

## Child Health

# Managing vitamin D deficiency in children

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**Keywords:** antenatal vitamin supplement, children, lifestyle, sun exposure, vitamin D

- Antenatal care is a particularly important area to target for supplementation of vitamin D

### Key messages

- Vitamin D deficiency is a problem among many of London's children. Clinical manifestations of this deficiency are varied but most cases are subclinical
- Recommendations to expose skin to some sunlight are rarely followed

### Why this matters to us

There are currently high frequencies of vitamin D deficiency in children. However, by using simple strategies index cases can be identified and families treated at low cost. The long-term benefits of this to child and adult health are likely to be substantial.

## Introduction

During the reign of Queen Victoria, James Greenwood wrote in the broadsheet newspapers of the era that children in the capital were increasingly afflicted with weak leg bones or rickets. The disorder of rickets, described two centuries before by Francis Glisson, was evident in over a quarter of London's children, particularly among the poor.

Over a century later similar numbers of children in London are being diagnosed with vitamin D disorders, and critically it is no longer just the children of the poor that are affected.

General practitioners (GPs) and other primary care practitioners are most likely to observe and manage malnutrition among their patients. Despite a culture of nutritional supplements and additive-free foods promoted by supermarkets and health food shops, the importance of vitamin D supplements among London's children is difficult to estimate. Differences observed in nutritional status are often attributed to different levels of income, education, mental health, migration status and health beliefs. The challenge is how or whether these deficiencies should be corrected.

## How does deficiency present clinically in children?

Vitamin D deficiency typically presents in a hospital setting with either a history of hypocalcaemic seizures in infancy, or rickets or with delayed gross motor milestones in toddlers. More recently and strikingly, measures of serum vitamin D level have demonstrated that there is a wider prevalence of deficiency in the population, and that hypovitaminosis D is often associated with deficiencies among family members of the index child.<sup>1-3</sup>

We reviewed 17 infants admitted to Ealing Hospital during a two-year period (from 2006 to 2008), who presented with hypocalcaemic seizures secondary to vitamin D deficiency. The majority of these infants had raised alkaline phosphatase and parathyroid hormone levels,<sup>3</sup> and a large number of them suffered delay in achieving gross motor milestones, especially in walking, as was reported in Victorian times. Small numbers of cases presented with cardiac failure, clinical rickets, tuberculosis, fractures and respiratory complications including wheezing in infancy.<sup>4</sup>

Receptors for 1,25-dihydroxyvitamin D have been identified in many tissues other than those related to calcium homeostasis. Such receptors have been

implicated in the regulation of immune function. Low levels of vitamin D are known to be associated with higher rates of infectious diseases, such as tuberculosis, as well as autoimmune diseases, for example diabetes. Vitamin D deficiency in a mother can have an effect on the bone mass of her children that will extend far into their childhood.<sup>5</sup> It has also been established that vitamin D deficiency among pregnant women is accompanied by an increased risk of wheezing in infants: the current VDAART trial in Boston is directed at determining whether various doses of vitamin D might alter the risk or rate of wheezing in infants.<sup>4,6</sup>

How we work and pass our leisure time has reduced our exposure to sunlight as well as influencing our intake of foods rich in vitamin D. Studies in the UK, northern Europe and Canada all suggest that an increasingly sedentary and indoor lifestyle, combined with dysfunctional nutrition contributes strongly to the increasing numbers of individuals identified with low vitamin D levels.

Children who present to hospital with clinical signs of vitamin D deficiency represent a small proportion of sufferers. The graph below indicates the results of all vitamin D assays undertaken at Ealing Hospital either by hospital clinicians or by GPs during the period from 1 July 2009 to 22 October 2009. Fifteen percent of the results related to paediatric patients. Approximately two-thirds of patients sampled were deficient in vitamin D when the current levels of 'normal' were applied (that is, normal levels between 50 and 80 nmol/l). There is therefore a large, hidden, sub-clinically affected population of individuals with low levels of this vitamin – an iceberg phenomenon.

We found along with others that when assays for vitamin D are carried out, larger numbers of children with low levels of vitamin D are identified. In Ealing this was particularly obvious in children presenting with pulmonary tuberculosis or infected eczema, the majority of whom required vitamin supplementation. In the case of tuberculosis the association with vitamin

D deficiency is well established. However in infected eczema there may not be a causative association. If one looks to national surveys of the British population, evidence of vitamin D deficiency is clear and a recent publication recommended a national strategy to tackle at-risk groups.<sup>7</sup>

## Are the 'normal' levels of vitamin D in biochemical assays significant in the absence of clinical symptoms?

The Institute of Medicine (IOM) reviewed the recommended daily intake (RDI) of vitamin D in 2008. Research published in the last ten years, mainly on studies of bone mass and strength among the elderly, state that the current RDI should be increased.<sup>4,8</sup> IOM recommends a daily intake of 400 international units (iu) with a tolerable upper limit of 2000 iu daily. More recent recommendations for daily intake to raise the serum 25-hydroxyvitamin D to over 75 nmol/l require a daily intake of 1000–2000 iu. This would reduce the risks in adults of bone fracture and lower limb dysfunction, improve dental health and reduce the risk of colorectal cancer.

