

PREVENTING VITAMIN D DEFICIENCY IN TODDLERS

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LEARNING POINTS

- 1 Vitamin D deficiency is avoidable by taking vitamin D supplements as recommended by Public Health England
- 2 Healthcare professionals should advise all families to take vitamin D supplements
- 3 Infants and toddlers are at greater risk of vitamin D deficiency if their mother was vitamin D deficient during pregnancy, through low exposure to sunlight or not taking vitamin D supplements
- 4 Vitamin D is essential for healthy bone growth through regulating the absorption of calcium and phosphorus from the diet – minerals that contribute to the structure and strength of bones during child development
- 5 Very low levels of vitamin D in infants and toddlers can lead to:
Rickets – soft or deformed bones and short stature
Fits – caused by low levels of calcium in the blood (hypocalcaemic seizures)
- 6 Vitamin D deficiency is also associated with SIDS and some infectious, allergic and autoimmune diseases such as diabetes and asthma
- 7 Vitamin D is synthesised in the skin (cutaneous synthesis) under the influence of sunlight, in the summer months in the UK (April to September). Less vitamin D synthesis occurs in the north of the UK than in the south
- 8 Sunscreen blocks the cutaneous synthesis of vitamin D but should be used to prevent burning
- 9 Food sources of vitamin D are few and oily fish is the only significant source
- 10 Children with pigmented skins, especially those of Asian, African and Middle Eastern origin, are at greater risk of vitamin D deficiency than white children

PREVENTING VITAMIN D DEFICIENCY IN TODDLERS

Vitamin D deficiency in toddlers and infants is preventable, but in the absence of clear policy and appropriate advice from health professionals it has re-emerged in the UK, particularly in young children with pigmented skins in inner city areas. Cases of rickets and hypocalcaemic seizures in infants and toddlers, caused by vitamin D deficiency, have increased.¹ Vitamin D deficiency during pregnancy is the main cause of the deficiency in infants and toddlers.^{2,3} Some pregnant women are unaware that they should take a vitamin D supplement for their health and that of their baby.^{2,3} Public Health England now recommend a supplement for all toddlers and all infants from birth.

WHAT IS VITAMIN D?

Vitamin D is sometimes called the 'sunshine vitamin'. It is found in a few foods, but the main source is from synthesis in the skin by the action of sunlight (cutaneous synthesis). Ultraviolet rays of wave length 290-315nm convert 7-dehydrocholesterol in the skin to previtamin D3.

The two main forms of vitamin D are:

- vitamin D3 (cholecalciferol) produced by cutaneous synthesis and provided by a few foods and some vitamin supplements
- vitamin D2 (ergocalciferol) provided by some supplements and found in very small amounts in some mushrooms

Both forms of vitamin D are metabolized in the liver to 25-hydroxyvitamin D which is a stable metabolite, that is then converted in the kidneys to 1,25-di-hydroxyvitamin D, the active form of the vitamin.

Vitamin D is a fat-soluble vitamin and is stored in the body (in adipose tissue or fat deposits) when cutaneous synthesis and dietary intakes exceed daily requirements. Stores are used during the winter months when the critical wavelength in sunlight is insufficient for cutaneous synthesis.



FUNCTIONS

Vitamin D controls the absorption of calcium and phosphorus in the intestine. These essential minerals, along with other nutrients, are components of the structure of bones and teeth. Calcium and phosphorus are therefore vital for the healthy growth of the skeleton during childhood.

Vitamin D also regulates the deposition and reabsorption of calcium, in and out of bony tissues, to maintain blood calcium levels within a normal range. It also plays a part in immune function, growth and defence against infections.^{4,5}

Blood serum or plasma are used to measure vitamin D levels. There is debate about the lower cut off for vitamin D sufficiency, which ranges between 25 and 75 nmol/l of 25-hydroxyvitamin D.^{4,6} The American Academy of Paediatrics (AAP), the Institute of Medicine (IOM) and the European Society of Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) suggest 50 nmol/L as the cut off for deficiency.^{6,7}

Unit conversion factors for concentrations of vitamin D in blood, food and supplements

