BJR

RESEARCH

Osteoporosis in the community

SENSITIVITY OF SELF-REPORTED ESTIMATES AND MEDICATION USE OF THOSE DIAGNOSED WITH THE CONDITION

T. K. Gill,
A. W. Taylor,
C. L. Hill,
P. J. Phillips

From The University of Adelaide, Adelaide, South Australia

Objectives

To assess the sensitivity and specificity of self-reported osteoporosis compared with dual energy X-ray absorptiometry (DXA) defined osteoporosis, and to describe medication use among participants with the condition.

Methods

Data were obtained from a population-based longitudinal study and assessed for the prevalence of osteoporosis, falls, fractures and medication use. DXA scans were also undertaken.

Results

Overall 3.8% (95% confidence interval (CI) 3.2 to 4.5) of respondents and 8.8% (95% CI 7.5 to 10.3) of those aged ≥ 50 years reported that they had been diagnosed with osteoporosis by a doctor. The sensitivity (those self-reporting osteoporosis and having low bone mineral density (BMD) on DXA) was low (22.7%), although the specificity was high (94.4%). Only 16.1% of those aged ≥ 50 years and with DXA-defined osteoporosis were taking bisphosphonates.

Conclusions

The sensitivity of self-reporting to identify osteoporosis is low. Anti-osteoporotic medications are an important part of osteoporosis treatment but opportunities to use appropriate medications were missed and inappropriate medications were used.

Keywords: Osteoporosis, Population, Bisphosphonates, Bone mineral density, BMD, Self-reporting

Article focus

- To assess the levels of sensitivity and specificity of dual energy X-ray absorptiometry (DXA) measurements
- To compare DXA measurements with self-reported osteoporosis
- To analyse the use of medication for osteoporosis

Key messages

- The sensitivity of self-report is low
- Opportunities to use medications for osteoporosis are missed

Strengths and limitations

- The analysis was conducted on a randomly selected population cohort
- Over 1000 participants undertook a DXA scan
- Only a single self-report question to determine the prevalence of osteoporosis was used
- T-scores were determined for total body scan rather than the femoral neck
- A DXA scan was only conducted for those aged ≥ 50 years

Introduction

Osteoporosis is a serious disease,[1,2] a major public health problem[3-6] and an economic burden on health systems.[7-10] It is thought to be common in the population, although true population-wide prevalence estimates are rare[10] owing to the under-diagnosis of the condition and the expense of undertaking major epidemiological research to determine prevalence estimates. The major differences between estimates of prevalence arising from self-reporting and clinical examination are of concern. In an ageing society where health resources are increasingly scarce, evidence-based, population-wide, cheaply-assessed estimates of this condition are required so that effective interventions and appropriate

T. K. Gill, BAppSc, MAppSc, PhD, NHMRC Early Career Research Fellow
A. W. Taylor, BA, MPH, PhD, Manager, Population Research and Outcome Studies
The University of Adelaide, Population Research and Outcome Studies, Discipline of Medicine, 122 Frome Street, Adelaide, South Australia, 5000, Australia.

C. L. Hill, MBBS, MD, MSc, Staff Specialist, Clinical Associate Professor
The Queen Elizabeth Hospital, Rheumatology Unit, The University of Adelaide, The Health Observatory, 28 Woodville Road, Woodville, South Australia 5011, Australia.

P. J. Phillips, MBBS, Consultant Endocrinologist
Adelaide, South Australia, Australia.

Correspondence should be sent to Dr T. K. Gill; e-mail: tiffany.gill@adelaide.edu.au

10.1302/2046-3758.15.2000039
$2.00

Bone Joint Res 2012;1:93–8.
Received 16 November 2011; Accepted after revision 8 May 2012

preventive and treatment regimens can be implemented. In an era where chronic diseases are important and health resources are often determined on self-reported estimates, it is important that the difference between self-report and actual estimates are known and documented. Increasingly, self-reported estimates of diabetes, asthma, arthritis, mental health conditions and known risk factors are used for policy and planning purposes.[11,12] Osteoporosis is often overlooked as a priority chronic condition worthy of financial and policy considerations because of the lack of robust estimates.[13]

