Who are the older Australians referred for a bone density scan? Data from the Barwon region

Amelia G Dobbins[1], Sharon L Brennan[1,2,3], Lana J Williams[1], Mark A Kotowicz[1,2,4], Bree Sarah[5], Yvonne Birch[4], Julie A Pasco[1,2]

[1]*School of Medicine, Deakin University, Geelong, Australia*
[2]*NorthWest Academic Centre, Department of Medicine, The University of Melbourne, Sunshine Hospital, St Albans, Australia*
[3]*Australian Institute for Musculoskeletal Sciences, Melbourne, Australia*
[4]*Department of Endocrinology and Diabetes, Barwon Health, Geelong, Australia*
[5]*Clinical Trials Unit, Department of Medicine, Barwon Health, Geelong, Australia*

Author for correspondence and reprint requests
Dr Sharon L Brennan
Epi-Centre for Healthy Ageing,
Deakin University,
C/-Barwon Health,
PO Box 281, Geelong, VIC 3220, Australia
Ph: +61 3 4215 3334
sharob@barwonhealth.org.au

Keywords: bone densitometry, health service utilisation, referral, older adults, osteoporosis

Word count: Manuscript 2,098; Abstract 250

Mini abstract (48 words)
We investigated the reasons for referral of older Australians aged 70 years and older to DXA. The most common clinical indication was being aged 70 years and older, followed by monitoring for fracture or low BMD. Compared to males, females were twice as likely to have osteoporotic BMD.

Abstract

Purpose/Introduction: Little is known about reasons for the referral of older Australians to dual energy X-ray absorptiometry (DXA) for bone mineral density (BMD) measurements. Thus, we aimed to document the reasons for referral to DXA in Australian men and women aged 70 years and older, and investigate any differences between the sexes.

Methods: Reasons for DXA referral were examined in 5,438 patients aged ≥70 years (78.5% female), referred to the Geelong Bone Densitometry Service, south-eastern Victoria, 2003-10. Clinical indication codes derived from patient records were used to ascertain reasons for referral. We ascertained age, sex and BMD measures at the femoral neck and spine for each patient.

Results: The most common reason for DXA referral was being aged ≥70 years (64.6%), followed by monitoring of fracture or low BMD. In this referred population, a greater proportion of men than women had BMD in the normal range (men 30.2% *vs.* women 10.9%, $p<0.001$), whereas sex-differences in the opposite direction were seen for BMD in the osteopenic range (women 47.7% *vs.* men 44.3%, $p=0.04$) and in the osteoporotic range (women 41.4% *vs.* men 25.5%, $p<0.001$). After age-adjustment, women were twice as likely to have BMD in the osteoporotic range compared to men (OR 2.25, 95%CI 1.95-2.61).

Conclusion: For both sexes, the most common reason for referral was being aged 70 years or older. Referred females were twice as likely as men to have BMD in the osteoporosis range. These data suggest that even more women may need to be referred to DXA.

Introduction

Osteoporosis is a systemic skeletal disease characterized by low bone mineral density (BMD), and micro-architectural deterioration of bone tissue, with a consequent increase in susceptibility to fracture (1, 2). Fragility fractures at the spine, hip, forearm and proximal humerus are a major public health problem for both sexes, and current estimates of annual direct and indirect costs are in excess of $2.75 billion (3). Approximately 4.7 million Australians have osteoporosis or osteopenia (low BMD), and this figure is estimated to reach 6.2 million by the year 2022 (3). Although osteoporosis increases the risk of fracture, it is suggested that the population burden arises from individuals with osteopenia, not osteoporosis (1, 4). Despite osteoporosis prevalence being greater for women than men (3, 5), it is men that experience higher rates of osteoporosis-related mortality (6), and are more likely to remain untreated for the disease (7, 8).