Concentration in blood levels:
2.5nmol/l = 1ng/litre

Amounts in food and supplements:
1µg vitamin D = 40 International Units (IU)
[µg = mcg = microgram]

VITAMIN D DEFICIENCY

Clinical manifestations of extremely low levels of vitamin D in infants and toddlers are:

- Rickets – soft, poorly formed and misshapen bones seen in growing children – and osteomalacia in adults
- Fits (hypocalcaemic seizures) in infants due to low blood calcium levels as a result of vitamin D deficiency

There are also reported associations between low vitamin D levels and the development of certain diseases including type 1 and 2 diabetes, allergy, upper respiratory tract infections and asthma, infectious diseases, multiple sclerosis, rheumatoid arthritis, cardiovascular disease, some cancers and mental health.^{4,6,8}

Low levels of vitamin D during pregnancy is associated with a higher risk of severe pre-eclampsia^{9,10} and infants born with low birth weight (LBW) and small for gestational age (SGA).¹¹ Evidence is emerging of a link between sudden infant death syndrome (SIDS) and low vitamin D levels.¹²



An X-ray of the legs of a young child with rickets caused by vitamin D deficiency.

DIETARY REQUIREMENTS FOR VITAMIN D

In 2016 the Scientific Advisory Committee on Nutrition (SACN) set new recommended dietary intakes. They set a Reference Nutrient Intake (RNI) of 10µg vitamin D per day for all age groups from 4 years and a safe intake of 8.5-10µg for infants and 10µg/day for children 1-4 years.¹³ These recommendations are set to guarantee sufficiency in those whose needs may not be met by sunlight alone.

Other countries set different dietary recommendations of vitamin D e.g. between 5-10µg/day for children in most European Countries and 15µg vitamin D for all children in the USA.

Dietary sufficiency is considered vital for:

- infants, toddlers and adolescents to support their rapid rates of bone growth
- pregnant women to ensure adequate levels of vitamin D for the fetus to grow and develop and to lay down stores of vitamin D for the first few months of life
- breastfeeding mothers to support the bone remineralisation that occurs after breastfeeding ceases
- the elderly to maintain bone and muscle strength

Dietary Vitamin D recommendations in the UK

Age group	Daily Recommended Intake from Food and Supplements		
		Micrograms (µg)	International Units (IU)
0-12 months	Safe Intake	8.5-10	340-400
1-4 years	Safe Intake	10	400
Over 4 years	RNI	10	400

SOURCES OF VITAMIN D

The principal source of vitamin D is cutaneous synthesis - which occurs when the skin is exposed to sunlight. Few foods contain vitamin D.

1. Sunlight

The ideal time to spend outside each day to ensure adequate vitamin D levels is not easy to define as cutaneous synthesis varies between individuals and depends on:

- **Season** – The critical wavelength in sunlight for cutaneous vitamin D synthesis reaches the UK only between April and September; it is absorbed by the atmosphere during winter months
- **Latitude** – In the south of the UK there is more sunlight of the critical wavelength
- **Weather** – Less vitamin D is synthesised on cloudy days than on bright sunny days
- **Air Pollution** – It reduces the critical UV light waves available for skin synthesis
- **Time Spent Outside** – Light with this wavelength cannot pass through glass so children must be outside for cutaneous vitamin D synthesis to occur
- **Time of Day** – More vitamin D is synthesised when sunlight is most intense in the middle of the day compared to early morning and late afternoon
- **Colour of Skin** – Darker skins require more time in the sun to synthesise the same amount of vitamin D as light skins.¹⁶ Toddlers of African, African-Caribbean and South Asian origin are more likely to have lower vitamin D levels than Caucasian children^{1,14-15}
- **Lifestyle** – Vitamin D synthesis is greatly diminished when most skin is covered by clothes, as can be the fashion, or is the case in girls and women with certain religious and cultural traditions
- **Sunscreen Use** – It blocks cutaneous synthesis of vitamin D but should be used to prevent the skin burning¹⁷

Vitamin D excess as a result of excessive sunshine exposure does not occur.