In addition, appropriate treatment of those with osteoporosis and adherence to treatment is of major concern. As the population ages, the numbers of those with both osteoporosis and fractures will increase. Recently, it has been suggested that the current indications for subsidised treatment of osteoporosis specified in the Australian Pharmaceutical Benefits Scheme (PBS) 'encourage over-prescribing on the one hand, yet, on the other, deny many patients with osteoporosis the treatment they need'.[14] However, Seeman et al[15] in response to this letter suggest that there is more likely to be an underutilisation of drug therapy for osteoporosis rather than over- or inappropriate prescribing, and that 'osteoporosis remains underdiagnosed, underinvestigated and undertreated'.[15] Various studies have demonstrated that higher mortality occurs among community dwelling males and females and those who have had a fracture, who do not use osteoporosis medications, vitamin D or calcium,[16-20] thus indicating the possible importance of these medications in reducing mortality following fracture of the hip. Osteoporotic fractures also have a high economic and social cost, placing a burden on the health care system and limiting activities of daily living.[21] The use of osteoporosis medications such as calcium, vitamin D, hormone replacement therapy (HRT) and bisphosphonates has also been shown to improve the cost effectiveness of screening strategies.[22] However, long-term adherence to drug therapy does remain an issue.[23]

We aimed to investigate and compare the prevalence and agreement of self-reported osteoporosis and dual energy X-ray absorptiometry (DXA) diagnosed osteopenia and osteoporosis in a group of adults undergoing screening DXA as part of a major population-based, randomly-selected, cohort study (the North West Adelaide Health Study (NWAHS)). A further aim was to determine the use of relevant medications for those who had osteoporosis or osteopenia (either self-reported or DXA diagnosed).

Materials and Methods

Data were obtained from the NWAHS; a population based biomedical cohort study established in 2000. This study involves people living in the north-west region of Adelaide, South Australia, randomly selected to participate and covers a broad range of socioeconomic areas. It was designed to investigate the prevalence of chronic conditions and health related risk factors, and to monitor progression of diseases over time in order to help plan health care provision in South Australia. The methodology has been described in detail elsewhere.[24]

Stage 2 of the study was conducted between 2004 and 2006, and comprised a Computer Assisted Telephone Interview (CATI), a self-completed questionnaire and a clinical assessment. Respondents completed surveys and a clinic assessment that included measurement of blood pressure, information assessing doctor-diagnosed conditions (including osteoporosis, arthritis and cardiovascular disease) and doctor-diagnosed and clinically assessed conditions (diabetes and asthma), self-reported falls and behavioural risk factors, health service utilisation and demographics. The questionnaires were undertaken prior to the clinic assessment. All medications that participants were taking, including complementary and alternative medicines, were recorded at the clinic visit. Those aged ≥ 50 years and attending the clinic were offered the opportunity to have a total body DXA scan. Respondents were classified as having osteoporosis (T-score ≤ -2.5) or osteopenia (-1.0 > T-score > -2.5) using the World Health Organization (WHO) definition of osteoporosis.[25]

Sample characteristics. The following data are weighted, as described in the Statistical Analysis. A total of 1718 males (49.1%) and 1782 females (50.9%) with a mean age of 47.4 years (20 to 93) completed the CATI; 1600 males (49.1%) and 1659 females (50.9%) with a mean age of 47.6 years (20 to 95) undertook the self-completed questionnaire; and 1573 males (49.1%) and 1632 females (50.9%) with a mean age of 47.6 years (20 to 95) undertook the clinical assessment.

This paper focuses on those aged ≥ 50 years. In this group, there were 684 males (46.8%) and 779 females (53.2%) (mean age 65.0 years) who completed the CATI; 642 males (46.9%) and 726 females (53.1%) (mean age 65.0 years) who completed the self-completed questionnaire; and 631 males (46.8%) and 717 females (53.2%) (mean age 65.0 years) completing the clinical assessment.