Dual energy x-ray absorptiometry (DXA) is used to measure BMD, and acts as one of the key strategies to inform decision-making processes regarding low BMD and anti-fracture therapies (9, 10). We recently reported there was minimal increase in the utilization of DXA by Australian men and women aged 70 years and older, after changes to national health policy introduced by Medicare Australia in 2007 (11). We found that although the proportion of men undergoing DXA doubled from 2003 to 2010, the proportion tripled for women; importantly, the overall utilization of DXA in this age group remained low (11). In order to make a conceptual advance in our understanding of physician referral behaviour and patient initiation of testing, it is imperative from a treatment and public health standpoint that we understand the clinical indications for which older Australians are referred to DXA. Thus, we aimed to document the reasons for referral to DXA in Australian men and women aged 70 years and older, and investigate any differences between the sexes.

Methods

Study region

Data were derived from the electronic records of the Geelong Bone Densitometry Service, Barwon Health, Victoria, Australia. The Geelong Bone Densitometry Service is the major DXA service provider for the Barwon Statistical Division (BSD), south-eastern Australia, and operates two DXA machines to serve a regional population of approximately 250,000 of

whom 30,252 (57.2% female) were aged 70 years or over at the 2006 Australian Census (12). This study was approved by the Barwon Health Human Research Ethics Committee.

Study population

All men and women aged ≥70 years referred to DXA for osteoporosis-related reasons (non-research purposes) during 2003-10 were identified from the administrative patient records database of the Geelong Bone Densitometry Service by use of the Medicare Australia item numbers that were associated with the referral.

Patients were included for analyses if they underwent a DXA test during the period 2003-10, resided in the BSD at time of DXA and were aged ≥70 years. Subsequent attendances at DXA were not included in analyses, and individuals that were scanned for research purposes were excluded. Of the total 15,032 patient records identified from the database as aged ≥70yrs, records were excluded for the following reasons: missing values for the lowest BMD T-Score (n=7), missing data regarding reason for referral (n= 547), patient duplicates (n=7) and not a resident of the BSD (n=97). BMD values measured at the femoral neck and spine (L2-L4) were ascertained for each patient, and using the T-score provided by the DXA manufacturers (Lunar DPX-L [Lunar Corporation, Madison, WI, USA] or GE Lunar Prodigy [GE Lunar, Madison, WI, USA] after the DPX-L was outmoded) were classified as being within the normal range (-1.0 or more SD below the young reference mean), osteopenic range (-1.0 to -2.5 SD below the young reference mean) or osteoporotic range (<-2.5 SD below the young reference mean) at either the femoral neck or spine.

Medicare Australia Item Numbers

The Medicare item numbers of interest were: 12306 (minimal trauma fracture or monitoring of low BMD as detected by a previous scan); 12312 (prolonged glucocorticoid therapy, excess glucocorticoid secretion or hypogonadism in both sexes); 12315 (secondary osteoporotic conditions such as chronic liver or kidney disease, primary hyperparathyroidism, malabsorption disorders, rheumatoid arthritis or excess thyroxine); 12321 (changes in class of drug therapy): and 12323 (persons aged ≥70yr).

Statistical analysis

Sex-differences in demographic characteristics, BMD (categories, and as a continuous measure) and clinical indications for DXA referral were examined using the chi-square test or Kruskal-Wallis for categorical and non-parametric data, respectively. The likelihood of having BMD in the osteoporotic range *vs.* the normal or osteopenic range was examined using binary logistic analyses, with adjustment made for age (as a continuous variable) and sex; the referent categories in the models were male sex, the age group of 70-74 years, and the clinical indication for referral of being a person aged ≥70 years (Medicare Item number 12323). Results are presented as odds ratios (ORs), 95% confidence intervals (95%CI), and *p*-values. Statistical analyses were performed using Minitab (Version 16; Minitab, State College, PA), and significance was set at $p<0.05$.

