ORIGINAL ARTICLES

Vitamin D Deficiency in Outpatients: - a Scottish Perspective

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Abstract

Vitamin D deficiency is common in older people and increases risk of falls, osteoporosis and fracture. This may be reduced with supplements. Recent Scottish guidelines recommend routine use of vitamin D and calcium for all older housebound, sunlight deprived or institutionalised people. Whilst many outpatients will undoubtedly meet these criteria, others who would benefit may not. We have determined the extent of vitamin D deficiency in older outpatients in our geographical area, to clarify further whether those found to be deficient, would receive supplementation under current guidelines

Methodology
102 new patient referrals to outpatient clinics and day hospital were questioned over their social circumstances and activity levels, and had serum 25 - Hydroxy Vitamin D (25(OH)D) levels measured in wintertime.

Results
Mean age was 79.6 (SD 7.3), 31.4% were housebound and 51.0% exposed their skin to sunlight. 72.6% had insufficient vitamin D levels [25(OH)D < 50 nmol/l], 27.5% of whom levels were frankly deficient [25(OH)D < 25 nmol/l]. Deficiency was significantly more common in females (p=0.002), those attending the falls clinic or day hospital (p=0.021), the housebound (p=0.012) or patients who never exposed their skin to sunlight (p=0.007). However, even in those patients who were outdoors frequently or who did expose their skin to the sun, the mean vitamin D levels remained insufficient [mean 25(OH)D = 45.6 (SD 26.2) nmol/l and 47.9 (SD 26.3) nmol/l respectively].

Conclusions
The prevalence of vitamin D deficiency is high in older outpatients in this geographical area. These patients may benefit from routine vitamin D and calcium, but currently many would not be targeted in recent Scottish Executive recommendations because they are not housebound and sunlight deprived.

Key Words
Vitamin D, Older people, Outpatients, Supplementation

Introduction

Vitamin D is known to be involved in muscle metabolism[1-2]. Deficiency has been significantly correlated with reduced muscle strength[3-5], increased falls risk[6] and with increased body sway[7]. All have improved following supplementation with vitamin D and calcium preparations[8-10]. Furthermore, vitamin D with or without calcium supplementation has increased bone mineral density in osteoporotic patients and reduced the incidence of hip fractures[11-13] although recent studies have cast some doubt[14-15]. Hip fracture in particular can cause considerable distress and increased mortality to the individuals concerned[16].

Vitamin D deficiency is common in the elderly[17]. A Europe wide survey, (excluding Great Britain), of 824 elderly people aged over 70 years found 36% of men and 47% of women had wintertime serum 25-hydroxyvitamin D3 concentrations <30 nmol/l[18]. Similar findings have been reported in British older people, particularly in Asians[19-20]. In Scotland in 1997 and 2000, the National Nutritional Audit of Elderly Individuals in Long Term Care found the majority of nutrients offered to older people were below Dietary Reference Values[21]. Routine dietary supplementation of vitamin D and calcium has now been recommended in the Scottish Office Home and Health Department's report "The Scottish Diet"[22], the Scottish Intercollegiate Guidelines Network's report "Management of elderly patients with fractured hip"[23], and more recently in the Scottish Executive Health Department Working Group's report "Vitamin D supplements for older people receiving long term care"[24].

These reports recommend routine vitamin D and calcium to be provided to all long term care elderly and those who do not receive sufficient sunlight, such as people over the age of 65 who are housebound or who rarely get out of doors and are receiving care at home or are living in nursing or residential institutions. Many older people attending outpatient services in our unit will undoubtedly meet these criteria for receiving supplements given that many are housebound and depend on care packages in the home. However, a proportion of patients attending outpatients will be at risk of falling, osteoporosis and fractures, and not be recommended vitamin D supplementation because they are fitter and not necessarily confined indoors. Data on the extent of vitamin D deficiency in our population is currently unknown. Indeed there is relatively little in the literature pertaining to the prevalence of vitamin D deficiency in Scotland, or in older general outpatients as a group across the United Kingdom.

Furthermore, the contribution of sunlight in this group in Glasgow is unclear. Current recommendations do not advocate routine vitamin D and calcium supplementation for those that are not housebound. The investigators consider that sunlight exposure may not be significant in improving vitamin D levels even in those that are not housebound, as previous work in the USA has demonstrated that at northern latitudes, skin is unable to make vitamin D effectively in winter months[25].

