Age and Ageing 2010; **39:** 62–68
doi: 10.1093/ageing/afp195
Published electronically 23 November 2009

Urgent action needed to improve vitamin D status among older people in England!

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Abstract

Background: the importance of vitamin D for bone health is well known, but emerging evidence also suggests that adequate vitamin D status may also be protective against non-communicable diseases. In the UK, government initiatives highlighting the importance of adequate vitamin D among older people have been in place since 1998.
Objectives: the aim of this analysis is to assess vitamin D status in people aged ≥65, living in private households in England, 2005 and make comparisons with the Health Survey for England (HSE) 2000 and the National Diet and Nutrition Survey (NDNS), 1994. We also examine associations of hypovitaminosis D [serum 25(OH)D <50 nmol/l] with demographic, geographic, lifestyle and health risk factors.
Design and setting: a nationally representative sample of older people living in England in 2005.
Participants: 2,070 adults aged ≥65, living in private households taking part in the HSE 2005.
Results: in the HSE 2005, mean serum 25(OH)D levels were 53 and 49 nmol/l in men and women, respectively, these levels are significantly lower than currently recommended at ≥75 nmol/l. Prevalence of vitamin D deficiency [25(OH)D <25 nmol/l] in people aged ≥65 in 2005 was 13% in women and 8% in men. Nearly two thirds (57%) of women and half of men (49%) had serum 25(OH)D <50 nmol/l. Only 16% of men and 13% of women aged ≥65 years had serum 25(OH)D levels ≥75 nmol/l. There is no improvement in vitamin D status in 2005 compared to 2000 and a significant decline in vitamin D status among men in 2005 in comparison to the 1994/1995 NDNS results. The odds of hypovitaminosis D increased by age group from those aged 75–79 to aged ≥85. Season of taking a blood sample, obesity, dark skin pigmentation, not taking vitamin supplements, cigarette smoking, poor general health and longstanding illness were all significant predictors ($P < 0.05$) of serum 25(OH)D status in adjusted regression models.
Conclusions: poor vitamin D status of older people continues to be a public health problem in England. Hypovitaminosis D is associated with many risk factors and poor health outcomes. There is now an urgent need for a uniform policy on assessment and dietary supplementation of vitamin D in older people to prevent poor vitamin D status and its negative consequences.

Keywords: *vitamin D status, older people, England, population survey*

Introduction

The importance of vitamin D for bone health is well known. Prolonged vitamin D deficiency in adults clinically manifests itself as osteomalacia and osteoporosis. Adequate vitamin D status may also be protective against non-communicable diseases [1] like diabetes, cancers, cardiovascular disease, rheumatoid arthritis and autoimmune conditions like multiple sclerosis [2]. The clinical manifestation of suboptimal vitamin D levels has a significant physical, psychological and financial impact on older people and society as a whole [3].

The amount of sun exposure necessary to meet requirements depends on factors such as age, latitude, season, time of day, time of year, clothing and skin pigmentation [4]. Older people are at higher risk of poor vitamin D status due to a decline in efficiency of vitamin D synthesis and a lowered renal conversion to its active form [5]. Low endogenous production during winter months can be compensated for by dietary intake and supplement use, but vitamin D intake among older people is presently low in the UK [6].

A high prevalence of vitamin D deficiency has been shown, particularly among older people living in institutions [7, 8]. Concerns over vitamin D deficiency worldwide have prompted the World Health Organisation (WHO) to produce guidelines on the importance of vitamin D and supplementation [9].

In the UK, there is renewed government interest in healthy lifestyles [10], the role of vitamin D in prevention of osteoporosis [11] and initiatives to achieve adequate vitamin D status in older people [12]. A recent consensus statement [13] has suggested an intake of 800–1,000 IU of vitamin D to be sufficient to achieve a serum 25(OH) D level of 75 nmol/l, considered optimal for falls and fracture prevention [14]. Vieth *et al.* [15] suggests a higher amount is required to achieve desirable 25(OH)D concentration of 75 nmol/l.