Results

Characteristics of the study population are presented in Table 1 (78.5% female). Of the 5,438 eligible patient records, fractures were observed in all 5 year age stratum: 70-75 years (n=1,815), 75-80 years (n=1,724), 80-85 years (n= 1,259), 85-90 years (n=546), 90-95 years (n=86) and ≥95 years (n=8). No age differences were observed between the sexes ($p=0.32$). The most common reason for referral to DXA was being aged 70 years or older (64.6%), with a greater proportion of women than men referred for this reason (65.9% *vs.* 60.0%, $p<0.001$). The opposite was seen for the clinical indication of prolonged glucocorticoid therapy, for which men were more likely referred than women (14.4% vs. 6.6%, $p<0.001$). A non-significant sex-differences in referral reasons was also observed for patients that were being monitored for changes in class of drug therapy, however the numbers of referrals in this category were small (0.5% for men *vs.* 1.1% for women, $p=0.08$). No sex-differences were observed for those referred to DXA due to minimal trauma fracture or low BMD. Women had a lower BMD T-score compared to men (-2.3 ± 1.1 *vs.* -1.6 ± 1.4 SD below the adult sex-specific reference ranges, respectively). A greater proportion of men than women had BMD in the normal range (30.2% for men *vs.* 10.9% for women, $p<0.001$), whereas sex-differences in the opposite direction were seen for BMD in the osteopenic range (47.7% for women *vs.* 44.3% for men, $p=0.04$) and in the osteoporotic range (41.4% for women *vs.* 25.5% for men, $p<0.001$).

Table 2 presents the binary logistic regression associations between clinical indications for referral to DXA and the odds of having BMD in the osteoporotic range, adjusted for age and sex. Compared to individuals referred to DXA because they were aged 70 years or older (referent group), individuals that were referred because of minimal trauma fracture or for the purposes of monitoring low BMD were more likely to have BMD in the osteoporotic range (OR 1.46, 95%CI 1.28-1.67). We also observed that individuals referred to DXA because of change in class of drug therapy were more likely to have BMD in the osteoporotic range (OR 2.12, 95%CI 1.19-3.76) compared to those that were referred because they were aged 70 years or older (referent group). Advancing age showed a proportional relationship with osteoporotic BMD; the strength of association ranged from OR 1.34 (95%CI 1.16-1.54) for the 75-79 year age group to OR 5.63 (95%CI 1.13-28.03) for those aged 95 years or older. Females were more than twice as likely to have BMD in the osteoporotic range compared to men (females OR 2.25, 95%CI 1.95-2.61).

Table 3 presents the median BMD T-scores for each of the clinical indications for DXA referral, stratified by sex. Sex-differences were observed for BMD for each of the clinical indications (all $p \leq 0.006$), with the exception of monitoring changes in the class of drug therapy ($p=0.89$). Men and women referred to DXA for this latter category also had the lowest median BMD T-scores compared to all other referral reasons (men -2.8 [-5.1, -0.3] and females -2.7 [-6.6, -0.5]).

Discussion

In this referred population of older Australians, the most common clinical indication for undergoing DXA was being aged 70 years or older, followed by monitoring for a fracture or low BMD. We report a proportional association between advancing age and the likelihood of having a BMD in the osteoporotic range. We also report that, compared to males, females were twice as likely to have osteoporotic BMD. The following discussion pertains to each of the referral reasons.

Ageing is one of the major factors that influence the risk of osteoporosis (3, 5); being aged 70 years or older was the most common reason for referral. In our referred population, we observed no age differences between the sexes at the time of DXA. As might be expected,

advanced age was strongly associated with having BMD in the osteoporotic range. Undergoing a DXA when aged 70 years or older is a likely consequence of the nation-wide push to increase the utilization of DXA testing in older Australians, introduced in 2007, to avoid or delay minimal trauma fractures. (11, 13). However, we have previously reported from this same study region that 1.8% of men and 6.3% of women aged 70 years or older were referred to DXA in 2010 (11); proportions that are unlikely to impact on reducing fracture risk in Australia.

