis in women with POI	Agree/strongly agree	488 (70.9)
T score < − 1.0 indicates low bone density in women with POI < 40 years	Disagree/strongly disagree	129 (18.8)
Z score < − 2.0 indicates low bone density in women with POI < 40 years	Agree/strongly agree	457 (66.4)
Women with POI should maintain a healthy lifestyle including weight-bearing exercise, avoidance of smoking and maintenance of normal body weight to optimise bone health	Agree/strongly agree	677 (98.4)
Women with POI should obtain the recommended intake of calcium and vitamin D to optimise bone health	Agree/strongly agree	675 (98.7)

POI premature ovarian insufficiency, *HRT* hormone replacement therapy

for analysis due to the small number of respondents. Demographic data and clinical characteristics are displayed in Table 4. Significantly fewer women in regional, rural and remote locations used vitamin D supplements, and significantly more women in rural or remote locations had a family history of osteoporosis, compared with metropolitan locations (both $p < 0.05$). These differences remained significant after adjusting for age, education level and country of birth.

The mean ± SD OKAT score was 8.2 ± 3.1/20 (Table 5). Women in rural or remote locations had significantly lower OKAT scores than those in metropolitan locations; this difference remained significant on multivariable linear regression adjusting for age, education level, country of birth, vitamin D, HRT use and family history (difference − 1.3, 95% CI − 2.3, − 0.25, $p = 0.02$). Women with education levels > year 12 or equivalent, Australian born women, women with a family history of osteoporosis and women using HRT had a significantly higher OKAT score (Supplementary Table 3). However, a diagnosis of osteoporosis/osteopenia, and past history of a fragility fracture, was not related to OKAT score. There was no significant difference in osteoporosis health belief scale scores or osteoporosis self-efficacy scores between locations (Table 5).

Discussion

This is the first study examining Australian GPs' knowledge of osteoporosis in POI. Despite many GPs in the study seeing few regular patients with POI, they demonstrated sound knowledge of several aspects of care. There were, however, gaps in knowledge and barriers to care which differed according to practice location. In consumers, we found that knowledge gaps exist among women with POI/EM, with differences in osteoporosis knowledge and risk factors according to location.

Over 80% of GPs in our study identified a need to learn more about osteoporosis in POI. This differs from a small European study involving 50 healthcare professionals (GPs and specialists), of whom 78% felt confident in the management of POI [17]. Interestingly, the same study also found < 50% of clinicians routinely perform bone densitometry for women with POI, suggesting a gap between knowledge and practice [17]. In our study, most respondents thought that a T score < − 1.0 could be used to diagnose osteoporosis and that fracture risk calculators could be used to stratify fracture risk, in women < 40 years of age, suggesting a lack of understanding about differences in investigating osteoporosis in younger people. Most respondents knew HRT was recommended to prevent bone loss in POI; however, the majority believed that HRT and the combined oral contraceptive pill (COCP) were equally effective. In previous studies, up to 68% of clinicians would use COCP to treat women with POI [17]. However, evidence indicates that the COCP is less effective in preventing bone loss in women with POI than conventional doses of HRT [1, 18].

We did not find a difference in GP osteoporosis knowledge based on practice location. Data examining care of older patients with osteoporosis suggests lower bone density testing and antiresorptive prescribing in rural areas, which may be related to access [10, 19]. However, a study using a mobile bone density van to facilitate access for remote communities

Table 3 Multivariable logistic regression comparing barriers experienced by GP in managing osteoporosis in POI, by practice location, after adjustment for age, gender, training status and state

