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How Sunlight Can Save Your Life

Part 1

By Oliver Gillie

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It's the great cancer cover-up. Panicked into avoiding sunlight by health experts, we are now dying in our thousands from diseases linked to deficiencies of vitamin D. But still the exaggerated warnings come. Oliver Gillie reveals how sunbathing can save your life...

How many times have you heard it: "There's no such thing as a healthy tan." Second only to "smoking kills", avoiding the sun is the health advice that has most permeated our consciousness. Young and old, rich and poor, everyone knows that exposure to the sun puts us at risk of skin cancer. But does it? What if the advice we've been given to avoid the sun is wrong? What if hiding your skin from those seductive rays is putting your health in danger?

While every summer cancer charities and skin experts launch their annual campaign to persuade people, against their natural inclination, to cover up and stay out of the sun, there is growing evidence that lack of exposure to sunlight is responsible for a multitude of disease from multiple sclerosis and diabetes to several types of cancer and schizophrenia. And it's all down to a deficiency of vitamin D - some 90 per cent of which we get from sunlight.

Most medical researchers have been slow in recognising the potentially lethal consequences of vitamin D deficiency. In part this is because vitamin D is not the only trigger for these diseases. However in the British Isles with our long winters and cloudy summers, it seems that insufficient exposure to the sun can make the difference between illness and health, between life and death.

Dr Peter Selby, lecturer in medicine at Manchester Royal Infirmary, says: "Reducing exposure to solar radiation, far from preventing cancer, may have the opposite effect." He points out that a 10 per cent decrease in exposure to sunlight would not greatly reduce skin cancer but could lead to a 6 per cent increase in certain other cancers. And these extra cancer deaths, he points out, would exceed all the deaths from skin cancer put together.

In the UK about 14,000 women a year die of breast cancer - some 40 per cent of these may be caused by deficiency of vitamin D, estimates William Grant, a NASA scientist who has become an expert in vitamin D epidemiology. He calculates that 12-15% of all cancers in the UK, apart from lung cancer, are linked to vitamin D deficiency. That adds up to some 20,000 cancer deaths a year in the UK resulting from too little exposure to the sun, compared with only 2,000 deaths per year from skin cancer of all kinds - not all of which are caused by too much sun. Melanoma, the commonest skin cancer (1,600 deaths per year) may also be caused by diet, overweight and lack of exercise.

Multiple sclerosis is almost unknown in Europeans who are born in South Africa and so in the old days, when doctors worried about the rigours of weather, people with MS were often advised to move to a sunnier climate. Many studies have since shown that MS is more common in cold northern latitudes than it is in sunnier places. In a pioneering study in the 1960s, Professor Sir Donald Acheson, now Dean of Southampton Medical School, found that MS in US war veterans was most closely related to the amount of December sunlight in their place of birth. Winter sunshine, which we now know can make a crucial difference to vitamin D stores, was implicated.

But Acheson's ideas fell on stoney ground. "Sunshine? More like moonshine, what absolute poppycock," one senior colleague remarked in a public put down. It was an idea before its time and the work remained a curiosity, largely forgotten until now.

Over the next 40 years several quite different diseases were found to be linked geographically with MS. Deaths from cancer of the colon and cancer of the prostate were found to be most frequent in the same countries where deaths from MS are most often seen. These were the least sunny northern countries of Europe and the least sunny northern states of the US. Dental decay and rickets were also found to be most common in these areas. And strangest of all, schizophrenia, an extremely disabling mental illness, was found to be more common in the colder northern states of America and in colder northern districts of Italy. While Parkinson's disease, another nervous disorder (causing primarily tremor and stiffness), had a similar geographical distribution.

Theories abounded. Sunlight was too obvious an answer for many researchers. Nor did anyone dare suggest that such different nervous diseases as schizophrenia, Parkinson's disease and MS might all have the same ultimate cause. Perhaps, they proposed, the diseases were caused by viruses? People in the north eat more fat, perhaps that was causing these diseases? Maybe it was all a matter of heredity. The research was like a giant jigsaw puzzle with thousands of pieces. But many important pieces were missing, and thousands of pieces from other jigsaws were muddled up in the same box. Nevertheless, piece by piece connections were made and the jigsaw began to fit together.