Of the 1463 subjects aged ≥ 50 years who completed the telephone interview, 581 (39.7%) were aged 50 to 59 years, 383 (26.2%) were aged 60 to 69 years and 499 (34.1%) were aged ≥ 70 years. Of the 1348 subjects aged ≥ 50 years who completed the clinical assessment, 540 (40.1%) were aged 50 to 59 years, 347 (25.7%) were aged 60 to 69 years and 461 (34.2%) were aged ≥ 70 years.

Statistical analysis. Data were weighted to Census data by region, age group, gender and probability of selection in the household, to provide population representative estimates, and all analyses are presented using weighted values. Data were analysed using SPSS version 19.0 (SPSS Inc., Chicago, Illinois). The study was approved by the institutional ethics committees of the North West Adelaide Health Service and all subjects gave written informed consent. A p-value < 0.05 was considered statistically significant.

Table I. Prevalence of dual energy X-ray absorptiometry (DXA)-diagnosed osteoporosis and osteopenia in patients aged ≥ 50 years (CI, confidence interval)

	Number*	Prevalence (%) (95% CI)
Normal DXA scan	867	*81.3* (79.1 to 83.4)
Osteopenic	161	*15.1* (13.2 to 17.1)
Osteoporosis	38	*3.6* (2.6 to 4.9)
Total	1066	*100.0*

* the weighting of data can result in rounding discrepancies or totals not adding

Table II. Self-reported *versus* dual energy X-ray absorptiometry (DXA)-diagnosed osteoporosis and osteopenia in patients aged ≥ 50 years (CI, confidence interval)

	No/don't know self-reported osteoporosis		Self-reported osteoporosis	
	n*	Prevalence (%) (95% CI)	n*	Prevalence (%) (95% CI)
Normal DXA	825	*84.8* (82.5 to 86.8)	49	*52.9* (43.4 to 62.1)
Osteopenia	120	*12.4* (10.6 to 14.4)	35	*38.1* (29.1 to 48.6)
Osteoporosis	28	*2.9* (2.0 to 4.1)	8	*9.0* (5.0 to 15.7)
Total	973	*100.0*	93	*100.0*

* the weighting of data can result in rounding discrepancies or totals not adding. Includes only those respondents who completed both the telephone survey and undertook a DXA scan

Results

Overall, 79.1% (n = 1066) of participants aged ≥ 50 years underwent DXA scanning. The remainder did not undergo DXA scanning primarily due to scheduling issues, although females (54.7%, n = 583) were significantly more likely to undergo a DXA scan compared with males (45.3%, n = 483) (Pearson chi-squared test = 4.79, p = 0.03), and those aged ≥ 70 years (31.9%, n = 340) were less likely to undergo a scan compared with those aged 50 to 59 years (41.1%, n = 438) and those aged 60 to 69 years (26.9%, n = 287), as were those aged 60 to 69 years compared with those aged 50 to 59 years and those aged ≥ 70 years (Pearson chi-squared test = 11.82, p = 0.003). The overall prevalence of DXA-diagnosed osteopenia or osteoporosis was 18.7% (95% confidence interval (CI) 16.6 to 20.9) (Table I). Of the participants who underwent a DXA scan, 3.6% (95% CI 2.6 to 4.9) had osteoporosis (a T-score ≤ -2.5) and 15.1% (95% CI 13.2 to 17.1) were osteopenic (-1.0 > T-score > -2.5) (Table I).

The overall prevalence of self-reported osteoporosis in the NWAHS was 3.8% (n = 133; 95% CI 3.2% to 4.5%) while the prevalence of self-reported osteoporosis amongst participants aged ≥ 50 years was 8.8% (n = 129; 95% CI 7.5 to 10.3). This was higher in female participants at 14.4% (n = 112; 95% CI 12.2 to 17.0) than in men at 2.5% (n = 17; 95% CI 1.6 to 3.7) (p < 0.001) and among those aged ≥ 70 years at 15.3% (n = 76; 95% CI 12.4 to 18.7). The prevalence was statistically significantly lower, compared with the other age groups, in those 50 to 59 years (3.6%; n = 21; 95% CI 2.4 to 5.4) (p < 0.001). The prevalence in those aged 60 to 69 years was 8.3% (n = 32; 95% CI 6.2 to 11.0).