The aim of this paper is to examine serum vitamin D status among older people aged ≥65 using data from the 2005 Health Survey for England (HSE), compare results with HSE 2000 and the UK-wide National Diet and Nutrition Survey (NDNS) carried out in 1994/1995 [6]. We also investigate the associations between hypovitaminosis D and demographic, lifestyle and health risk factors.

Methods

Participants

The HSE is a continuous series of annual surveys designed to provide information on various aspects of the health of people in England. From 1991 to 2004, it was commissioned by the English Department of Health and since 2005 by the NHS Information Centre. In 2005, the HSE included nationally representative general population sample of English people aged ≥65, living in private households [16]. The sample included 4,269 residents (1,897 men and 2,372 women) who were interviewed. Like in previous years, in the HSE, the 2005 survey adopted a multi-stage stratified probability sampling design using the Postcode Address File as the primary sampling frame. It comprised the core (general population) sample and a boost sample of people aged ≥65. The overall response rate was 71% in the general population sample and 74% in the boost sample. The sampling design and methods used have been described in detail elsewhere [16].

Interviewers collected data from participants by computer-aided personal interview on socio-demographic aspects (including age, sex, ethnicity and region), health behaviours (including questions about general self-reported health, smoking etc.) and doctor diagnosed health conditions (ischaemic heart disease, stroke and diabetes). Height and weight measurements were taken in light clothing without shoes, and body mass index (BMI: weight (kg)/height $(m)^2$) was calculated.

After the interviewer visit, those who agreed had a nurse visit. Nurses collected information including current medication and vitamin supplement usage and took measurements such as blood pressure and obtained non-fasting blood samples.

Among those aged ≥65 participating in a nurse visit (2,174), a blood sample was obtained from 70% of men and 71% of women with written consent. A valid serum 25(OH)D sample was obtained from 2,070 informants, 950 men and 1,120 women. Those who gave a blood sample were representative of those interviewed (see details in Appendix 1 in the supplementary data available in *Age and Ageing* online). Blood samples were collected throughout the year from January to December 2005.

Comparisons of the vitamin D results were made with HSE 2000 [17], which included a valid serum 25(OH)D sample obtained from 1,766 informants (708 men and 1,058 women) throughout January to December 2000, analysed in the same laboratory (Royal Victoria Infirmary in Newcastle upon Tyne, UK) and used the same method as in HSE 2005.

The HSE data were compared with the NDNS [6], a nationally representative survey of people aged ≥65 living in private households in Great Britain. The NDNS sample was also selected using a multi-stage random probability design; the study designs for all three surveys were comparable [6, 16, 17]. It included analyses of serum 25(OH)D concentrations for (927 people from private households). The NDNS was carried out from October 1994 to September 1995.

The methods by which serum 25(OH)D samples were analysed (using the DiaSorin Kit, DiaSorin Inc, Stillwater, MN, USA) in all three surveys were comparable. The laboratories performing the 25(OH)D analyses took part in the Vitamin D External Quality Assessment Scheme. In these surveys, there was no significant change in the assay's performance throughout its use, as assessed from quality assurance parameters [6, 17, 18].

In this study, vitamin D deficiency was defined as serum concentrations 25(OH)D <25 nmol/l [12], while a level <50 nmol/l was defined as hypovitaminosis [19].

Statistical analysis

Analysis was carried out using SPSS v15 and STATA v9.0. The descriptive data were analysed by 5-year age bands to calculate age-specific mean, prevalence of vitamin D deficiency and hypovitaminosis. Comparisons of mean and prevalence of vitamin D status of the three surveys included age standardisation of the data using the mid 2000 population estimates. In all three surveys, informants with missing information were excluded from the analysis. Descriptive statistics were weighted to correct for the sampling probabilities in all three surveys and non-response in HSE 2005 [18]. The normality of the data was confirmed using both the Kolmogorov–Smirnov test and the 'Skewness index' which was between 0.3 and 0.7 in the three surveys.