According to one school of thought, MS is a hereditary disease of northerners, possibly borne round the world by Vikings. Researchers rushed to find the MS gene. But now Australians, who over the years have received the most dire warnings to keep out of the sun, have found that MS is six times less common in tropical Queensland than it is in

Tasmania which has much less sun, particularly in winter. Genetics could not explain the difference: the people of Tasmania and Queensland have the same Anglo-Irish and European ancestors. Children in Tasmania who did not develop MS were more likely to have spent two to three hours a day playing outdoors in summer during weekends and holidays. Maybe these diseases can be prevented by playing in the sun. Fun in the sun, could the answer be so simple?

Then came a breakthrough. MS is caused by patches of damage in parts of the brain and spinal cord leading to severe disability and eventually paralysis. The symptoms come and go. People with MS may improve for a while and then relapse for no apparent reason, until now. Brain scans of people with MS investigated by a team of scientists in Germany have shown that the number of MS lesions increase during winter when the amount of vitamin D in the body declines.

And other pieces of the jigsaw were falling into place. In 1992 Gary Schwartz, a researcher at the University of Pittsburg, suggested that the common factor linking MS and prostate cancer could be vitamin D. Schwartz showed that consumption of cod liver oil (a good source of vitamin D) in youth reduces the risk of prostate cancer in old age. Finally evidence linking prostate cancer directly with sunlight came two years ago from Professor Richard Strange and colleagues at Keele University. They found that men in North Staffordshire with prostate cancer had had substantially less exposure to the sun than men who did not have prostate cancer. On average, men who had least exposure to the sun developed prostate cancer four years earlier than men who had more exposure. Regular foreign holidays and sunbathing were found to protect against the disease.

Northern Europe is not man's natural environment. Recent studies of human DNA tell us that man evolved in Africa. Small bands of people left the African continent some 80,000 years ago following the southern coast of Asia, and eventually colonising what is now Iraq and Iran. These people, who were almost certainly dark skinned, moved into Europe via Turkey, the Black Sea and the Mediterranean as the northern ice cap retreated some 50,000 years ago. The story of this epic human journey has been reconstructed from modern DNA studies and is told by Oxford professor Stephen Oppenheimer in his authoritative book "Out of Eden".

The virgin territory of Europe must have supplied plentiful food in summer but in winter not only was food in short supply, low levels of vitamin D must have increased the susceptibility of these pioneering bands of people to disease and reduced their fertility. Dark skin takes six to 10 times as long as white skin to make a given quantity of vitamin D and so those with lighter skins would have had an advantage as the pioneers moved north.

The importance of skin colour for human survival outside the Tropics has been shown by Dr Nina Jablonski of the California Academy of Sciences in San Fransisco and George Chaplin of Manchester Metropolitan University. They found that skin colour of 180 different indigenous peoples is linked closely to the amount of autumn and winter

sunlight where they live. Not only do native peoples everywhere have paler skins the further they live from the equator, but women and children in the human groups studied by Dr Jablonski always had paler skins than men, a neat adaptation to provide the maximum vitamin D that is needed for fertility in women and growth in children.

Northern Europe was the end of the line for the successive waves of people travelling through Turkey and the Balkans after the ice age. It was further north than man had ever lived before and the cloudy maritime climate of the British Isles and other countries bordering the North Sea have reduced sunlight even in summer. And so Europeans evolved a pale skin that enables the first weak rays of spring sun to be used to make vitamin D. This enables body stores of the vitamin depleted during winter to be replaced at the earliest opportunity, while tanning provides some protection as sunlight becomes stronger over the summer. For thousands of years into historic times, Europeans living an outdoor life in the countryside do not seem to have suffered from obvious vitamin D deficiency.