Table II highlights the poor agreement between self-reported and DXA scores for osteoporosis for those respondents aged ≥ 50 years who provided both of these measures. As the questionnaires were undertaken prior to the DXA scan, the self-report results were not influenced by the clinical assessment. Over half of the participants who reported that they had been told by a doctor that they had osteoporosis, had normal bone mineral density (BMD) on DXA (52.9%; 95% 43.4 to 62.1), with the remaining 47.1% having abnormal BMD (either osteopenia (38.1%) or osteoporosis (9.0%)). Of the participants with DXA-diagnosed osteopenia or osteoporosis (n = 192), 22.7% reported that they had been diagnosed with osteoporosis (n = 44; 95% CI 17.8 to 28.6), resulting in the remaining 77.3% (95% 71.4 to 82.2) being classified as newly diagnosed or undiagnosed osteopenia or osteoporosis.

The use of self-reported osteoporosis in epidemiological or population studies as a screening tool for DXA-diagnosed osteopenia or osteoporosis was assessed, and the sensitivity, specificity, positive and negative predictive values were calculated. The sensitivity was 22.7%, specificity 94.4%, positive predictive value 47.1%, and negative predictive value 84.8%. This shows that the positive predictive value of having low BMD on DXA in people who self-report that they have osteoporosis is poor (47.1%), but the proportion of people with no self-reported osteoporosis who have normal DXA results is high (specificity of 94.4%).

In terms of medication use, of the respondents who self-reported that they had osteoporosis, 43.9% (n = 50) used oral bisphosphonates and a small proportion of respondents who stated that they did not have osteoporosis also took bisphosphonates (0.4%; n = 13), indicating a lack of understanding as to why they were taking particular medications. Of those who self-reported that they had osteoporosis, the most frequently used bisphosphonate was alendronate (72.2%; n = 36). There were also three respondents (2.4%) who stated that they had osteoporosis and were taking raloxifene. No other bone specific drugs such as zolendronate or strontium ranelate (available on the PBS since 2009 and 2007, respectively) were used. Finally, there were nine respondents (7.8%) who said they had been told that they had osteoporosis and took a form of hormone replacement therapy (HRT). Of the participants with DXA-defined osteoporosis or osteopenia, 16.1% (n = 21) and 13.3% (n = 6) were taking bisphosphonates, respectively, as were 3.1% (n = 27) of those with a normal DXA scan.

However, among all respondents who stated that they had osteoporosis and were taking a bisphosphonate, only 12.1% (n = 6) also took both calcium and vitamin D (including calcitriol). Of those with osteoporosis and

taking a bisphosphonate, 31.4% (n = 16) were also taking proton pump inhibitors.

Of all participants aged ≥ 50 years, 2.9% (n = 38; 95% CI 2.1 to 3.9) were on oral steroids and eight of these (21.4% (95% CI 10.6 to 38.5)) were also taking bisphosphonates. Of those on steroids, 0.8% (n = 1) and 22.2% (n = 6) had DXA-defined osteoporosis and osteopenia respectively and 37.7% (n = 2) of those who had took steroids and had undertaken a DXA scan were also taking bisphosphonates.

Among respondents who had a fracture as a result of a fall from a standing height or less in the last five years, 16.8% (n = 33; 95% CI 11.9 to 23.2) had been told by a doctor that they had osteoporosis. Of these respondents, 59.0% (n = 9; 95% CI 41.8 to 74.2) were on bisphosphonates and 12.0% (n = 4; 95% CI 4.6 to 27.6) were currently on benzodiazepines. When considering those aged ≥ 50 years, only 7.8% (n = 7) of those who had a fall had a bone density in the osteoporotic range. Of those taking benzodiazepines 3.8% (n = 2) and 14.0% (n = 8) respectively had DXA-defined osteoporosis or osteopenia.

Discussion

Our results show that self-reported osteoporosis is poorly predictive of DXA-diagnosed osteopenia or osteoporosis, with a positive predictive value no better than chance at 47%. Of those participants who had stated that they had been diagnosed by their doctor as having osteoporosis, 9.0% had DXA-defined osteoporosis, further suggesting that self-reported medically diagnosed osteoporosis is likely to lack accuracy in a population study such as this. In addition, our results also show that even though medication is an important part of osteoporosis treatment and fracture prevention, for those whose doctor had told them they had osteoporosis, and those who had suffered a minimal trauma fracture, opportunities to use appropriate medications were missed and inappropriate medications were used.