A referral due to fracture or low BMD was the second most common reason for referral for older adults of both sexes. As has previously been observed in younger adults (14), there were no sex-differences in the proportion of referrals for this category. However, women had lower BMD T-scores compared to men; in addition, the BMD T-score of women fell into the osteoporotic range, whereas for men, their BMD T-score indicated osteopenia. These findings may be influenced by the definitive reason for referral, whether it was for fracture or monitoring of BMD; however, the period of our data ascertainment did not enable us to distinguish between the two, as we were unable to determine whether patients had a scan prior to 2003. We can confirm, however, that we included only the initial scan and excluded subsequent scans, and we can thereby speculate that the majority of the DXA referrals in this population were related to minimal trauma fractures.

Compared to women, a higher proportion of men were referred for DXA because of glucocorticoid exposure. Glucocorticoid use increases the likelihood for the development of secondary osteoporosis; a meta-analysis showed that the frequency of glucocorticoid-induced osteoporosis is as high as 50% of individuals that used glucocorticoids for six months or longer (15).

No sex-differences were observed in the proportion of men and women referred to DXA because of changes in drug therapy. Individuals who undergo DXA for the purposes of monitoring drug therapy would by nature already have a diagnosis of osteoporosis. It is interesting that, in this referral category, men made up only 11.5% of all older adults tested, suggesting that men continue to remain under-treated for this disease.

Our study has strength. Prior to this study there were little comprehensive data identifying the reasons older Australians undergo DXA testing. Our analyses spanned an eight-year period and encompassed all adults aged 70 years and older that attended the one major DXA service provider for an entire geographical district. Our study also has some limitations. The period of our data extraction did not unable us to clarify whether patients had a DXA prior to 2003. Our observed sex-differences in the proportion of referrals could be influenced by competing mortality. Given that we are unable to account for the possibility that some older adults may have undergone a DXA test at a small private service provider that also services the BSD region, and even though we speculate our data ascertainment includes the majority of DXA tests, this limited in our ability to investigate the referral rates per head of population in this region. We make the assumption that the Medicare Australia Item numbers recorded in the electronic database of the Geelong Bone Densitometry Service were precise, although acknowledge that administrative data records such as these may be influenced by misclassification due to human error. Finally, whilst we acknowledge that the presence of abnormalities at the spine may artefactually influence BMD at this site (16); x-rays of the spine were not comprehensively available.

We observed the most common reason for referral, regardless of sex, was being aged 70 years or older. However, given that referred females were twice as likely as men to have BMD in the osteoporosis range this suggests that even more women may need to be referred to DXA.

Conflicts of interest

AG Dobbins, SL Brennan, LJ Williams, B Sarah, and JA Pasco have no conflict of interest. MA Kotowicz is the Director of the Geelong Bone Densitometry Service, Australia. Y Birch is employed by the Geelong Bone Densitometry Service, Australia, as a Senior Technician.

Acknowledgements

SLB is the recipient of a National Health and Medical Research Council (NHMRC) of Australia Early Career Fellowship (GNT1012472). LJW is supported by a NHMRC of Australia Career Development Fellowship (GNT1064272). LJW, MAK and JAP have received project funding from the NHMRC.