2. Foods

Very few foods naturally contain vitamin D. Oily fish is the only significant source. Eggs and meat provide very small amounts. Breast milk provides extremely small amounts.



Oily fish (salmon). Portion appropriate for 1–4 year olds.
See Factsheet 1.3

3. Fortified foods

Foods in the UK that are fortified with vitamin D include:

- margarine – fortification has been a legal requirement since the Second World War
- formula milks – infant formulas, follow-on formulas and growing up milks
- evaporated milk
- a few breakfast cereals
- some brands of yogurts

Vitamin D content in UK foods^{16,18}

Portion sizes for toddlers	Vitamin D	
	Micrograms (µg)	International Units (IU)
2–3 Tbsp Sardines canned in tomato sauce (45g)	3.6	144
2–3 Tbsp Grilled salmon (45g)	3.2	128
2–3 Tbsp Sardines canned in vegetable oil (45g)	2.25	90
2–3 Tbsp Canned tuna in oil (45g)	1.35	54
1 Egg (60g)	1.1	44
2–3 Small thin slices liver (20g)	0.22	9
1/2–1 Slice cooked lamb (30g)	0.18	7
1–2 Small slices chicken (30g)	0.06	9

Fortified foods	Vitamin D	
	Micrograms (µg)	International Units (IU)
100mls Infant Formula – varies between brands	0.8–1.2	32–48
100mls Follow-on formula – varies between brands	1.2–1.5	48–60
100mls Infant or Follow-on Formula from 2020	1.3–1.95	52–78
100 mls Formula Milk for over one year	1.3–3.1	52–124
30mls Evaporated milk	1.2	48
3-6 Heaped tbsp fortified breakfast cereal (18g)	0.7	28
1 Tsp margarine (5g)	0.4	16

In some countries e.g. Finland, Canada and the USA a wider range of foods are fortified with vitamin D, such as fresh cow's milk, other dairy products and some fruit juices.

4. Supplements of vitamin D

In the UK a balanced diet and sunlight will not necessarily provide vulnerable populations with sufficient amounts of vitamin D to prevent deficiency. For this reason, PHE have made the following recommendations:

Mothers and children in the UK¹⁹

Fortified foods	Recommended daily supplement	
	Micrograms (µg)	International Units (IU)
Pregnant and breastfeeding women	10	400
Breastfed infants from birth	8.5–10	340–400
Formula-fed infants who are drinking less than 500mls formula milk/day	8.5–10	340–400
Formula-fed infants who are drinking more than 500mls formula milk/day	No supplement required as formula milk is fortified with vitamin D	
Children one to four years	10	400

Children five years and over and other adults¹⁹

	Recommended daily supplement	
	Micrograms (µg)	International Units (IU)
Those whose skin has little or no exposure to the sun, like those in institutions such as care homes, or who always cover their skin when outside	10	400
Ethnic minority groups with dark skin, from African, Afro-Caribbean and South Asian backgrounds	10	400
Others in autumn and winter	10	400
Others in spring and summer	–	–

Most vitamin supplements for infants, children and pregnant and breastfeeding women sold in the UK include vitamin D along with other vitamins, but the vitamin D content varies. Supplements containing vitamin D alone are widely available over the counter in some shops and chemists. Healthcare professionals should only recommend those brands with good quality control i.e. those brands sold in pharmacies.

Healthy Start vitamins are available free for pregnant and breastfeeding women and infants and children aged one to four years who are beneficiaries of the Healthy Start Scheme.



NICE recommendations²⁰ for commissioners and managers responsible for public health are to:

- **increase access to vitamin D supplements** including those provided as part of the Healthy Start supplements scheme
- **increase local availability of vitamin D supplements for at-risk groups**
- **ensure health professionals recommend vitamin D supplements**
- **raise awareness of the importance of vitamin D supplements among the local population**
- **ensure a consistent multiagency approach**
- **monitor and evaluate the provision and uptake of vitamin D supplements**

5. Safe upper limits of supplementation

The European tolerable upper intake level of vitamin D for infants is 25µg (1000IU)/day, 50µg (2000IU)/day for children one-10 years and 100µg (4000IU)/day for children 11-17 years and adults.²¹ The Institute of Medicine in the USA considers it to be 50µg (2000IU)/day for infants and 100µg (4000IU)/day for toddlers and older children.²² Excess vitamin D taken as supplements could have detrimental effects on health. Therefore, parents must be advised to give their toddlers only one supplement containing vitamin D, at the recommended dose.