Moreover, our population is generally dressed in such a way that limits skin exposure when outdoors, such that insufficient vitamin D stores may be accumulated during summer months. The aim of this study therefore, was to determine how many older patients attending outpatient services are vitamin D deficient, and to observe whether vitamin D deficiency is confined solely to those older people who are eligible currently in guidelines for routine vitamin D and calcium because they are housebound or sunlight deprived.

Methods

All patients over 65 years referred as a 'new patient' to any of the outpatient clinics or day hospital of a Glasgow teaching hospital between December 2002 and March 2003 were eligible for entry into the study. Clinics available included general medical, falls, movement disorder and stroke. Day hospital is used for those patients requiring a more complex multi-disciplinary assessment of their needs.

All new patients were given a patient information sheet prior to meeting with medical staff and those agreeable to participation, gave written consent. In those who were incapable, consent was sought from an accompanying relative as stated in the Adults with Incapacity (Scotland) Act 2000[26].

On a standardised data collection form, information on the patients' characteristics including co-morbid illnesses, falls history, previous fracture history, nature of clinic attended, and drug history, were recorded. We also noted whether they were already taking calcium or vitamin D preparations. Similarly, use of other drugs known to affect bone metabolism, (thyroxine, anticonvulsants, steroids and hormone replacement therapy), was collected. To determine whether individuals were housebound or sunlight deprived, we also collected a detailed social history, information on how often patients went outdoors, and whether they routinely exposed their bare arms to sunlight. Cognitive function was assessed using the abbreviated mental test score (AMT). Body mass index (BMI) was calculated using the formula weight/height ^{2} (kg/m ^{2}).

Definition of vitamin D groups

Patients were grouped according to their vitamin D levels. Those with serum 25(OH)D levels < 25 nmol/l were termed deficient, those with 25(OH)D levels of 25-50 nmol/l were termed insufficient, those with 25(OH)D levels > 50 nmol/l were termed satisfactory. These stratifications are commonly accepted in the literature with evidence existing to support that 25(OH)D levels < 50 nmol/l generates a secondary hyperparathyroidism response which in turn influences bone metabolism[27-28]. Others have suggested that 25(OH)D levels should be maintained above 100nmol/l in order to remain vitamin D replete and reduce the risk of fracture[28]. However, levels of this magnitude are unlikely to be achieved in Scottish individuals and most would pragmatically accept values > 50 nmol/l as being satisfactory.

Laboratory analyses

Blood sampling was performed for analysis of urea & electrolytes, corrected calcium, phosphate, albumin and serum 25-OH vitamin D levels using the Nichols Advantage Analyser (Nichols Institute Diagnostics, San Juan Capistrano, California, USA).

Statistical analyses, funding and ethics

Comparisons between groups were made using unpaired t test and ANOVA as appropriate. All statistics were performed using SPSS for Windows (version 11.0.0). A probability value of $p<0.05$ was taken as statistically significant. Ethical approval was obtained from the Local Ethics Committee. This research was supported by a grant from the British Geriatrics Society Research Start Up Grant.

Results

Data was collected prospectively in 114 new patients. Vitamin D levels were unavailable in 12 patients. Results are presented for the remaining 102 patients.

The mean age was 79.6 years (SD 7.3) with a female preponderance of 72.5%. The mean BMI was 24.2 (SD 5.9) and the majority were cognitively intact (4.9% had AMT < 7/10). A previous falls and fractures history occurred in 43.1% and 25.5% respectively, although only a tenth were already on calcium and vitamin D supplements. The majority of patients lived in their own homes unsupported (64.7%), the remainder either being at home with input from social services (31.4%) or in residential care in a small number of cases (3.9%). Patients were recruited from mainly the general medical clinic, falls clinic or the day hospital.

Results of vitamin D levels and its associations.

Vitamin D levels were low in this population (Figure 1). The overall mean 25(OH)D level was 41.5 (SD 24.8) nmol/l. Using the predetermined stratification into vitamin D groups, only 28 patients had satisfactory levels (> 50 nmol/l), 4 of whom achieved levels > 100 nmol/l. 46 were insufficient (25 – 50 nmol/l) and 28 were deficient (< 25 nmol/l). Excluding patients who were already prescribed vitamin D and calcium supplements, gave a lower mean 25(OH)D level of 38.9 (SD 23.7) nmol/l. Other biochemical parameters were unremarkable.