Table 1. Mean 25(OH)D concentrations, prevalence of vitamin D deficiency (25(OH)D <25 nmol/l) and hypovitaminosis D (25(OH)D <50 nmol/l) among older people aged 65 years and over living in private households by sex and age group in HSE 2005

		Age group (HSE 2005)					
		65–69	70–74	75–79	80–84	85+	All aged 65 and over
Men	*N*	331	250	205	98	66	950
	Mean vitamin D[a] (SE)	53 (1.3)	56 (1.7)	52 (1.6)	49 (2.0)	48 (2.3)	53 (0.8)
	Vitamin D deficiency, %	8	8	12	7	8	8
	Hypovitaminosis, %	46	44	53	57	55	49
Women	*N*	349	308	221	155	87	1,120
	Mean vitamin D[a] (SE)	52 (1.4)	52 (1.3)	44 (1.4)	45 (1.6)	42 (2.6)	48 (0.7)
	Vitamin D deficiency, %	7	11	19	16	22	14
	Hypovitaminosis, %	51	50	62	66	69	58

[a]nmol/l.

Table 2. Age standardised mean 25(OH)D concentrations, prevalence of vitamin D deficiency (25(OH)D <25 nmol/l) and hypovitaminosis D (25(OH)D <50 nmol/l) among older people aged 65 years and over living in private households (NDNS 1994/1995 HSE 2000 and HSE 2005)

		NDNS 1994/1995	HSE 2000	HSE 2005	Difference in vitamin D status between years 95% CI and *P* values		
					NDNS vs HSE 2000[b]	NDNS vs HSE 2005[c]	HSE 2000 vs HSE 2005[d]
Men	*N*	476	485	950			
	Mean vitamin D[a] (SE)	59 (1.3)	60 (1.3)	53 (0.7)	1 (−2.6, 4.6, $P = 0.5$)	−6 (3.1, 8.9, $P < 0.001$)	−7 (4.0, 10.0, $P < 0.001$)
	Vitamin D deficiency, %	7	7	8	0	1 (−1.9, 3.9, $P = 0.5$)	1 (−1.9, 3.9, $P = 0.5$)
	Hypovitaminosis D, %	41	42	49	1 (−5.7, 7.2, $P = 0.75$)	8 (2.6, 13.4, $P = 0.004$)	7 (1.6, 12.4, $P = 0.01$)
Women	*N*	451	565	1,120			
	Mean vitamin D[a] (SE)	51 (1.1)	53 (1.0)	49 (0.7)	2 (−0.9, 4.9, $P = 0.18$)	−2 (−0.5, 4.5, $P = 0.12$)	−4 (1.6, 6.4, $P = 0.001$)
	Vitamin D deficiency, %	12	8	13	−4 (0.3, 7.7, $P = 0.03$)	1 (−2.7, 4.7, $P = 0.6$)	5 (1.9,8.1, $P = 0.03$)
	Hypovitaminosis D, %	55	50	57	−5 (−1.2, 11.2, $P = 0.12$)	2 (−3.4, 7.4, $P = 0.5$)	7 (2.0,12.0, $P = 0.006$)

[a]nmol/l.
[b]Compares difference between NDNS 1994/1995 and HSE 2000.
[c]Compares difference between NDNS 1994/1995 and HSE 2005.
[d]Compares difference between HSE 2000 and HSE 2005.