But in the past 400 years, when large numbers of people began to congregate in towns and cities a severe problem of vitamin D deficiency developed. In 1650, treatises were written on rickets, the bone deforming disease of children that became known as the English disease. The disease was most common in cities, where narrow streets and air pollution prevented the penetration of the sun. Children developed deformities of the legs which made it difficult for them to walk and women suffering from the disease had flat deformed pelvises which caused difficulty in childbirth.

The link between rickets and lack of sunlight was not made until 1822 when a Polish doctor noted that children living in Warsaw frequently suffered from the disease while children living in the surrounding countryside did not. He recommended fresh air and sunlight. In 1889 the British Medical Association reported that rickets, common in cities, was unknown in rural areas. A year later another British doctor reported in the Practitioner that rickets did not occur among the poor living in the city slums of China and India and concluded that exposure to sunlight would prevent the disease. It would be another 30 years before these ideas began to be accepted.

The demonstration in 1919 that ultra-violet light from a mercury arc lamp could cure rickets in children provided dramatic scientific "proof" that rickets was caused by lack of sunlight. At about the same time it was shown that cod liver oil (which is now known to be rich in vitamin D) could cure rickets in dogs raised exclusively indoors. It took a few more years for scientists to chemically identify vitamin D and show that it was responsible for the ability of cod liver oil to cure rickets. By the 1930s vitamin D was being added to foods such as margarine and rickets became relatively rare.

The discovery of vitamin D was an early triumph of modern science which caught the public imagination and fed the craze for city people to seek health in the open air. Cycling, rambling and youth hostelling all became immensely popular between the two world wars - a movement which reached a summit of sorts with the invention of the bikini by a French engineer in 1946. The full delight of sun on naked skin was re-

discovered and forty years of carefree sunbathing followed before the spectre of skin cancer cast its pall over summer fun.

Nicolai Gogol's short story Dairy of a Madman (1834) is one of the earliest and most complete descriptions of schizophrenia. Brief accounts of the disease had appeared in Paris and London in 1809 but, with the possible exception of the character Poor Tom in Shakespeare's King Lear, earlier descriptions of schizophrenia do not seem to exist. Schizophrenia appears to have been virtually unknown before 1800 while most other psychiatric and nervous diseases such as epilepsy are described in the Old Testament or other early historical works.

These literary observations made by Dr Eric Altschuler of the Brain and Perception Laboratory at the University of California provide historical support for a theory that schizophrenia may be caused by a deficiency of vitamin D during pregnancy. Schizophrenia, it seems, emerged as a new disease with the great expansion of modern European cities, at much the same time as rickets began its most devastating phase.

For many years geneticists claimed that schizophrenia was an inherited disease and poured scorn on other ideas. But they were at a loss to explain why people with schizophrenia had winter birthdays more often than would be expected. Extra vitamin D is required in the last three months of pregnancy to support the rapid growth of the baby. When the level of the vitamin is low, as occurs most frequently in winter, there may not be enough to provide for normal development of the brain or other organs causing more winter births of people with schizophrenia.

The nervous system of the developing baby may be damaged in other ways by vitamin D deficiency. Other diseases which occur more frequently than would be expected in babies born in winter or early spring are autism, Alzheimer's disease, Parkinson's disease, and MS. The cause of these diseases is still being hotly debated by experts but vitamin D deficiency is one theory that is gaining increasing support. Like schizophrenia, these diseases may appear to be more strongly inherited than they really are because family members influence each other in the way they seek or avoid the sun.

Schizophrenia is one of several diseases that has been found to be more common among dark-skinned people than among whites in Britain. Diabetes, multiple sclerosis, autism and rickets have also been reported to be more frequent among immigrant families who came to Britain from Tropical countries. First generation immigrants born in the Tropics are no more vulnerable to schizophrenia than native British whites, but the disease is more frequent among their children than among white British people, according to several research studies led by Professor Glynn Harrison at the University of Nottingham, Dr Dinesh Bhugra at the Institute of Psychiatry, London, and others.

Many explanations, including prejudice, psycho-social stress and inheritance have been considered, but they do not explain the facts. Investigators have repeatedly pointed to the consistency of their findings and concluded that an environmental factor must be responsible. Now in the light of other research it seems obvious that deficiency of vitamin D, caused by the slow absorption of ultra-violet light by black skin and low levels

of sunlight in northern climates, is the most likely explanation for the increased incidence of these diseases in immigrant families.