Figure 1 - Vitamin D levels in an out-patient population

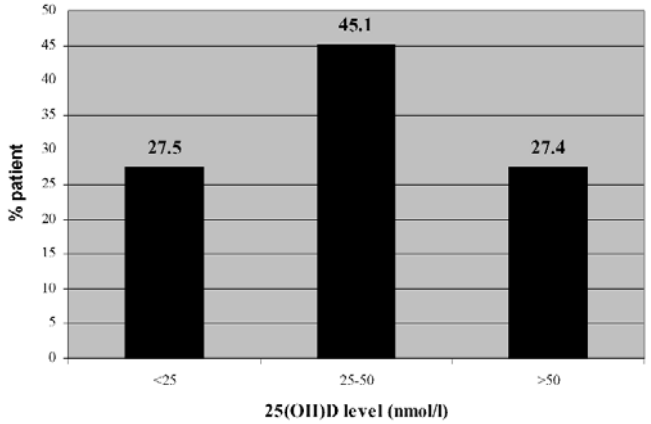

Table 1 Clinical characteristics of patients and association with vitamin D level

		% *n* =102	Mean 25(OH)D level	vitamin D grouping	*p* value
Sex	male	27.5	48.7 (33.2)	insufficient	0.002
	female	72.5	38.7 (20.4)	insufficient	
Age	63 – 74 years	25.5	43.2 (26.5)	insufficient	0.480
	75 – 84 years	52.0	43.0 (26.7)	insufficient	
	85 + years	22.5	35.9 (35.9)	insufficient	
BMI	< 20	16.7	43.7 (27.0)	insufficient	0.536
	20 – 25	31.4	36.5 (17.8)	insufficient	
	>25	25.5	41.1 (25.3)	insufficient	
Cognition	AMT <7	4.9	25.2 (13.8)	insufficient	0.154
	AMT >/= 7	74.5	41.7 (25.2)	insufficient	
Co-morbidity	< 2 conditions	52.0	41.2 (24.9)	insufficient	0.909
	>/= 2 conditions	48.0	41.8 (24.9)	insufficient	
Residence	home alone	64.7	44.9 (27.9)	insufficient	0.162
	home with services	31.4	35.5 (16.7)	insufficient	
	residential	3.9	32.3 (14.5)	insufficient	
Falls	none	56.9	43.3 (23.4)	insufficient	0.390
	previous history	43.1	39.0 (26.6)	insufficient	
Fractures	none	74.5	39.6 (23.1)	insufficient	0.198
	previous #	25.5	46.9 (30.0)	insufficient	
Drugs	none [1]	77.4	38.7 (24.0)	insufficient	0.013
	calcium/vit D	11.8	61.0 (24.7)	satisfactory	
	other drugs [1]	10.8	40.1 (22.5)	insufficient	
Clinic	general med./other [2]	45.1	48.8 (26.6)	insufficient	0.021
	falls	26.5	34.0 (23.9)	insufficient	
	day hospital	28.4	36.8 (19.7)	insufficient	

There was no significant relationship found between age, BMI status, cognition, co-morbidity, previous falls or fracture history and the mean level of 25(OH)D. In every group, patients were found to be insufficient (Table I). Females were statistically more likely to have lower vitamin D levels, as were patients not already on calcium and vitamin D supplements compared to those that were taking them. Similarly, 25(OH)D levels were significantly lower in those attending the falls clinic and the day hospital compared to those attending other clinics. Only patients on calcium/vitamin D supplementation fell by definition, into a higher vitamin D grouping.

A falls history was more prevalent in the patients attending the falls clinic or day hospital compared to other clinics ($p = 0.001$). The same did not hold true for a fracture history ($p = 0.526$).