Differences in mean serum concentration of 25(OH)D between HSE 2005, HSE 2000 and NDNS 1994/1995 were compared using Analysis of Variance (ANOVA). The Chi square test was used to test differences in prevalence of vitamin D deficiency and hypovitaminosis D between the years. A logistic regression model was developed to examine the link between hypovitaminosis D and possible risk factors. The dependant variable was hypovitaminosis D. The independent variables were age group, BMI, cigarette smoking status, chronic diseases (including hypertension, coronary heart disease, Type 2 diabetes and stroke), ethnicity, general health, longstanding illness. current musculoskeletal condition, multivitamin supplement use, use of diuretics (thiazides), vitamin D and calcium taken for osteoporosis, region, sex, season and social class (further information can be found in Appendix 2 in the supplementary data available in *Age and Ageing* online). Analyses were conducted using forward stepwise regression in SPSS to select the variables related to hypovitaminosis D. The final model was run in STATA to enable statistical adjustment for the complex (clustered and stratified) survey design (described in detail in the report) [18]. We found no significant interactions between the variables included in the regression analysis.

Results

Table 1 in Appendix 3 (supplementary data available on *Age and Ageing* online) presents participants' characteristics. The age standardised mean serum 25(OH)D levels in HSE 2005 were significantly higher among men than women (53 nmol/l and 49 nmol/l, respectively; $P < 0.0001$). Among men, mean serum 25(OH)D levels ranged from 56 nmol/l (95% confidence interval (CI) 52.7–59.4) in those aged 70–74 to 48 nmol/l (95% CI 43.3–52.6) among those aged ≥85; in women, 52 nmol/l (95% CI 49.4–54.6) among those aged 65–69 to 42 nmol/l (95% CI 36.9–47.1) among those aged ≥85 (Table 1).

Table 1 also shows the prevalence of vitamin D status by sex and age group for HSE 2005. Prevalence of vitamin D deficiency (25(OH)D <25 nmol/l) among men and

Table 3. Estimated odds ratio for hypovitaminosis D (25(OH)D <50 nmol/l), by demographic, lifestyle and health status variables among people aged 65 years and over living in private households in England 2005

Variables	*N*	Unadjusted odds ratio and 95% CI†	*P* values	Adjusted* odds ratio and 95% CI†	*P* values
Age (*P* = 0.0001)					
65–69	680	1		1	
70–74	558	0.9 (0.76, 1.19)	0.65	0.9 (0.71, 1.17)	0.48
75–79	426	1.4 (1.12, 1.83)	0.004	1.4 (1.09, 1.88)	0.01
80–84	253	1.7 (1.29, 2.32)	<0.001	1.8 (1.26, 2.48)	0.001
85+	153	1.8 (1.27, 2.61)	0.001	1.8 (1.18, 2.60)	0.01
Sex (*P* < 0.0001)					
Male	950	1		1	
Female	1,120	1.4 (1.15, 1.63)	0.0004	1.5 (1.19, 1.78)	<0.001
Ethnicity (*P* < 0.0001)					
White	2,032	1		1	
Non-white	34	5.6 (2.15, 14.43)	0.002	7.9 (2.76, 22.6)	<0.001
Season (*P* < 0.0001)					
Spring: March–May	473	1		1	
Summer: June–August	574	0.6 (0.50, 0.82)	<0.001	0.6 (0.43, 0.74)	<0.001
Autumn: September–November	582	1.2 (0.93, 1.50)	0.18	1.1 (0.86, 1.46)	0.42
Winter: December–February	441	2.2 (1.68, 2.88)	<0.001	2.4 (1.77, 3.19)	<0.001
Region (*P* = 0.02)					
London	170	1		1	
North East	118	0.9 (0.53, 1.38)	0.53	1.2 (0.68, 1.98)	0.58
North West	314	0.7 (0.47, 1.00)	0.05	0.6 (0.42, 0.99)	0.04
Yorkshire and The Humber	226	1.0 (0.67, 1.50)	1.00	1.1 (0.71, 1.77)	0.64
East Midlands	185	0.7 (0.45, 1.03)	0.07	0.8 (0.49, 1.24)	0.30
West Midlands	208	1.0 (0.63, 1.44)	0.82	1.1 (0.71, 1.79)	0.61
East of England	231	0.7 (0.48, 1.07)	0.11	0.8 (0.51, 1.24)	0.32
South East	359	0.6 (0.42, 0.87)	0.05	0.7 (0.48, 1.10)	0.13
South West	259	0.6 (0.42, 0.91)	0.01	0.7 (0.44, 1.05)	0.08
General health (*P* = 0.02)					
Very good/good	1,311	1		1	
Fair	571	1.6 (1.29, 1.92)	<0.001	1.3 (0.99, 1.58)	0.06
Bad/very bad	188	2.7 (1.96, 3.81)	<0.001	1.6 (1.11, 2.39)	0.01
Longstanding illness (*P* = 0.01)					
No longstanding illness	646	1		1	
Limiting longstanding illness	596	1.8 (1.10, 1.72)	0.005	1.3 (1.02, 1.68)	0.03
Non-limiting longstanding illness	828	1.4 (1.48, 2.24)	<0.001	1.4 (1.09, 1.81)	0.01
Cigarette smoking (*P* = 0.003)					
Never smoked	978	1		1	
Ex smoker	873	1.0 (0.82, 1.18)	0.84	1.0 (0.84, 1.29)	0.69
Current smoker	217	1.8 (1.30, 2.39)	<0.001	1.8 (1.26, 2.46)	<0.001
Taking multivitamin supplement (*P* < 0.0001)					
Yes	929	1		1	
No	1,141	2.7 (2.23, 3.19)	<0.001	2.6 (2.17, 3.21)	<0.001
BMI status (*P* = 0.0002)					
20–24.9 kg/m^2	458	1		1	
<20 kg/m^2	41	1.0 (0.55, 1.97)	0.91	0.8 (0.40, 1.54)	0.48
25–29.9 kg/m^2	782	1.1 (0.84, 1.34)	0.60	1.1 (0.86, 1.43)	0.41
>30 kg/m^2	455	1.6 (1.21, 2.04)	0.001	1.6 (1.16, 2.10)	0.003