Barrier	Location	OR	95% CI	*P* value
It is the responsibility of another doctor to commence treatment	Major capital city	1.00		
	Major regional city	0.77	0.39, 1.53	0.45
	Regional area[a]	0.66	0.25, 1.72	0.39
	Rural area[b]	0.33	0.11, 0.95	*0.04*
	Remote area	0.17	0.04, 0.72	*0.02*
Time constrains when consulting with patients	Major capital city	1.00		
	Major regional city	0.62	0.35, 1.11	0.11
	Regional area	1.13	0.55, 2.32	0.75
	Rural area	0.66	0.33, 1.33	0.25
	Remote area	0.57	0.27, 1.20	0.14
Difficult accessing bone densitometry	Major capital city	1.00		
	Major regional city	0.84	0.34, 2.03	0.69
	Regional area	1.30	0.46, 3.68	0.62
	Rural area	1.19	0.44, 3.26	0.73
	Remote area	2.89	1.34, 6.24	*0.007*
Difficulty referring patients to specialist osteoporosis clinics	Major capital city	1.00		
	Major regional city	1.71	0.91, 3.19	0.09
	Regional area	0.76	0.26, 2.24	0.61
	Rural area	2.47	1.24, 4.93	*0.01*
	Remote area	2.53	1.22, 5.22	*0.01*
Lack of guidelines regarding osteoporosis in POI	Major capital city	1.00		
	Major regional city	0.55	0.31, 0.98	*0.04*
	Regional area	0.50	0.20, 1.22	0.13
	Rural area	0.32	0.14, 0.74	*0.008*
	Remote area	1.05	0.540, 2.04	0.89
Difficulty explaining the risks and benefits of treatment to patients	Major capital city	1.00		
	Major regional city	0.62	0.32, 1.23	0.17
	Regional area	0.79	0.31, 2.03	0.62
	Rural area	0.38	0.14, 0.99	*0.048*
	Remote area	1.10	0.53, 2.26	0.80
Difficulty accessing information for patients	Major capital city	1.00		
	Major regional city	1.62	0.85, 3.08	0.14
	Regional area	0.81	0.28, 2.40	0.71
	Rural area	0.37	0.11, 1.27	0.11
	Remote area	0.78	0.32, 1.92	0.59
Lack of confidence in prescribing osteoporosis therapy in POI	Major capital city	1.00		
	Major regional city	0.50	0.24, 1.06	0.07
	Regional area	0.55	0.19, 1.60	0.27
	Rural area	0.15	0.03, 0.64	*0.01*
	Remote area	0.35	0.12, 1.05	0.06
Consumer concern regarding osteoporosis therapy	Major capital city	1.00		
	Major regional city	0.91	0.56, 1.50	0.72
	Regional area	2.04	1.01, 4.13	*0.048*
	Rural area	1.13	0.63, 2.04	0.68
	Remote area	1.98	1.06, 3.71	*0.03*
Cost of osteoporosis therapy	Major capital city	1.00		
	Major regional city	1.07	0.64, 1.79	0.80
	Regional area	1.12	0.55, 2.27	0.76

Table 3 (continued)

Barrier	Location	OR	95% CI	*P* value
	Rural area	2.28	1.25, 4.15	*0.007*
	Remote area	1.74	0.94, 3.25	0.08
Lack of confidence in prescribing hormone replacement therapy in POI	Major capital city	1.00		
	Major regional city	0.57	0.31, 1.06	0.07
	Regional area	0.51	0.19, 1.31	0.16
	Rural area	0.41	0.17, 0.97	*0.04*
	Remote area	1.21	0.60, 2.42	0.60
Consumer concern regarding hormone replacement therapy	Major capital city	1.00		
	Major regional city	0.95	0.57, 1.58	0.85
	Regional area	0.91	0.45, 1.85	0.80
	Rural area	1.31	0.69, 2.50	0.41
	Remote area	1.10	0.58, 2.06	0.78
My own concerns regarding hormone replacement therapy in POI	Major capital city	1.00		
	Major regional city	0.82	0.31, 2.14	0.69
	Regional area	0.15	0.02, 1.53	0.11
	Rural area	0.96	0.30, 3.06	0.94
	Remote area	1.18	0.42, 3.28	0.75
Consumer preference for alternative/complementary therapy	Major capital city	1.00		
	Major regional city	1.84	1.10, 3.06	*0.02*
	Regional area	1.16	0.55, 2.47	0.70
	Rural area	2.37	1.31, 4.30	*0.004*
	Remote area	0.84	0.42, 1.69	0.62

Binomial logistic regression analysis for each barrier by location. *OR* odds ratio, *CI* confidence interval, *POI* premature ovarian insufficiency

[a] Rural area: combines Modified Monash categories 3–4

[b] Remote area: combines Modified Monash categories 5–7

found low uptake, with < 10% of eligible people screened, suggesting other factors are involved [20]. Interestingly, female GPs had greater knowledge about osteoporosis in POI. No previous studies have assessed factors relating to GP osteoporosis knowledge. Given that POI affects women, and osteoporosis prevalence is higher in females, it is possible that female GPs have greater exposure to these conditions which may lead to better knowledge; however, this requires further confirmation.

We identified several barriers to osteoporosis care in POI, which differed by practice location. GPs in remote areas reported difficulty accessing bone densitometry, which reflects the need for bone densitometers and radiologists qualified to report bone density scans in these areas. GPs in rural and remote areas reported difficulty referring patients to specialty clinics, which are usually located in urban tertiary hospitals. GPs in rural and remote areas were less likely to feel that it was the responsibility of another doctor to commence treatment for women with POI and OP, which may reflect the lack of available specialist, or reluctance of patients to travel.

