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## Low bone mineral density measurements in care home residents—a treatable cause of fractures

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### Abstract

**Purpose:** to assess predictors of fracture risk and treatment for osteoporosis among elderly care home residents.

**Subjects and methods:** *Design:* cross-sectional survey; *Setting:* residents of care homes in Newcastle upon Tyne, UK; *Participants:* representative sample from residential care (87), nursing homes (105) and specialist homes for elderly people with dementia [elderly mentally infirm (EMI)]: residential (124) and nursing (76); *Main outcome measures:* dual-energy X-ray absorptiometry bone mineral density (BMD) at calcaneum; functional assessments, including cognition, using Mini-Mental State Examination

(MMSE), Clifton Assessment Procedure for the Elderly–Behaviour Rating Score (CAPE–BRS) and Functional Assessment Staging Test (FAST) scores; current drug prescription.

**Results:** MMSE, CAPE, FAST (all ANOVA  $P < 0.001$ ) and weight (ANOVA  $P < 0.02$ ) were lower in EMI homes. Drugs with sedative effects (chi-square,  $P < 0.0001$ ) were more likely and calcium and vitamin D (CaD) supplementation (chi-square,  $P < 0.02$ ) less likely in EMI care. For residential care, the odds ratio (OR) for sedative drugs in EMI was 2.13 (95% CI 1.11–4.06) with no significant difference between nursing homes. For CaD supplementation, the OR for EMI nursing homes was 0.19 (95% CI 0.05–0.72) and for EMI residential homes 0.38 (NS to 95% CI 0.12–1.27). BMD was low: mean T-score was  $-2.29$  (95% CI  $-2.48$  to  $-2.09$ ) and Z-score  $-0.96$  (95% CI  $-1.16$  to  $-0.76$ ) with a prevalence of osteoporosis (T-score  $< -1.6$ ) of 69.2%. MMSE and FAST scores did not predict BMD. In EMI residential care, a decrease of CAPE score by 5 points was associated with a decrease in T-score by 0.6 (95% CI 0.15–1.1).

**Conclusions:** of the tools used to assess function, only CAPE predicted low BMD in EMI residential care. Rates of CaD supplementation are particularly low in EMI care, where risk factors for fracture were the greatest. We conclude that fracture risk is neglected in these homes, and targeted education and treatment are warranted.

**Keywords:** osteoporosis, dementia, care homes, british, bone densitometry, elderly

## Introduction

Osteoporosis has been defined as a skeletal disorder characterised by compromised bone strength, predisposing a person to an increased risk of fracture [1]. The incidence of fractures of the forearm, vertebra, hip, humerus and pelvis increases with advancing age, but rises particularly rapidly after the age of 75 years [2]. The majority of these fractures occur in older people, where they are associated with excess mortality, morbidity and health and social services expenditure [3].

There is a strong inverse relationship between bone mineral density (BMD) and fracture risk, with a 2- to 3-fold increase in fracture incidence for each standard deviation (SD) reduction in BMD [4]. The Rotterdam Study showed that although the incidence of hip fracture increased 13-fold from the age of 60 to 80 years, the reduction in BMD accounted for only a small part of this increase [5]. Studies from Europe, USA and Australia suggest that the risk of fracture is determined not only by BMD and other skeletal risk factors, but also by factors associated with physical frailty and an increased risk of falls [6–8].

Although the incidence of fractures increases with advancing age, recent work shows that the risk of fracture is significantly higher in older people living in residential or nursing homes, than in those dwelling in the community [9]. Previous studies have also shown an increased risk of fractures in older people with dementia [10]. The relative importance of skeletal and non-skeletal risk factors in the pathogenesis of fractures in institutionalised older people and those with dementia remains uncertain. In order to develop appropriate strategies for the prevention of fractures in these groups, it is important that these issues are explored. We have therefore performed peripheral BMD measurements in older people living in ordinary residential and nursing homes and in equivalent residential and nursing homes for elderly mentally infirm (EMI) people. As calcium and vitamin D supplementation decreases the risk of hip and other non-vertebral fractures in institutionalised elderly people [11], we have also investigated the use of these supplements and specific treatments for osteoporosis in the participants in this study.