*Adjusted by age, sex, ethnicity, vitamin supplement use, season, BMI status, cigarette smoking status, region, general health, longstanding illness (limiting and non-limiting).

†Odds ratio and confidence interval (CI) are weighted to represent English population.

women aged ≥65 years was 8% (95% CI 6.3–9.7) and 14% (95% CI 12.0–16.0), respectively. Prevalence of hypovitaminosis D (25(OH)D <50 nmol/l) was 49% (95% CI 45.8–52.2) in men and 58% (95% CI 55.1–60.9) in women. Further analysis shows that only 16.2% (95% CI 13.9–18.5) of men and 13.2% (95% CI 11.2–15.2) of women aged ≥65 years had serum 25(OH)D levels ≥75 nmol/l (data not shown).

In NDNS and HSE 2005, vitamin D deficiency was more prevalent among women than men (12 vs 7%, *P* = 0.01 and 13 vs 8%, *P* < 0.001, respectively). Women were also significantly more likely to have hypovitaminosis D than men in 1994 (55 vs 41%, *P* < 0.001), 2000 (50 vs 42%, *P* = 0.02) and in 2005 (57 vs 49%, *P* < 0.001, Table 2).

There have been no significant improvements in vitamin D status among older people since 1994 (Table 2). In women, the prevalence of vitamin D deficiency was significantly higher in 2005 than in 2000 ($P = 0.03$). Among men, there was no significant change with time. The prevalence of hypovitaminosis D was significantly higher in 2005 than in 2000 in men ($P = 0.01$) and in women ($P = 0.006$), and in men only, the prevalence of hypovitaminosis D was also higher in 2005 than in 1994 ($P = 0.004$, Table 2).

Table 3 shows unadjusted and adjusted regression analyses. Adjusted analyses showed significant associations indicating that women were more likely to have hypovitaminosis D than men. Odds of hypovitaminosis D increased with age and were more likely in people who described their ethnicity as non-white in people who are obese, current smokers, reported poor general health, reported limiting or non-limiting longstanding illness and did not take vitamin supplements. Hypovitaminosis D was also more frequent in blood samples taken in the winter than in the spring and summer (Table 3).