HOW DO CRITICALLY LOW LEVELS OF VITAMIN D OCCUR IN INFANTS AND TODDLERS?

Low vitamin D levels in women of child bearing age may be a risk factor accounting for the rising incidence of vitamin D deficiency in infants and toddlers. A national survey of adults showed that 25 per cent of women of child bearing age have low vitamin D levels.²³ It varies over seasons from 10 per cent in late summer to 40 per cent in winter. The risk of low levels is highest in women with dark pigmented skins; a survey from Wales has reported that about 50 per cent of pregnant women with pigmented skins have low vitamin D levels.²⁴

Infants whose mothers had low vitamin D levels during pregnancy and who did not take the recommended vitamin D supplement during pregnancy, are likely to be born with low levels of vitamin D and deficient stores.^{3,25} Exclusively breastfed infants rely on their stores of vitamin D acquired in the womb and on any cutaneous synthesis after birth, because the vitamin D content of breastmilk is very low. It is lower still in the milks of mothers who are vitamin D deficient.²⁶

Infant formula is fortified with vitamin D (see 'Vitamin D content in UK foods' table on page 4) but this concentration may not be adequate for infants born very early or with very low stores.^{27,28}

When body stores are low and cutaneous synthesis and dietary sources of vitamin D are limited, vitamin D deficiency is likely to develop in those children with high requirements, such as rapidly growing infants and toddlers.

ADVICE ON THE USE OF SUNSCREEN

Concern over the balance between having sufficient sun exposure to produce vitamin D, and over-exposure leading to burning of the skin and an increased risk of skin cancer, has led to confusion of public health messages. To provide balanced, evidence-based advice, a consensus statement on vitamin D has been produced by several organisations concerned with these questions.

Consensus Vitamin D Position Statement²⁹

This represents the unified views of the British Association of Dermatologists, Cancer Research UK, Diabetes UK, the Multiple Sclerosis Society, the National Heart Forum, the National Osteoporosis Society and the Primary Care Dermatology Society.

Vitamin D is essential for good bone health and for most people sunlight is the most important source of vitamin D. The time required to make sufficient vitamin D varies according to a number of environmental, physical and personal factors, but is typically short and less than the amount of time needed for skin to redden and burn. Enjoying the sun safely, while taking care not to burn, can help to provide the benefits of vitamin D without unduly raising the risk of skin cancer. Vitamin D supplements and specific foods can help to maintain sufficient levels of vitamin D, particularly in people at risk of deficiency. However, there is still a lot of uncertainty around what levels qualify as “optimal” or “sufficient”, how much sunlight different people need to achieve a given level of vitamin D, whether vitamin D protects against chronic diseases such as cancer, heart disease and diabetes, and the benefits and risks of widespread supplementation.

NICE guidance¹⁷ is:

- children under 6 months of age should be kept out of direct strong sunlight
- between March and October in the UK, children and young people need their skin protecting. They should cover up with suitable clothing, be encouraged to spend time in the shade (particularly between 11am and 3pm) and wear sunscreen
- the parents and carers of children younger than five should be given advice on vitamin D supplements



ROLE FOR HEALTH PROFESSIONALS IN PREVENTING VITAMIN D DEFICIENCY

Timely advice by health professionals to families is critical to preventing vitamin D deficiency and its health consequences.