## Methods

Subjects were recruited from 18 care homes in Newcastle upon Tyne, representing a range of residential and nursing care home settings, including specialist (EMI) units. Height and weight were recorded. All subjects were invited to have peripheral dual-energy X-ray absorptiometry (pDXA) BMD measurements at the calcaneum performed in the care home using a portable device (PIXI, Lunar). BMD measurements were expressed as T-scores (SDs above and below the mean for young adults) and, in women only, Z-scores (SDs above or below the age-related mean). For the purposes of this study, osteoporosis was considered as a calcaneal BMD T-score of  $\leq -1.6$ , which the manufacturer suggests is equivalent to the WHO criteria for osteoporosis of a T-score of  $\leq -2.5$  at the hip [12]. This suggestion is supported by previous studies, comparing the results of calcaneal and hip BMD [13–16].

Assessments of cognitive function and activities of daily living were made using Folstein Mini-Mental State Examination (MMSE), Clifton Assessment Procedure for the Elderly–Behaviour Rating Score (CAPE–BRS) and Functional Assessment Staging Test (FAST) scores [17–19]. Subjects or their carers were questioned regarding their risk of fracture including general health, previous fracture history, smoking, routine exercise habits and use of non-pharmacological agents such as hip protectors. A current drug history was ascertained by viewing their records within the care homes. Drugs likely to decrease bone mass such as oral glucocorticoid therapy and anticonvulsants were noted, along with drugs that may increase the risk of falls, i.e. sedatives and hypotensive medication. Bone-protective agents including bisphosphonates and calcium and vitamin D supplementation were also recorded.

Informed consent was obtained from all subjects who were deemed competent and, for those who were cognitively impaired, assent for participation in the study was sought from their relative or main carer within the home. The study was approved by the Local Research Ethics Committee.

**Table 1.** Subjects studied and summary data by care home type—statistically significant differences are detailed in the *Results* section

Variables mean (SD) except where stated	Number	Nursing	EMI nursing	Residential	EMI residential
All subjects	392	105	124	87	76
Number of females (%)	392	83 (78.3)	95 (77.2)	65 (74.7)	65 (86.7)
Age (years)	381	85.7 (6.7)	82.3 (7.8)	86.5 (3.8)	83.7 (5.5)
Weight (kg)	368	58.9 (8.15)	53.4 (1.13)	59.3 (3.13)	57.2 (4.14)
Height (m)	196	1.545 (0.105)	1.58 (0.098)	1.583 (0.125)	1.575 (0.111)
Ever smoked (%)	392	26.7	15.3	8.0	17.1
Current smoker	392	7.6	3.2	3.5	5.2
MMSE score	392	11.9 (9.9)	2.3 (2.5)	18.1 (4.8)	9.2 (2.7)
CAPE score	392	15.8 (4.9)	22.0 (2.3)	8.3 (6.9)	16 (4.0)
FAST score	366	6.3 (1.56)	6.6 (0.54)	3.6 (2.79)	5.7 (1.68)
Drugs prescribed number (%)					
Sedatives	392	70 (66.7)	95 (76.6)	40 (50)	49 (64.5)
Calcium any	392	19 (18.1)	9 (7.2)	19 (21.8)	8 (10.5)
Vitamin D any	392	13 (12.4)	3 (2.4)	11 (12.6)	4 (5.3)
Calcium and vitamin D	392	12 (11.4)	3 (2.4)	11 (12.6)	4 (5.3)
Bisphosphonate	392	2 (1.9)	1 (0.8)	1 (1.1)	1 (1.3)
BMD (g/cm <sup>2</sup> )	292	0.304 (0.158)	0.355 (0.161)	0.335 (0.144)	0.346 (0.133)
Z-score <sup>a</sup>	234	−1.26 (1.567)	−0.93 (1.803)	−0.89 (1.317)	−0.81 (1.460)
T-score	292	−2.62 (1.780)	−2.10 (1.767)	−2.39 (1.543)	−2.13 (1.476)
Osteoporosis (%) <sup>b</sup>	292	76	66	73	63