Relationship between vitamin D levels and being 'housebound and sunlight deprived'

This is explored in Table 2. Less than a third of this patient cohort were housebound (31.4%). Mean vitamin D levels were higher in patients who managed outdoors on a daily or weekly basis compared to the housebound (mean 25(OH)D = 45.6 (SD 26.2) & 32.4 (SD 18.9) respectively; $p = 0.012$). A similar

Table 2 Association between vitamin D level and exposure to sunlight

		% *n* =102	Mean 25(OH)D level	vitamin D grouping	*p* value
Outdoors					
	daily / weekly	68.6	45.6 (26.2)	insufficient	0.012
	housebound	31.4	32.4 (18.9)	insufficient	
Time outside in past week					
	none	43.1	33.3 (16.7)	insufficient	0.006
	< 5 hours	37.3	44.8 (24.6)	insufficient	
	5 + hours	19.6	53.2 (33.8)	satisfactory	
Exposure of skin to sunlight					
	yes	51.0	47.9 (26.3)	insufficient	0.007
	no	49.0	34.8 (21.4)	insufficient	

relationship was found when asked how many hours they had been outside in the fresh air in the preceding week; those spending more than 5 hours, having the highest levels. In 51%, patients stated that they would roll their sleeves up and expose their skin to the sun if warm enough. These patients had a significantly higher vitamin D status compared to the remaining 49% (mean 25(OH)D = 47.9 (SD 26.3) & 34.8 (SD 21.4) respectively; p =0.007). Once again all the patients could be classed as being vitamin D insufficient, the exception being patients who were outdoors for more than 5 hours per week (reaching satisfactory D status). Patients living independently in their own homes were more likely to expose their skin to sunlight than those needing social input or residential care (p = 0.029).

Discussion

We have found a high prevalence of vitamin D deficiency in outpatients in our geographical area. Even though levels were higher in those able to get outdoors more often, overall, patients' vitamin D levels remained sub-optimal.

In our study, 72.6% of older outpatients had serum 25(OH)D levels of less than 50 nmol/l. Similar proportions were found recently in a falls clinic population[29]. Other work has concentrated on community dwellers or inpatients whose vitamin D status may be different to our population by virtue of their different health status[18,20-22,30]. In addition, there is little published on vitamin D status in a Scottish population where one might anticipate a higher prevalence of deficiency given the more northern latitude. This is the first report of vitamin D levels in general outpatients and day hospital attendees in Scotland.

Our results are in keeping with the well-established pattern of a high prevalence of vitamin D deficiency in older people. The mean 25(OH)D value in this study group was 41.5 (SD 24.8) nmol/l; 48.7 (SD 33.2) nmol/l in males and 38.7 (SD 20.4) nmol/l in females. These values are lower than the national averages in community dwelling 75-84 year olds; 54.7 (SD 24.9) nmol/l in males and 49.7 (SD 24.0) nmol/l in females,found in the National Diet and Nutrition Survey in 1998[30]. This may reflect increasing frailty in the outpatient population when compared to healthier non-hospital attendees. Only those patients receiving vitamin D and calcium supplementation achieved satisfactory 25(OH)D levels. McKenna et al would argue that even this group may not be vitamin D replete[28].

Low vitamin D levels were not limited to only those attending a falls service, but encompassed all those attending day hospital and general and specialist clinics alike. Even though levels were significantly higher in general clinics, these patients were still classified as being vitamin D insufficient and hence at increased risk of fracture. Many older people attend specialised medical and surgical clinics across the hospital. Should all medical personnel be considering vitamin D deficiency in any older person referred to their specialist clinic?

In our population, we did not find a direct relationship between low vitamin D and a previous history of falls and fractures, however, this is probably attributable to the smaller numbers included in our study. Such a relationship has been demonstrated previously and seems to be mediated by vitamin D's influence on muscle strength[3-6], body sway[7] and bone metabolism[11-12]. The risk of falls and serious injury may be reduced with the use of supplements [8-10]. Certainly in our study, falls were common in every clinic group, in particular in the day hospital attendees. Given that 72.6 % of patients were not vitamin D replete; this would suggest that many of our outpatient population could potentially benefit from regular vitamin D and calcium supplementation.