References

1. Pasco JA, Seeman E, Henry MJ, Merriman EN, Nicholson GC, Kotowicz MA (2006) The population burden of fractures originates in women with osteopenia, not osteoporosis. Osteoporos Int 17:1404-1409.
2. WHO (2007) Prevention and management of osteoporosis: report of a WHO scientific group. In. World Health Organisation Scientific Group on the prevention and management of osteoporosis.
3. Watts J, Abimanyi-Ochom J, Sanders KM (2013) Osteoporosis costing all Australians: A new burden of disease analysis - 2012 to 2022. In. Osteoporosis Australia, Glebe, NSW.
4. Pasco JA LS, Brennan SL, Timney EN, Bucki-Smith G, Dobbins AG, Nicholson GC, Kotowicz MA (2014) Fracture risk among older men: osteopenia and osteoporosis defined using cut-points derived from female versus male reference data. Osteoporos Int 25:857-862.
5. Henry MJ, Pasco JA, Nicholson GC, Kotowicz MA (2011) Prevalence of osteoporosis in Australian men and women: Geelong Osteoporosis Study. Med J Aust 195:321-322.
6. Kiebzak GM, Beinart GA, Perser K, Ambrose CG, Siff SJ, Heggeness MH (2002) Undertreatment of osteoporosis in men with hip fracture. Arch Int Med 162:2217-2222.
7. Otmar R, Henry MJ, Kotowicz MA, Nicholson GC, Korn S, Pasco JA (2011) Patterns of treatment in Australian men following fracture. Osteoporos Int 22:249-254.
8. Ebeling PR (1998) Osteoporosis in men. New insights into aetiology, pathogenesis, prevention and management. Drugs Aging 13:421-434.
9. WHO (1994) Assessment of fracture risk and its application to screening for postmenopausal osteoporosis. In. World Health Organisation, Geneva, Switzerland.
10. (2006) Medicare Services Advisory Committee: An application for increasing the availability for bone mineral densitometry (BMD) testing to at-risk groups by Osteoporosis Australia. In. Osteoporosis Australia, p 45.
11. Brennan SL, Kotowicz MA, Sarah B, Leslie WD, Ebeling WD, Metge CJ, Dobbins AG, Pasco JA (2013) Examining the impact of reimbursement on referral to bone density testing for older adults: 8 years of data from the Barwon Statistical Division, Australia. Arch Osteoporos 8:152.
12. ABS (2006) Australian Bureau of Statistics, Socio-economic Indices for Areas [SEIFA] - technical paper. In. ABS, Canberra.

13. Henry MJ, Pasco JA, Sanders KM, Kotowicz MA, Nicholson GC (2008) Application of epidemiology to change health policy: defining age-related thresholds of bone mineral density for primary prevention of fracture. J Clin Densitom: Assess Skel Health 11:494-497.
14. Torpy AMJ, Brennan SL, Kotowicz MA, Pasco JA (2012) Reasons for referral to bone densitometry in men and women aged 20-49 years: population-based data. Arch Osteoporos 7:173-178.
15. van Staa TP, Leufkens HG, Cooper C (2002) The epidemiology of corticosteroid-induced osteoporosis: a meta-analysis. Osteoporos Int 13:777-787.
16. Henry MJ, Pasco JA, Korn S, Gibson JE, Kotowicz MA, Nicholson GC (2010) Bone mineral density reference ranges for Australian men: Geelong Osteoporosis Study. Osteoporos Int 21:909-917.

Table 1: Characteristics and referral reasons for patients aged ≥ 70 years referred to DXA at the Geelong Bone Densitometry Service (2003-2010); data presented as median (range), mean and standard deviation (±), or n (%).

Variables	**All (n=5,438)**	**Male (21.5%)**	**Female (78.5%)**	***p*-value**
Age (years)	77.5 (70.0-98.3)	77.3 (70.0-94.3)	77.6 (70.0-98.3)	0.32
Clinical indications for DXA				
Fracture or low BMD[a]	1,288 (23.7%)	270 (23.1%)	1,018 (23.5%)	0.58
Glucocorticoid use[b]	450 (8.3%)	169 (14.4%)	281 (6.6%)	**<0.001**
Secondary osteoporosis[c]	134 (2.5%)	24 (2.0%)	110 (2.5%)	0.30
Monitoring of drug therapy[d]	52 (0.9%)	6 (0.5%)	46 (1.1%)	0.08
Aged 70yrs or older[e]	3,514 (64.6%)	701 (60.0%)	2,813 (65.9%)	**<0.001**
BMD T-score [†]				
Normal	818 (15.0%)	353 (30.2%)	465 (10.9%)	**<0.001**
Osteopenic	2,554 (47.0%)	519 (44.3%)	2,035 (47.7%)	**0.04**
Osteoporotic	2,066 (38.0%)	298 (25.5%)	1,768 (41.4%)	**<0.001**
Lowest T-score (femoral neck or spine)	-2.1 ± 1.2	-1.60 ± 1.41	-2.29 ± 1.10	**<0.001**