Among women with POI, we found higher osteoporosis knowledge scores in women living in metropolitan areas compared with rural or remote areas. Despite this, there was no difference in beliefs or self-efficacy between locations, suggesting knowledge is not translating into practice. Vitamin D supplement use was lower in rural or remote areas compared to metropolitan areas, despite no difference in diagnosed vitamin D deficiency, suggesting lower medication utilisation in these areas. Almost half of women did not undertake regular weight-bearing exercise, and the majority consumed insufficient calcium in their diet, a figure much higher than previously reported studies, performed in lower risk populations, highlighting a need for education [21].

We did not find a difference in the prevalence of fragility fractures or osteoporosis/osteopenia between locations. This is the first report looking at differences in osteoporosis based on location in POI. The Australian Commission on Safety and Quality in Health Care released rates of hip fracture admissions by local area in 2015. In most states, the highest rates were outside of capital cities [11]. This contrasts to studies performed overseas, and an older Australian study, which have documented no difference, or higher rates of hip fractures, in urban compared with rural areas [22–24]. The discrepancy may be related to the greater distance between rural

Table 4 Demographic data for consumer study

	Total (n = 316)	Metropolitan (n = 194)	Regional (n = 71)	Rural or remote (n = 51)	P value for difference
Demographic data					
Age (years) mean ± SD	54.7 ± 10.3	54.3 ± 10.5	54.1 ± 10.1	57.4 ± 9.66	0.14
Born in Australia n(%)	249 (78.8)	147 (75.8)	60 (84.5)	42 (82.4)	0.24
Education level n(%)					0.51
Year 12 or equivalent	73 (23.1)	44 (22.7)	17 (23.9)	12 (23.5)	
Undergraduate diploma	99 (31.3)	53 (27.3)	28 (39.4)	18 (35.3)	
Bachelor degree	71 (22.5)	47 (24.2)	15 (21.1)	9 (17.6)	
Postgraduate diploma, masters, doctorate	57 (18.0)	40 (20.6)	10 (14.1)	7 (13.7)	
Age of menopause median ± IQR	40 ± 5	41 ± 5	39 ± 6	40 ± 5	0.09
Time since POI/EM dx n(%)					0.69
< 1 year	6 (1.90)	4 (2.06)	1 (1.41)	1 (1.96)	
1–4 years	49 (15.5)	33 (17.0)	11 (15.5)	5 (9.80)	
>/= 5 years	242 (76.6)	143 (73.7)	56 (78.9)	43 (84.3)	
No dx made	18 (5.70)	14 (7.22)	2 (2.82)	2 (3.92)	
Cause of POI/EM n(%)					0.85
Spontaneous	139 (44.0)	82 (42.3)	34 (74.9)	23 (45.1)	
Iatrogenic	174 (55.1)	110 (56.7)	36 (50.7)	28 (54.9)	
Osteoporosis diagnosis and treatment					
Previous fragility fracture n(%)	65 (20.6)	36 (18.6)	19 (26.8)	10 (19.6)	0.35
Screened for osteoporosis n(%)	250 (79.1)	158 (81.4)	54 (76.1)	38 (74.5)	0.57
Osteoporosis/osteopenia diagnosis n(%)	61 (19.3)	39 (20.1)	14 (19.7)	8 (15.7)	0.81
Systemic HRT use n(%)	54 (18.1)	38 (19.6)	13 (18.3)	3 (5.88)	0.06
Antiresorptive use n(%)	55 (17.4)	34 (17.5)	14 (19.7)	7 (13.7)	0.72
Vitamin D supplement n(%)	171 (54.1)	120 (61.9)	31 (43.7)	20 (39.2)	*0.002*
Calcium supplement n(%)	113 (35.8)	75 (38.7)	22 (31.0)	16 (31.4)	0.41
Osteoporosis risk factors					
Dietary calcium < 1200 mg/d n(%)	312 (98.7)	192 (99.0)	70 (98.6)	50 (98.0)	0.75
</= 90 min strenuous exercise per week n(%)	156 (49.4)	98 (50.1)	39 (54.9)	19 (37.3)	0.92
Current/past smoker n(%)	97 (30.7)	59 (30.4)	23 (32.4)	15 (29.4)	0.95
> 3 alcoholic drinks/day n(%)	35 (11.1)	22 (11.3)	8 (11.3)	5 (9.80)	0.97
Family history osteoporosis n(%)	76 (24.1)	43 (22.2)	12 (16.9)	21 (41.2)	*0.005*
Vitamin D deficiency n(%)	81 (25.6)	51 (26.3)	17 (23.9)	13 (25.5)	0.93
>/ = 2 comorbidities associated with osteoporosis[a] n(%)	68 (21.5)	41 (21.1)	17 (23.9)	10 (19.6)	0.83
>/ = 3 months of glucocorticoids n(%)	17 (5.38)	10 (5.15)	3 (4.23)	4 (7.84)	0.67
Aromatase inhibitor therapy n(%)	37 (11.7)	19 (9.79)	10 (14.1)	8 (15.7)	0.40