It is also well established in the literature that sunlight exposure significantly contributes to patients' vitamin D status, dietary intake being the other important factor. Our findings have shown an association between time spent outdoors and exposure of skin to sunlight with serum 25(OH)D levels. However, even in those patients who were not housebound and who rolled up their sleeves in the sun, vitamin D levels remained insufficient (< 50 nmol/l). These results probably reflect poor vitamin D synthesis during winter months along with low vitamin D body stores. Webb et al have already shown that in the USA, ineffective vitamin D synthesis extended from October through March in Edmonton (52 degrees N) [25]. Glasgow is a further 3 degrees north and likely to have a similar if not longer ineffective winter period. Studies have shown that secondary hyperparathyroidism arises when vitamin D levels fall below 50 nmol/l, leading to increased bone turnover and reduction in bone mineral density [28]. Indeed maintenance of levels above 100 nmol/l may be desirable to reduce the incidence of non-vertebral fracture [9, 31]. Hence in our population, climate and lack of sunlight may prevent even the most active from achieving normal vitamin D status. Using 'being housebound' as a criteria for routine supplementation may be sub-optimal therefore. We cannot of course make any comment on the influence of dietary intake in our population, but Scottish Executive publications have already revealed nationwide deficits in vitamin D and other nutrient intake, making sunlight contribution even more necessary in older people.

Dhesi et al have advocated a pragmatic approach to vitamin D supplementation in older patients at the falls clinic[29]. Furthermore, in recent reports, the Scottish Executive has recommended routine vitamin D and calcium supplementation for all over 65 year olds living in long term care or who receive limited sunlight, such as the housebound or those living in residential and nursing homes[21, 22-24]. Our study supports these recommendations. In addition, we would suggest that our findings support the use of routine vitamin D and calcium supplementation, be extended to *all* older people attending medical services regardless of their ability to get outdoors and expose their skin to sunlight, as our work has shown that at least in wintertime, the overwhelming majority have low vitamin D levels.

Limitations of our work include the small patient numbers, which may not reflect properly on the general population in our area. But since our findings are in keeping with those found in other outpatient populations, we are less concerned[29]. The accuracy with which patients reported how often they went outdoors in the previous week might also be questioned, although the majority were cognitively intact. We have also deliberately chosen to study patients during wintertime. One could argue that sunlight exposure becomes irrelevant at this time of year. Nevertheless, these people were largely vitamin D deficient even though they would not neatly fit the criteria of being 'housebound and sunlight deprived', indicating that diet alone does not give adequate vitamin D levels in this outpatient population. These people may still benefit from routine supplementation.

We are repeating this study in summertime to allow a comparison with the wintertime values found in this study. We also have limited evidence as yet, on the reduction in incidence of falls and fractures with routine calcium and vitamin D supplementation in this group of patients. One would expect that given the high prevalence of vitamin D deficiency and previous falls and fractures, that they have potentially much to gain.

In summary we have found a high prevalence of vitamin D deficiency in older outpatients attending geriatric services in our geographical area. Vitamin D levels remained sub-optimal even in those who were not housebound and who were outdoors regularly. The same is true of patients attending *all* clinic types where a high prevalence of falls was also found. These patients may benefit from routine vitamin D and calcium supplementation but currently would not be targeted in recent recommendations by the Scottish Executive.

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References

1. Janssen HCJP, Samson MM, Verhaar HJJ. Vitamin D deficiency, muscle function and falls in elderly people (review). Am J Clin Nut 2002; 75 (4):611–5

2. Latham NK, Anderson CS, Reid IR. Effects of vitamin D supplementation on strength, physical performance, and falls in older persons: a systematic review. J Am Geriatr Soc 2003; 51:1219–1226

3. Kemm JR, Ancill RJ. Vitamin deficiency in the elderly. Oxford: Blackwell Scientific Publications 1985. 26, 72–6

4. Bischoff HA, Stahelin HB, Urscheler N et al. Muscle strength in the elderly; its relation to vitamin D metabolites. Arch Phys Med Rehabil 1999; 80:54–8

5. Mets T. Calcium, vitamin D and hip fractures. Incidence of falls may have decreased. BMJ 1999; 309:193

6. Mowe M, Haug E, Bohmer T. Low serum calcidiol concentration in older adults with reduced muscular function. J Am Geriatr Soc 1999; 47: 220–6

7. Pfiefer M, Begerow B, Minne HW et al. Vitamin D status, trunk muscle strength, body sway, falls and fractures among 237 postmenopausal women with osteoporosis. Exp Clin Endo Diabetes 2001; 109(2): 87–92