ADVICE ON VITAMIN D SUPPLEMENTS FOR MOTHERS, INFANTS AND TODDLERS

Health professionals should recommend a daily supplement containing:

- 10µg (400IU) vitamin D for all mothers including those who are pregnant or breastfeeding
- 8.5–10µg (340–400IU) for all infants from birth except those drinking more than about 800 mls formula milk each day. This varies from the PHE recommendation of '500mLs formula milk' because the vitamin D content of formula milks varies from brand to brand and 500mLs formula does not provide the safe intake of 8.5–10µg (340–400IU)
- 10µg (400IU) vitamin D for all toddlers

TARGETING ADVICE TO VULNERABLE GROUPS

All families should receive advice about vitamin D, but the populations most at risk of deficiency are:

- families with darker skins, of African, African-Caribbean and South Asian origin
- infants and toddlers whose mothers:
 - cover up for religious or cultural reasons thereby limiting cutaneous vitamin D synthesis
 - did not take vitamin D supplements during pregnancy and/or while breastfeeding
 - lead mainly indoor lifestyles
- families living in the northern parts of the UK
- toddlers who do not have the opportunity to play outside regularly without sunscreen

ADVICE ON OUTDOOR PLAY AND SUNSCREEN USE

Concern about too much sun exposure has resulted in many families with young children using very high factor sun creams throughout the summer months to protect the skin.

It is preferable for parents and carers to get to know how much sun exposure their children's skin can take without sunscreen before signs of redness appear. For very fair skins this may be a short time in the middle of the day and longer in the morning and late afternoon. Children with pigmented skins are much less likely to burn and these toddlers may not need sunscreen at all in the UK climate.

Children with darker pigmented skins are more likely to have lower levels of vitamin D and will benefit from more time outside in the sunlight without sunscreen to make sure they are synthesizing adequate amounts of vitamin D.



DIETARY ADVICE

Including oily fish in meals once or twice each week will increase dietary intake of vitamin D. Oily fish include sardines, pilchards, mackerel, herrings, salmon, trout and fresh tuna. Department of Health advice is to limit oily fish intake to four times per week for boys and twice per week for girls. This is because some oily fish may contain small amounts of toxins that girls can retain into their childbearing years.

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Resources

Healthy Start scheme website (<http://www.healthystart.nhs.uk>)

PREVENTING VITAMIN D DEFICIENCY IN TODDLERS GUIDANCE & TIPS FOR PARENTS



Foods

- Vitamin D is found in only a few foods: oily fish is the best source and eggs and meat contain small amounts.
- Some foods are fortified with vitamin D – formula milks, margarine and some yogurts and breakfast cereals.

Sunlight

- Most of your toddler's vitamin D is made in his/her skin when outside in the sunlight in the summer months (April-September).
- Sunscreen will stop your toddler making vitamin D in his/her skin so allow your toddler to play outside without sunscreen at times when he/she is unlikely to burn.
- The amount of time toddlers can spend outside in the sunshine without burning will vary depending on their skin type.

Vitamin D Deficiency

- Babies, toddlers and mothers with dark skins living in the UK are the most likely to become deficient in vitamin D if they do not take a daily supplement of vitamin D.
- Mothers who cover most of their skin when outside are most at risk of vitamin D deficiency.
- Babies and toddlers with very low amounts of vitamin D could have fits or get rickets – a disease when bones become soft and misshapen.

- Low vitamin D levels may make toddlers more likely to get diabetes and diseases later in life such as heart disease, multiple sclerosis and arthritis.

Supplements of Vitamin D

- Your toddler is not guaranteed to get enough vitamin D from foods and sunshine alone, so give him/her a vitamin supplement containing 10µg vitamin D every day.
- The Healthy Start children's vitamin drops contain vitamins A, C and D.
- Pregnant and breastfeeding mothers should take a daily supplement of 10µg (400IU) vitamin D every day. This is to make sure your baby grows and develops in your womb and is born with sufficient stores of vitamin D to make use of in the first few months of life.

Healthy Start Vitamin Vouchers

- If you are receiving Healthy Start vouchers then you will also get Healthy Start vitamin vouchers every eight weeks to exchange for free Healthy Start vitamin drops for your infant or toddler. Ask your health visitor where to get them.
- Pregnant and breastfeeding women signed up for Healthy Start also get vitamin vouchers to exchange for free Healthy Start tablets with vitamin D.



Practical advice for healthy eating habits
from pregnancy to preschool





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