Concerns are justifiably raised relating to the risks of toxicity of vitamin D supplementation due to hypercalcemia. However, the relative risk of toxicity may be overstated. Reports of toxicity are rare in UK children.<sup>9</sup>

## Who else is at risk of vitamin D deficiency?

Apart from children, case series report a range of at-risk groups; the elderly, pregnant and lactating

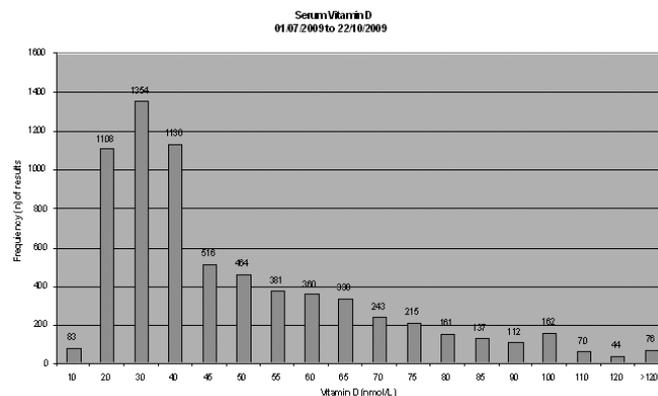


Figure 1 Serum Vitamin D levels

mothers, adolescents and those with a high body mass index (BMI).<sup>9–11</sup> Populations with darker skin are more likely to have lower levels of vitamin D, both because of difficulties utilising ultraviolet light and due to a greater propensity to degrade the vitamin in the skin once synthesised. South Asian communities have been singled out in particular as having low levels of vitamin D both in the UK and in New Zealand.

Vitamin D deficiency was observed in two national British surveys of adults; the National Diet and Nutrition Survey (NDNS) and the Low Income Diet and Nutrition survey (LDNS). The surveys showed that those with low levels of vitamin D in their diet are more likely to be deficient, suggesting that for many people sun exposure is not a good source of vitamin D. Low income or the receipt of benefits was not a predictor of vitamin D deficiency.<sup>7</sup>

Some practical steps to improve knowledge and healthy behaviour relating to vitamin D are proposed (see Box 1).

## Public health challenges

This brief outline of a nutritional disorder presents challenges to those in primary care. Although it may be tempting to investigate further the effect of vitamin D deficiency, there is a public health duty to correct it. There are sufficient data from national surveys, as well

as district general hospital case series, to indicate that pregnant mothers and children in particular merit treatment. Decisions must be made as to how to manage this, in order to reduce the risk of further deficiency and to empower patients or parents to take this responsibility themselves. The authors of this review are not alone in calling for attention to the problem.<sup>7,12,13</sup>

To correct deficiency one can recommend more sunshine, altering the diet or both (see Appendix 1). Initial forays into this area suggest it will not be easy to convince patients to take more sunshine for themselves and their children. The message of sunshine and melanoma has been a powerful one. We recommend moderate exposure (10–15 minutes exposing head, neck and arms each day). However, a number of surveys of mothers of infants with vitamin D deficiency indicated that they employed both sun block and skin lightening creams for themselves, and sun block for their children. The cosmetic value of pale skin often considerably outweighs any health messages (see Box 2).

Dietary interventions are well known to be difficult to implement. Parental perceptions of infant and toddler diet are often inaccurate,<sup>14</sup> and dietary modification among this age group is challenging. Paediatricians are aware that the deficiency problem develops during pregnancy and lactation when mothers do not receive vitamin D supplements.

The NICE guideline of 2004, updated in March 2008, recommended that at-risk mothers should receive vitamin D supplements during pregnancy.<sup>15</sup> This clear guidance has been augmented by the implementation of Healthy Start, an initiative directed at ensuring that pregnant mothers receive free vitamins and food vouchers to optimise their nutrition (see Appendix 2). Although initial pilots of Healthy Start in 2006 appear to have been successful, the implementation of this process has been slow and remains incomplete in 2010, with some areas in London having few or no vitamin packs available. There remain

### Box 1 Practical steps to improve knowledge and healthy behaviour relating to vitamin D

- Ensure Healthy Start vitamins are supplied to all mothers
- Check at-risk mothers are supplied with vitamin D throughout pregnancy and lactation (see NICE guidelines)
- Check that high BMI mothers received vitamin D – this is an at-risk group
- Ensure provision of information about vitamin D to all patients – posters and a mind map are available from the Arthritis Research Council
- Measure levels of vitamin D in all patients with weakness and non-specific pain
- Discuss prescriptions with local pharmacists: on occasions oral vitamin D preparations may be difficult to obtain
- Contact community dieticians, midwives and local obstetric units to ensure optimal supplementation

### Box 2 Explanations provided for low sun exposure and low vitamin D intake by mothers (outpatient survey, West London)

- Little time outside: busy indoors or at work
- Going 'out' often includes shopping in malls
- Use of sun block
- Dislike or fear of sunlight for themselves and their infants
- Regular use of skin lightening creams
- No Healthy Start vitamins
- No mention of vitamin D in antenatal care
- No knowledge of vitamin D

concerns that Healthy Start might not target all high-risk mothers; clinical studies suggest it is not necessarily low income mothers that are vitamin D deficient.