Comparison of age using ANOVA, comparison of categorical variables using Chi2. *POI* premature ovarian insufficiency, *EM* early menopause, *HRT* hormone replacement therapy

[a] Comorbidities included coeliac disease, chronic kidney disease, chronic liver disease, thyroid disorders, hyperparathyroidism, low vitamin D, rheumatoid arthritis, diabetes mellitus, obesity, underweight, epilepsy and malabsorption

and metropolitan areas in Australia compared with other countries. The previous Australian study investigated fractures in 1994–1996 in the Barwon Statistical Region in Victoria and so may not capture the current diversity of other rural areas [24].

Although we have demonstrated gaps in osteoporosis knowledge among GPs and women, we cannot determine whether this corresponds to practice or whether improving knowledge will improve outcomes. However, a recent Cochrane review of educational interventions to improve osteoporosis management found that educating both GPs and patients resulted in higher rates of bone densitometry and medication prescribing [25]. Osteoporosis in women with POI is an important topic for healthcare professionals from a variety of disciplines including GPs, endocrinologists,

Table 5 Consumer osteoporosis knowledge assessment tool, osteoporosis health belief scale and osteoporosis self-efficacy scale

	Total ($n = 316$)	Metropolitan ($n = 194$)	Regional ($n = 71$)	Rural or remote ($n = 51$)	*P* value for difference
OKAT score mean ± SD	8.24 ± 3.09	8.54 ± 2.98	8.03 ± 3.07	7.31 ± 3.37	*0.04*
OHBS total score mean ± SD	127.74 ± 13.09	126.73 ± 12.77	129.23 ± 12.25	129.33 ± 15.12	0.28
OHBS susceptibility to OP domain mean ± SD	19.6 ± 4.91	19.27 ± 4.83	20.13 ± 4.88	20.08 ± 5.27	0.25
OHBS seriousness of OP domain mean ± SD	17.05 ± 4.43	16.98 ± 4.44	16.81 ± 4.84	17.67 ± 3.75	0.56
OHBS exercise benefits domain median ± IQR	24 ± 4	24 ± 4	23 ± 2	24 ± 3	0.35
OSBS exercise barriers domain median ± IQR	12 ± 7	12 ± 7	12 ± 6	12 ± 9	0.26
OHBS calcium benefits domain median ± IQR	20 ± 5	20 ± 5	20 ± 5	21 ± 4	0.17
OHBS calcium barriers domain median ± IQR	12 ± 7	12 ± 6	13 ± 6.5	12 ± 8	0.23
OHBS health motivation domain median ± IQR	24 ± 5	23 ± 4	24 ± 3	24 ± 6	0.08
OSES total score median ± IQR	44 ± 12	44 ± 11	42 ± 12	45 ± 14	0.38
OSES exercise score median ± IQR	22 ± 7	22 ± 8	22 ± 7	23 ± 10	0.49
OSES calcium score median ± IQR	23 ± 8	23 ± 6	22 ± 6	24 ± 8	0.33

ANOVA used to compare normally distributed variables. Kruskal-Wallis used to compare non-parametric variables. *OKAT* osteoporosis knowledge assessment tool score out of 19; *OHBS* osteoporosis health belief scale, total score out of 210, each domain out of 30; *OSES* osteoporosis self-efficacy scale, total score out of 60, exercise and calcium scores out of 30

oncologists and gynaecologists, and ensuring educational strategies reach all specialties in different locations may require targeted interventions.

The limitations of this study include the non-randomised selection of participants, which may result in self-selection of GPs with an interest in women's health, who may not be representative of GPs in general. Small numbers of GPs in rural and remote communities meant these groups were combined for analysis, limiting the ability to detect differences between areas. Consumer questionnaires were distributed at a tertiary hospital and via support groups, which may have higher screening rates and knowledge, and women self-reported both menopause status and location by category rather than postcode.

In conclusion, we have demonstrated knowledge gaps and specific, location-dependent barriers to care for osteoporosis in POI among GPs. We have also demonstrated differences in osteoporosis knowledge in women with POI living in metropolitan compared with rural areas. These factors require further exploration and consideration when designing effective programs to improve osteoporosis prevention and treatment in POI.

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Compliance with ethical standards

Conflict of interest None.

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