8.Gloth FM III, Smith CE, Hollis BW et al. Functional improvement with vitamin D in a cohort of frail, vitamin D deficient older people. J Am Geriatr Soc 1995; 43:1269–71

9.Chapuy MC, Arlot ME, Duboeuf F et al. Vitamin D3 and calcium to prevent hip fractures in elderly women. N Engl J Med 1992; 327:1637–42

10. Pfiefer M, Begerow B, Minne HW et al. Effects of a short term vitamin D and calcium supplementation on body sway and secondary hyperparathyroidism in elderly women. J Bone Miner Res 2000; 15:1113–8

11. Lane JM, Russell L, Khan SN. Osteoporosis. Clin Orthop Relat Res 2000; 372:139–50

12. Gillespie WJ, Avenell A, Henry DA et al. Vitamin D and vitamin D analogues for preventing fractures associated with involutional and post–menopausal osteoporosis (Cochrane Review). The Cochrane Library 2001; Issue 3

13.Trivedi DP, Doll R, Khaw KT. Effect of four monthly oral vitamin D (cholecalciferol) supplementation on fractures and mortality in men and women living in the community: randomised double blind controlled trial. BMJ 2003; 326:469

14. The RECORD Trial Group. Oral vitamin D3 and calcium for secondary prevention of low–trauma fractures in elderly people (Randomised Evaluation of Calcium Or vitamin D, RECORD): a randomised placebo–controlled trial. Lancet 2005; 365(9471):1621–8

15. Porthouse J, Cockayne S, King C et al. Randomised controlled trial of calcium and supplementation with cholecalciferol (vitamin D3) for prevention of fractures in primary care. BMJ 2005; 330(7498):1003

16. Salkeld G, Cameron I, Cumming RG et al. Quality of life related to fear of falling and hip fracture in older women: a time trade off study. BMJ 2001; 320(7231):341–6

17.Gloth FM III, Gundberg CM, Hollis BW et al. Vitamin D deficiency in homebound elderly persons. JAMA 1995; 274: 1683–6

18. van der Weilen RPJ, Lowik MRH, van der Berg, et al. Serum vitamin D concentrations among elderly people in Europe. Lancet 1995; 346:201–10

19.Dunnigan MG, Fraser SA, McIntosh WB et al. The prevention of vitamin D deficiency in the elderly. Scott Med J 1986; 31(3):144–9

20. Solanki T, Hyatt RH, Kemm JR et al. Are elderly Asians in Britain at a high risk of vitamin D deficiency and osteomalacia? Age & Ageing 1995; 24(2):103–7

21. Scottish Office Department of Health's Clinical Resources Advisory Group National nutritional audit of elderly individuals in long term care 1997 & 2000

22. Scottish Office Home and Health Department. The Scottish diet – report of a working party to the Chief Medical Officer for Scotland 1994.

23. Scottish Intercollegiate Guidelines Network. SIGN 1997; Guideline 15 – Management of elderly patients with fractured hip.

24. Scottish Executive Health Department Working Group – Draft Report Vitamin D supplements for older people receiving long–term care. 2002.

25. Webb AR, Kline L, Holick MF. Influence of season and latitude on the cutaneous synthesis of vitamin D3. J Clin Endocrinol Metab 1988; 67(2): 373–8

26. Scottish Executive Health Department (2000) Adults With Incapacity (Scotland) Act 2000: Part 5 – Medical Treatment and Research.

27. Malabanan A, Veronikis IE, Holick MF. Redefining vitamin D deficiency. Lancet 1998; 351(9105):805–806

28. McKenna MJ, Freaney R. Secondary hyperparathyroidism in the elderly: a means to determining hypovitaminosis D. Osteoporos Int 1998; 8:S3–S6

29. Dhesi JK, Moniz C, Close JCT et al. A rationale for vitamin D prescribing in a falls clinic population. Age & Ageing 2002; 31:267–271

30. Finch S, Doyle W, Lowe C et al. National diet and nutrition survey: people aged 65 years and over. Volume 1: Report of the diet and nutrition survey. London: The Stationery Office, 1998.

31. Dawson–Hughes B, Harris SS, Krall EA et al. Effect of calcium and vitamin D supplementation on bone density in females and males 65 years of age and older. N Eng J Med 1997; 337:670–67