The use of calcium as well as vitamin D to treat individuals suffering depletion is a further area of contention. It is evident in vitamin D deficient adults that the use of both vitamin D and calcium shows additional benefits. However, there have been few trials with children. The assumption is often made that children have a higher calcium intake in the form of milk. This area of treatment requires further investigation. Similarly, the potential value of supplementing milk with vitamin D, as practised in the USA, is an area that deserves detailed investigation, as the benefits of such a strategy may not be as dramatic as one might assume.<sup>4,16–18</sup>

It would be quite wonderful in some halcyon state of euvitaminosis D, to see a reduction in rates of tuberculosis and type 1 diabetes. However, problems associated with one nutrient, vitamin D in this case, must not be seen in isolation, despite enthusiasm from experts in the field.<sup>19</sup> Children in London currently also have high levels of obesity and low levels of fitness; folate, iron and fibre intakes are often sub-optimal.

## Conclusions

Vitamin D deficiency is evident in children who present to district general hospitals in London. Although clinical manifestations of classic rickets may be infrequent, the rising numbers of cases of diabetes, pulmonary tuberculosis and hypocalcaemic seizure suggest that other effects of vitamin D deficiency may be present. The long-term risks of low levels of vitamin D are not clearly described in children, but work among adults suggests that significant health benefits arise by avoiding this situation. Advances in preventing vitamin D deficiency would be worth investment as the long-term savings will be significant. The next decade will see trials of various daily allowances of vitamin D for mothers, children and adolescents: the value of this will be an exciting area for study for all primary carers.

### FUNDING

None.

### CONFLICTS OF INTEREST

None.

### ACKNOWLEDGEMENTS

The authors would like to thank Dr Frank Geohagan for kindly sharing data on vitamin D assays performed in Ealing Hospital. Dr Donald Bently read and commented on the manuscript.

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*Submitted 12 February 2010, comments to authors 24 April 2010, revised 27 May 2010, accepted for publication 27 May 2010.*

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## Appendix 1

### Recommendations as to treatment of Vitamin D deficiency<sup>20,21</sup>

Treatment for rickets or low levels of vitamin D measured on serum 25-hydroxyvitamin D testing may be delivered either in stages or as a single dose. There is no consensus as to which of these is more effective. Further, the duration of treatment is not exactly determined as this will depend on the cause of the deficiency, the diet of the child and the availability of ultraviolet light to the skin of the patient. The majority of studies have not employed calcium or phosphate supplements in addition as the majority of paediatric diets supply adequate calcium. However, if a child has a renal condition or a history of poor nutrition this situation may have to be revised.

#### Gradual replenishment

If the gradual method is chosen, between 2000 and 5000 iu may be given daily, or 50 000 iu weekly by mouth. Such regimens need to be continued for two to three months. Efficacy may be checked by measuring alkaline phosphatase or vitamin D level. Those who have researched such regimens do not report hypercalcaemia or hypocalcaemia. The medication may be given as D2 (ergocalciferol) or D3 (cholecalciferol) as both are effective. However neither oral ergocalciferol nor cholecalciferol are licensed in the UK for use with children, so there may be occasions when for a short period of time a pharmacist cannot identify a supply of these medications.

#### Single day treatment

A single day of treatment may help avoid problems with compliance. This may be administered as four to six doses orally or a single intramuscular injection. For the oral route, 15 000 mcg (600 000 international units) of oral vitamin D (as ergocalciferol or cholecalciferol) may be given over one day as between four and six doses. If the vitamin D is administered in a single dose, an intramuscular injection of 15 000 mcg (600 000 iu) of vitamin D (as ergocalciferol or cholecalciferol) is available.

## Appendix 2

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### Preventing vitamin deficiency in pregnant women and young children<sup>15,21</sup>

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The NICE recommendation that 'Healthy Start' vitamin supplements (10 mcug of vitamin D and 400 mcug of folic acid) be given to women likely to become pregnant, to women who are pregnant or breastfeeding and to women with children less than four years old. Individuals from at-risk groups may need more vitamin D.

NICE recommend that Healthy Start vitamin drops (vitamins A, C and D) be given to all children from six months of age until their fourth birthday. Individuals from at-risk groups may require more vitamin D.