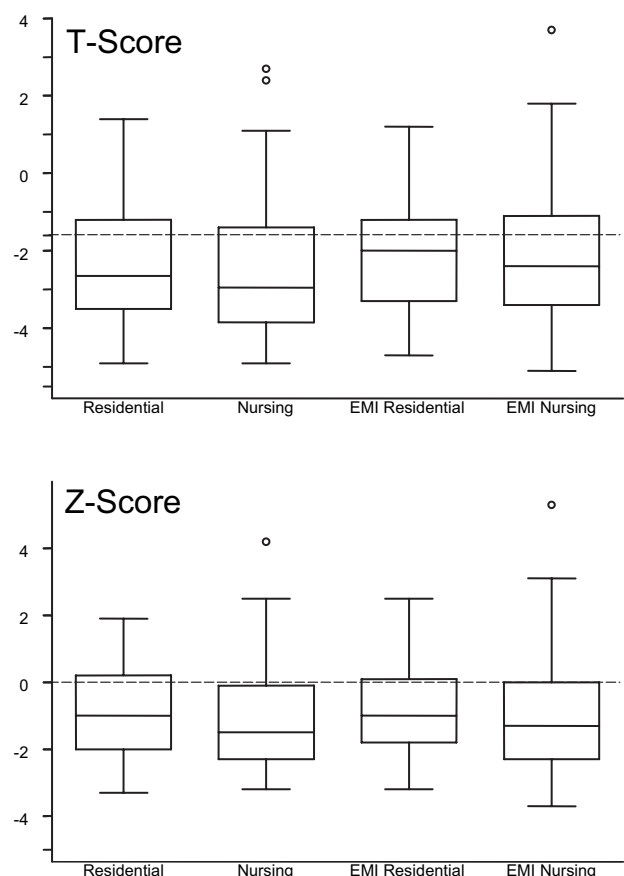
<sup>a</sup>Z-scores are available for women only; <sup>b</sup>osteoporosis defined as T-score  $\leq -1.6$ . MMSE, Mini-Mental State Examination; CAPE, Clifton Assessment Procedure for the Elderly; FAST, Functional Assessment Staging Test; BMD, bone mineral density; SD, standard deviation; EMI, elderly mentally infirm.

## Results

The details of the 392 subjects recruited are summarised in Table 1. There were no significant differences in age, height or proportion of the residents who were women, between the different types of care home. However, MMSE, CAPE score and FAST scores were all lower in the EMI care homes (ANOVA  $P < 0.001$ ) as well as weight (ANOVA  $P < 0.02$ ). There were also differences in the proportion of residents for whom data were missing on height and BMD. Height was measured in 13 of 105 general nursing, 87 of 124 EMI nursing, 46 of 87 residential and 50 of 76 EMI residential care residents. For pDXA, these figures were 64, 90, 74 and 64, respectively. In other cases, pDXA was attempted but where a scan was obtained, it was found to be of insufficient quality to allow an analysis.

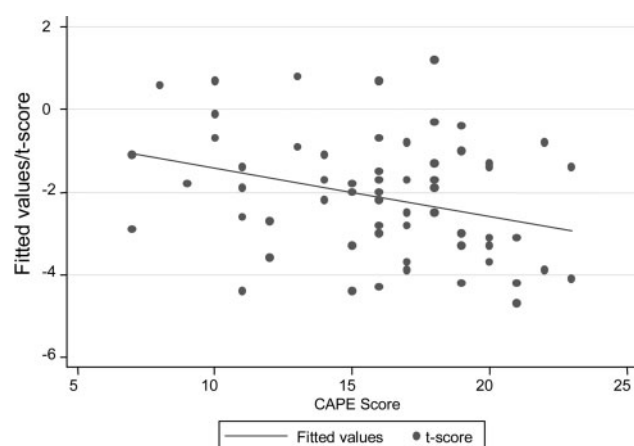
Prescribing practice differed between the care homes for drugs with sedative effects (chi-square,  $P < 0.0001$ ) and calcium and vitamin D supplementation (chi-square,  $P < 0.02$ ). For residential care, drugs with sedative effects were more likely to be prescribed in EMI homes with an odds ratio of 2.13 (95% CI 1.11–4.06), but there was no significant difference between nursing homes. The odds of receiving calcium and vitamin D supplementation in nursing homes which were EMI was 0.19 (95% CI 0.05–0.72) and for residential care which was EMI was 0.38 (NS to 95% CI 0.12–1.27).