In terms of the marked differences in self-reported and clinically diagnosed osteoporosis, using these data we are unable to determine why 53% of those over 50 years of age who had self-reported osteoporosis but normal BMD on DXA thought they had osteoporosis. Women particularly may have been told by a health professional that they had osteoporosis but never had a DXA in order to confirm or refute this possibility. Another possible reason is that the terms osteoporosis and osteoarthritis are often confused in lay terminology without the distinction between the two disease processes being recognised. As such, persons reporting that they have osteoporosis may instead have osteoarthritis. Interviewing of participants would be required to determine what the term osteoporosis meant to them individually. These data also showed that few men with osteoporosis are diagnosed (the small number made analysis by gender inappropriate), which supports data in the literature showing that while osteoporosis is under-diagnosed even in women, the under-diagnosis is more marked in men.[26]

Our study also demonstrates that, in this population-based sample, only a minority of participants with minimal trauma fractures (7.8%) were osteoporotic on DXA scan. This is consistent with previous data from the Study of Osteoporotic Fractures data set that demonstrated the proportion of fractures attributable to osteoporosis was modest (10% to 44% depending on the fracture), using the same commonly used definition of osteoporosis (a T-score ≤ -2.5). These results demonstrate that other interventions are required beyond pharmacological treatment for bone loss, such as prevention of falls and other fracture risk factors.[27] In our study, the majority of participants (59.0%) who had a minimal trauma fracture were prescribed bisphosphonates. In contrast, 16.1% of those aged 50 years and over, with DXA-defined osteoporosis, were on bisphosphonates.

The use of bisphosphonates in this study appeared to be consistent with the PBS-subsidised indications at the time of the study although it is of note that among respondents who stated that they did not have osteoporosis, 0.4% took bisphosphonates indicating a lack of understanding as to why they were taking particular medications. Since this study was completed, the PBS indications for use of bisphosphonates in Australia have broadened to include not only those who have sustained fracture, but also those ≥ 70 years of age with BMD T-score < -3.0 and those using long-term high-dose corticosteroid therapy with BMD T-score of -1.5 or less.[28,29]

Although there was a low rate of co-prescription of calcium and vitamin D with bisphosphonates in the current study, subsequent changes to the presentation of bisphosphonates now offer vitamin D and calcium supplementation with the bisphosphonate. This single prescription is likely to increase the rate of co-prescribing of bisphosphonates with vitamin D and calcium, in line with current recommendations.

The co-prescription of benzodiazepines in participants with fractures, self-reported falls and osteoporosis is troubling as benzodiazepines have been demonstrated to both increase the risk of falls and fracture in the elderly.[23,30] Almost a third of participants using bisphosphonates were also using a proton pump inhibitor, suggesting co-morbid gastro-oesophageal reflux or peptic ulcer disease and there may also be an effect on calcium absorption. Although caution needs to be taken with the use of bisphosphonates in patients with active upper gastrointestinal problems, such as oesophageal diseases, gastritis or ulcers,[31] results from the Fracture Intervention Trial demonstrated no increased risk of upper gastrointestinal events in patients taking alendronate compared to placebo.[32]

Although anti-osteoporotic medication is an important part of osteoporosis treatment and fracture prevention, opportunities to use appropriate osteoprotective medications (calcium, HRT, selective oestrogen receptor modulators and vitamin D) were missed and inappropriate medications such as benzodiazepines were used for those at risk of osteoporotic fracture.

The strengths of this study are that analysis was conducted on a randomly selected population cohort and over 1000 participants undertook a DXA scan. All DXA results were provided to general practitioners and/or patients if requested and while this is not an intervention cohort, follow-up assessments will determine if self-report and DXA information more closely align. The weaknesses of the study are using a single self-report question to determine the prevalence of osteoporosis rather than a self-assessment tool, that total body scan T-scores were determined rather than femoral neck, that the DXA scan was only undertaken for those aged ≥ 50 years, and that due to the cross-sectional nature of the study, there is an inability to examine effects on BMD over time due to medication use. There is also the issue of the health literacy level of participants; in that there was no assessment of the understanding of the term osteoporosis among those surveyed that may also impact on the ability to accurately self-report the existence of osteoporosis. However, despite the limitations, the results have an important message particularly with regard to understanding the condition of osteoporosis and the use of medications.