[†]BMD T-score (femoral neck) was categorised as being within the normal range (-1.0 or more SD below the young reference mean), osteopenic range (-1.0 to -2.5 SD) or osteoporotic range (<-2.5 SD). Clinical indications for DXA: [a]Minimal trauma fracture or monitoring low BMD; [b]Prolonged glucocorticoid therapy, excess glucocorticoid secretion of hypogonadism; [c]Secondary osteoporotic conditions including primary hyperparathyroidism, chronic renal and liver diseases, malabsorption disorders, rheumatoid arthritis and conditions associated with thyroxine excess; [d]Changes in class of drug therapy; [e]Persons aged ≥70yrs.

Table 2: Binary logistic regression model investigating associations between clinical indications for DXA referral and a BMD T-score (femoral neck) < -2.5 SD below the young reference mean (osteoporotic range), adjusted for age and sex. Data presented as odds ratios (OR), 95% confidence intervals (95% CI) and *p*-values; significant values are in boldface.

Variable	**OR (95%CI)**	***p*-value**
Age groups (years)		
70-74 (referent)	1.00	-
75-79	**1.34 (1.16-1.54)**	**<0.001**
80-84	**1.97 (1.70-2.29)**	**<0.001**
85-89	**3.50 (2.86-4.28)**	**<0.001**
90-94	**5.65 (3.46-9.24)**	**<0.001**
95+	**5.63 (1.13-28.03)**	**0.03**
Sex		
Male (referent)	1.00	-
Female	**2.25 (1.95-2.61)**	**<0.001**
Clinical Indications for DXA		
Aged 70yrs or older[a]	1.00	-
Fracture or low BMD[b]	**1.46 (1.28-1.67)**	**<0.001**
Glucocorticoid use[c]	1.19 (0.96-1.46)	0.11
Secondary osteoporosis[d]	0.94 (0.65-1.35)	0.94
Monitoring of drug therapy[e]	**2.12 (1.19-3.76)**	**0.01**

Clinical indications for DXA: [a]Persons aged ≥70yrs. [b]Minimal trauma fracture or monitoring low BMD; [c]Prolonged glucocorticoid therapy, excess glucocorticoid secretion of hypogonadism; [d]Secondary osteoporotic conditions including primary hyperparathyroidism, chronic renal and liver diseases, malabsorption disorders, rheumatoid arthritis and conditions associated with thyroxine excess; [e]Changes in class of drug therapy.

Table 3: Lowest median BMD T-score measured at either the femoral neck or spine (range) for each clinical indication for referral, stratified by sex. Significant *p*-values are in boldface.

	Men (n=1,170)	**Women (n=4,268)**	***p*-value**
Fracture or low BMD[a]	-1.7 (-5.1, 3.5)	-2.6 (-5.6, 1.4)	**<0.001**
Glucocorticoid use[b]	-2.0 (-5.6, 3.7)	-2.3 (-5.2, 1.4)	**0.006**
Secondary osteoporosis[c]	-1.4 (-2.4, 1.5)	-2.2 (-6.1, 0.4)	**0.004**
Monitoring of drug therapy[d]	-2.8 (-5.1, -0.3)	-2.7 (-6.6, -0.5)	0.89
Aged 70yrs or older[e]	-1.5 (-2.4, 3.1)	-2.3 (-5.7, 2.6)	**<0.001**

Clinical indications for DXA: [a]Minimal trauma fracture or monitoring low BMD; [b]Prolonged glucocorticoid therapy, excess glucocorticoid secretion of hypogonadism; [c]Secondary osteoporotic conditions including primary hyperparathyroidism, chronic renal and liver diseases, malabsorption disorders, rheumatoid arthritis and conditions associated with thyroxine excess; [d]Changes in class of drug therapy; [e]Persons aged ≥70yrs.