BMD was low in all four care home environments (see Table 1). The mean T-score was  $-2.29$  (95% CI  $-2.48$  to  $-2.09$ ) and Z-score  $-0.96$  (95% CI  $-1.16$  to  $-0.76$ ). Using a threshold T-score of  $-1.6$ , the overall prevalence of osteoporosis was 69.2%. The distribution of Z-scores (for women) and T-scores (for both sexes) is illustrated in Figure 1 for each of the care home types.



\* Horizontal Line on T-Score graph at  $-1.6$

**Figure 1.** Box and whisker plots of T-score (for both sexes) and Z-score (for women only).



Gradient (s.e.) = -0.12 (0.04),  $t = -2.7$

**Figure 2.** Partial regression plot for CAPE score and T-score in EMI residential care.

MMSE did not predict bone mass (T-score or Z-score), neither did FAST score. However, only in EMI residential care homes, a decrease of CAPE score by 5 points was associated with a decrease in T-score by 0.6 (95% CI 0.15–1.1, see Figure 2). After adjustment for age, the associated decrease in T-score was 0.65 (95% CI 0.20–1.1). In women, Z-score also decreased by 0.65 (95% CI 0.15–1.15) for 5 units of CAPE score.

## Discussion

This study indicates that there is a high prevalence of osteoporosis in care home residents, as reflected by low BMD at the calcaneus. These results suggest that the higher fracture incidence in care home residents is due not only to an increased risk of falls but also to a reduced bone density [9].

Functional and cognitive function scores were significantly lower in EMI residential and nursing homes, but dementia was still common in general nursing and residential care. None of the tools used to assess function or cognition consistently predicted low BMD except the CAPE functional score in EMI residential care home residents.

Calcium and vitamin D deficiency is associated with impaired muscle function, and treatment probably increases muscle strength [20] and decreases the risk of hip and other non-vertebral fractures in care home residents [11]. However, we found low rates of supplementation in this study. EMI care homes are a particular source of concern, as calcium and vitamin D prescribing was significantly lower but other risk factors for fracture were greater, including the prescription of sedative drugs and low body weight. Bisphosphonates were also rarely prescribed, despite increasing evidence for their use in the elderly coming from randomised controlled trials [21].

Although the use of pDXA measurements is not established in the diagnosis of osteoporosis, they are useful for the assessment of overall fracture risk [22]. DXA measurements of BMD at peripheral and axial sites are equally

effective at predicting overall fracture risk, but site-specific measurements provide the best estimate of fracture risk at any particular location [4]. However, the relationship of T-score at different sites varies, and a T-score of -2.5 at the hip is approximately equivalent of a T-score of -1.6 at the calcaneus [13–16]. In a proportion of cases, we failed to obtain a satisfactory scan, either because the patient was unable to comply with the procedure or because the procedure generated an image which could not be analysed. Our medical physics department reviewed these images. Air gaps at the transducer/skin interface or other positioning difficulties were identified. Despite the practical problems, we affirm our use of pDXA measurements in this study for pragmatic reasons. Many of these frail subjects were poorly mobile, and, had we chosen to use axial skeletal measurements, a large proportion of the frailer residents may not have been able to be transferred to the DXA machine at the hospital site.

We conclude that the problems of osteoporosis and fracture risk are relatively neglected in care homes. Despite evidence that residents in these environments are at highest fracture risk [9], effective interventions such as calcium and vitamin D supplementation [11] and hip protectors are not appropriately targeted [23]. Previous studies have shown that fracture risk may be particularly high in residents with dementia, as falls are common [24], and there is some evidence that bone mass is lower [25].

We recommend a more pro-active approach to the identification and treatment of osteoporosis and fracture risk in elderly care home residents, who are at the highest risk of fracture. This approach would be reflected in higher rates of prescribing of calcium and vitamin D supplements, bisphosphonates and other antiresorptive agents. The development of functional scores such as that recommended by Ranstam and colleagues [26] or the CAPE score used in our study should be explored to identify those at higher risk in this population.

## Key points

- We have found a high prevalence of low BMD measurements in a population of care home residents, which may contribute to their increased risk of fracture.
- Prescription of sedative drugs was higher and bone protection lower in care homes specifically catering for older adults with cognitive impairment (EMI homes).
- Functional assessment scores failed to predict low BMD except for the CAPE when used in EMI residential care.
- Generally, fracture risk is neglected in care homes, and targeted education and treatment are needed.

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