In conclusion, this study highlights that the sensitivity and positive predictive values for self-reporting to identify osteoporosis are low and there is mismatch between self-reporting and DXA diagnosis of osteoporosis, highlighting the need for better means of identifying osteoporosis at the population level. While the identification of osteoporosis in the population is a challenge, addressing health literacy and communication in relation to osteoporosis may be of benefit. The study also highlights that opportunities to provide osteoprotective medications are often missed and inappropriate medications are supplied. This indicates that prescribing practices need to be more carefully examined in order to assist in the prevention of osteoporosis and associated fractures.

References

1. **Samelson EJ, Hannan MT.** Epidemiology of osteoporosis. *Curr Rheumatol Rep* 2006;8:76–83.
2. **No authors listed**. Consensus development conference: diagnosis, prophylaxis, and treatment of osteoporosis. *Am J Med* 1993;94:646–650.
3. **Jordan KM, Cooper C.** Epidemiology of osteoporosis. *Best Pract Res Clin Rheumatol* 2002;16:795–806.
4. **Holroyd C, Cooper C, Dennison E.** Epidemiology of osteoporosis. *Best Pract Res Clin Endocrinol Metab* 2008;22:671–685.
5. **Wehren LE, Magaziner J.** Hip fracture: risk factors and outcomes. *Curr Osteoporos Rep* 2003;1:78–85.
6. **Sutcliffe A.** Impact of osteoporosis on quality of life. *Community Nurse* 1998;4:11–12.
7. **Osteoporosis Australia.** *The burden of brittle bones: costing osteoporosis in Australia.* Canberra: Access Economics, 2001.
8. **Borgström F, Kanis JA.** Health economics of osteoporosis. *Best Pract Res Clin Endocrinol Metab* 2008;22:885–900.
9. **Joel ME, Le Gales C.** Social and economic aspects of osteoporosis. *Curr Opin Rheumatol* 1998;10:362–367.
10. **Ben Sedrine W, Radican L, Reginster JY.** On conducting burden-of-osteoporosis studies: a review of the core concepts and practical issues: a study carried out under the auspices of a WHO Collaborating Centre. *Rheumatology (Oxford)* 2001;40:7–14.
11. **South Australia Department of Health.** Chronic disease action plan for South Australia, 2009-2018. http://www.health.sa.gov.au/Portals/0/ChronicDiseaseActionPlan2009-18-Statewide-sahealth-100504.pdf (date last accessed 21 May 2012.
12. **Queensland Health.** 2011-2012 target delivery plan. http://www.health.qld.gov.au/chronicdisease/documents/tdp_chronic_disease2.pdf (date last accessed 21 May 2012).
13. **All Party Parliamentary Osteoporosis Group.** Falling short: delivering integrated falls and osteoporosis services in England, 2004. http://www.nos.org.uk/document.doc?id=752 (date last accessed 21 May 2012).
14. **Nordin BE, Horowitz M, Chatterton BE.** Inappropriate prescribing for osteoporosis. *Med J Aust* 2009;190:519–520.
15. **Seeman E, Kotowicz MA, Nash PT, Sambrook PN.** Inappropriate prescribing for osteoporosis. *Med J Aust* 2009;191:355–356.
16. **Center JR, Bliuc D, Nguygen ND, Nguygen TV, Eisman JA.** Osteoporosis medication and reduced mortality risk in elderly women and men. *J Clin Endocrinol Metab* 2011;96:1006–1014.
17. **Beaupre LA, Morrish DW, Hanley DA, et al.** Oral bisphosphonates are associated with reduced mortality after hip fracture. *Osteoporosis Int* 2011;22:983–991.
18. **Nurmi-Lüthje I, Lüthje P, Kaukonen JP, et al.** Post-fracture prescribed calcium and vitamin D supplements alone or, in females, with concomitant anti-osteoporotic drugs is associated with lower mortality in elderly hip fracture patients: a prospective analysis. *Drugs Aging* 2009;26:409–421.