Discussion

The results from HSE 2005 show a high prevalence of sub-optimal serum 25(OH)D levels and a small proportion of older people with levels in line with current recommendations at ≥75 nmol/l [14]. The data also show no significant improvements since 1994/1995. It is disappointing that vitamin D deficiency continues to exist at high levels among older populations in the UK [7] and similarly in other countries [20, 21].

There is controversy regarding inadequate serum 25(OH)D values. Conventionally, vitamin D deficiency has been defined as serum concentrations 25(OH)D <25 nmol/l [12]; <50 nmol/l has been associated with mild increase of bone turnover [19]. In some studies, serum 25(OH)D concentrations <20 nmol/l have been clinically associated with rickets and osteomalacia [22]. Other studies suggest that 25(OH)D >80 nmol/l can reduce the risk of hip and other non vertebral fractures [14]. Levels above 75 nmol/l are currently considered to be desirable [14].

Our findings show that women were more likely to have hypovitaminosis D than men, consistent with other literature [23]. This may be due differences in dietary intake or in vitamin supplement use between the sexes. Information on dietary vitamin D intake on the HSE was not available, however, the NDNS [6] showed men to have higher dietary intake from vitamin D rich foods than women. In all three surveys vitamin supplement use was higher in women than men [6, 16]. Suboptimal vitamin D levels in post-menopausal women are increase risk of hip fractures [24]. In older women, calcium and vitamin D supplementation reduced the risk of hip fractures [25]. However, in other studies calcium (1,000–1,200 mg) and vitamin D (800 IU) supplementation did not reduce the incidence of fractures [26]. However, this study had a number of limitations, such as serum 25(OH)D levels not being measured at baseline and poor compliance.

Our findings also show that hypovitaminosis D is associated with poor general health and having a longstanding illness, whether limiting or non-limiting. This association was also shown for vitamin D deficiency (25(OH)D levels <25 nmol/l) in the earlier HSE 2000 results [7].

Our analysis confirms the expected seasonal differences in serum 25(OH)D levels <50 nmol/l. Informants with blood samples collected in the winter had lower serum 25(OH)D levels than those collected in the spring and in the summer (see Figure 1 in Appendix 4 in the supplementary data available in Age and Ageing online). Housebound older people are at increased risk of vitamin D deficiency and need to spend more time outdoors in all seasons. However, older people also have lowered capacity to synthesise vitamin D when exposed to sunlight, so it is difficult for them to meet their requirements via sunlight [5].

In our analysis, those with a BMI ≥30 kg/m^2 (obese) had >50% increased odds of having hypovitaminosis D in comparison with those with a normal BMI of 20–25 kg/m^2. Other studies also show this association [27], suggesting that this is due to decreased bioavailability of vitamin D due to its deposition in fat. However, other evidence shows very lean people are also prone to vitamin D deficiency [7, 28].

Our results are consistent with those of other researchers who found a greater risk of hypovitaminosis D in people who smoked cigarettes [29] and those with darker pigmented skin [30].

Recent reviews suggest suboptimal vitamin D status may play a role in the development of chronic diseases. We examined the relationship between serum 25(OH)D and various chronic diseases. In adjusted models, hypovitaminosis D did not show an association with any of the chronic diseases included in the model. Informants on medication for hypertension were less likely to have hypovitaminosis D than those that were not hypertensive, but this was no longer significant after adjustment for thiazide use, which suggests that vitamin D levels are affected by thiazide use. This has also been shown in a review by Hathcock *et al.* [31].

Our findings fail to show any improvement in vitamin D status in older people since 1994/1995. Interventions such as early detection and treatment, increasing awareness of consuming vitamin D rich foods and getting adequate sun exposure, widespread fortification of vitamin D in food and vitamin supplementation are timely to debate [32].