19. **Semba RD, Houston DK, Ferrucci L, et al.** Low serum 25-hydroxyvitamin D concentrations are associated with greater all-cause mortality in older community-dwelling women. *Nutr Res* 2009;29:525–530.
20. **Nurmi-Lüthje I, Sund R, Juntunen M, Lüthje P.** Post-hip fracture use of prescribed calcium plus vitamin D or vitamin D supplements and antiosteoporotic drugs is associated with lower mortality: a nationwide study in Finland. *J Bone Miner Res* 2011;26:1845–1853.
21. **Melton LJ 3rd.** Adverse outcomes of osteoporotic fractures in the general population. *J Bone Miner Res* 2003;18:1139–1141.
22. **Hiligsmann M, Gathon H- J, Bruyère O, et al.** Cost-effectiveness of osteoporosis screening followed by treatment: the impact of medication adherence. *Value Health* 2010;13:394–401.
23. **Perreault S, Dragomir A, Blais L, et al.** Population-based study of the effectiveness of bone-specific drugs in reducing the risk of osteoporotic fracture. *Pharmacoepidemiol Drug Saf* 2008;17:248–259.
24. **Grant JF, Chittleborough CR, Taylor AW, et al.** The North West Adelaide Health Study: detailed methods and baseline segmentation of a cohort for selected chronic diseases. *Epidemiol Perspect Innov* 2006;3:4.
25. **World Health Organization.** *Assessment of fracture risk and its application to screening for postmenopausal osteoporosis*: *Technical Report Series 843.* Geneva: World Health Organization, 1994.
26. **Phillips P, Leow S.** Osteoporosis and men: don't forget the blokes. *Aust Fam Physician* 2000;29:765–769.
27. **Stone KL, Seeley DG, Lui LY, et al.** BMD at multiple sites and risk of fracture of multiple types: long-term results from the Study of Osteoporotic Fractures. *J Bone Miner Res* 2003;18:1947–1954.
28. **Department of Health and Ageing.** PBS extended listing of alendronate for treating osteoporosis and Medicare extended listing for bone mineral density testing. http://www.health.gov.au/internet/main/publishing.nsf/Content/E14AAF411525C4F2CA257273007F98B2/$File/Alendronate.pdf (date last accessed 15 August 2011).
29. **Pharmaceutical Benefits Advisory Committee (PBAC).** Final public summary document, July 2008 PBAC Meeting. http://www.health.gov.au/internet/main/publishing.nsf/Content/BBF0723CF8D908ECCA2574EC0015422A/$File/Risedronate%20Final%20PSD%20Sanofi-Aventis.pdf (date last accessed 15 August 2011).
30. **Faulkner KA, Cauley JA, Studenski SA, et al.** Lifestyle predicts falls independent of physical risk factors. *Osteoporos Int* 2009;20:2025–2034.
31. **No authors listed.** Pharmaceutical Benefits Scheme: product information for Fosamax. http://www.pbs.gov.au/pbs/pdf-viewer?pdf=%2Fmeds%2Fpi%2Fmkpfosam11010.pdf (date last accessed 15 August 2011).
32. **Bauer DC, Black D, Ensrud K, et al.** Upper gastrointestinal tract safety profile of alendronate: the Fracture Intervention Trial. *Arch Int Med* 2000;160:517–525.

Funding statement:

- TKG is currently a National Health and Medical Research Council Early Career Fellow (Australian Public Health, ID: 1013552). This study was supported by funding from The Hospital Research Foundation: The Queen Elizabeth Hospital, the University of Adelaide, and SA Health.

Author contributions:

- T. K. Gill: Data analysis, Interpretation of results, Writing the manuscript
- A. W. Taylor: Interpretation of results, Writing the manuscript
- C. L. Hill: Interpretation of results, Writing the manuscript
- P. J. Phillips: Interpretation of results, Writing the manuscript

ICMJE Conflict of Interest:

- None declared