Our data shows that older people not taking vitamin supplements were more likely to have hypovitaminosis D. The use of vitamin D supplements (800 IU) is shown to be effective in reducing falls and fractures among older people [14], recommended in those at high risk of deficiency [12] to preserve functional ability [14]. It has also been suggested that doses of vitamin D higher than 800 IU are required to increase serum levels to the desirable levels [15], but there is little evidence on long-term compliance of vitamin D supplementation among older adults living in the community [26].

The main strengths of the study are that it provides valuable information on current prevalence of vitamin D status in older people in England and makes comparisons with the earlier HSE 2000 and NDNS [6] results. These surveys are large, national surveys designed to give a representative picture of the population groups examined. Specific statistical weighting was included in all three surveys to attempt to correct for unequal sample selection [18]. We show that poor vitamin D status is also associated with a risk of poor health outcomes. There are some limitations to our study; we had no information on dietary vitamin D intake on the HSE, about sun exposure or about the dose of vitamin D in the vitamin supplements taken by informants. We also had limited information about any medications that may affect vitamin D status. In HSE 2005, a small percentage (4.1%) of participants took calcium and vitamin D for osteoporosis, suggesting that vitamin D status has been underestimated.

Poor vitamin D status, a preventable public health problem exists at alarming levels among older people in England and is associated with many risk factors and poor health outcomes. Due to limited ability to access vitamin D due to ageing indicates a clear rationale and an urgent need for a uniform policy on the assessment and dietary supplementation of vitamin D in older people to prevent further decline in vitamin D status and its negative consequences.

Key points

- The HSE 2005 shows that mean serum 25(OH)D levels are 53 and 49 nmol/l in men and women, respectively, significantly lower than the currently recommended levels at ≥75 nmol/l.
- ge standardised prevalence of vitamin D deficiency [25(OH)D <25 nmol/l] in people aged ≥65 in 2005 was 13% in women and 8% in men, and prevalence of hypovitaminosis D [serum 25(OH)D <50 nmol/l] was higher in women (57%) than in men (49%).
- There is no improvement in vitamin D status in 2005 compared to 2000, and results show a significant decline in vitamin D status among men in 2005 in comparison to the 1994/1995 NDNS results.
- Multivariate regression analyses show that women were more likely to have hypovitaminosis D than men. Hypovitaminosis D was more likely in people who were obese, current smokers or those who did not take vitamin supplements.
- Assessment and dietary supplementation of vitamin D in older people are urgently required to prevent further decline in vitamin D status and consequent poor health outcomes.

Acknowledgements

We thank all the staff of the Joint Health Surveys Unit at Department of Epidemiology and Public Health and National Centre for Social Research and the participants in the surveys.

Conflicts of interests

None declared.

Funding

The HSE 2005 on which this paper is based was funded by the English Department of Health. The NDNS programme is commissioned jointly by the Food Standards Agency and the Department of Health and conducted by the Office for National Statistics and the Medical Research Council (MRC) Human Nutrition Research. The authors are currently funded by the National Health Service (NHS) Information Centre for health and social care to work on subsequent Health Surveys for England. The views expressed are those of the authors, not of the funders. Data analysis and interpretation were carried out by the authors independently of the funding sources based on the available data. The corresponding author had full access to the survey data and had final responsibility for the decision to submit for publication. The funding body played no role in the formulation of the design, methods, subject recruitment, data collection, analysis or preparation of this paper.

Ethical approval

Ethical approval for the HSE was obtained from the North Thames Multi-centre Research Ethics Committee (MREC) and from relevant Local Research Ethics Committees (LRECs) in England. The NDNS survey was approved by the South Thames MREC and National Health Service LRECs. Participants providing a blood sample gave written consent.

Supplementary data

Supplementary data mentioned in the text is available to subscribers in *Age and Ageing* online.

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Received 7 February 2009; accepted in revised form 25 September 2009