Not only are more people with schizophrenia born in winter, the number of people born each year who later develop the disease varies from year to year in a way that cannot be explained by chance. Investigations by Dr John McGrath and others at the University of Queensland have linked this variation in births of schizophrenic people with the amount of sunlight around the time of their birth. The observations fit in neatly with new findings that show the importance of vitamin D for growth of cells and for the development of the brain.

Dr McGrath, an Australian who is currently working at Harvard University, says: "Queensland, where I live, is in the Tropics so we get strong sun all the year round. I try to sit out in the sun every day and when I go to the beach with the children we have a half hour of exposure to the sun before we put on any suncream. Sunlight is specially important for pregnant and nursing mothers."

Babies in Finland often used to be given very large doses of vitamin D in the first year of life and now Dr McGrath, working with Finnish doctors, has shown that men who were given these large supplements as babies are less likely to develop schizophrenia than men who were not given the supplement. This same group of men given vitamin D as babies have been found to be less likely to develop diabetes before the age of 30. And in the UK people with this type of juvenile diabetes (known as diabetes type 1) are more likely to be born in the winter or early spring months when vitamin D is in short supply.

In juvenile diabetes the beta cells in the pancreas that normally produce insulin do not develop properly and are attacked by the body's own immune system. Deficiency of vitamin D is probably what causes these cells to develop abnormally, triggering the assault. Now a dramatic demonstration that vitamin D can rescue beta cells that are being attacked in this way is likely to sway scientific sceptics. Two independent trials conducted in Rome and Munich have shown that giving vitamin D to children when diabetes is first diagnosed can save the beta cells, at least temporarily, and delay development of the disease.

But these trials of the health benefits of vitamin D supplements are exceptional. Few trials have been made of vitamin D for treatment of diseases other than bone disease because the vitamin cannot be patented and drug companies cannot justify expensive trials which will not lead to profits. However trials of several compounds similar to vitamin D have begun recently for treatment of cancer because these compounds can be patented.

Crucial pieces of the jigsaw puzzle now seem to be in place and a consistent picture has emerged although many researchers remain sceptical, especially those who have spent most of their lives committed to other theories. The sceptics point to technical difficulties in the scientific evidence and the lack of final proof that vitamin D is the cause of most of these diseases. But the weight of so many different studies

demonstrating or suggesting the health benefits of sunbathing and vitamin D supplements can no longer be overlooked.

Yet every year doctors repeat the mantra: "There is no such thing as a healthy tan," words which are enshrined in a Consensus Statement of the UK Skin Cancer Prevention Working Party and endorsed by more than a dozen health charities as well as by UK government health departments. And every year doctors complain about the large number of people who ignore their advice by sunbathing and tanning.

The advice of the Skin Cancer Working Party has of course been given in good faith with the very best of intentions but it is based on a mistaken Consensus. It can no longer be defended. The stark truth is that advice to avoid the sun has put more lives at risk than it can possibly have saved and, it must be faced, is responsible for many thousands of deaths.

Dr Neil Walker, chairman of the UK Skin Cancer Prevention Working Party, says: "The phrase 'no such thing as a safe tan' is one way of getting the message across that sun damage can lead to the development of potentially fatal skin cancers. I think we need to look at this again. Personally I advise my patients not to bake and not to burn. I think telling people to avoid the sun entirely is draconian and unnecessary."

In fact, there is much scientific evidence showing that regular exposure to the sun does not necessarily carry any increased risk of skin cancer. Heavy occupational exposure to the sun such as is seen in farmers and construction workers is associated with a reduced risk of melanoma, the worst type of skin cancer. When care is taken not to burn, intermittent exposure to the sun probably carries relatively little risk of skin cancer, and provides a very great benefit from the vitamin D it gives.

This much has been clear since at least 1997 when Mark Elwood, a distinguished scientist at the University of Otago, New Zealand, published a review of 50 studies of melanoma and sun exposure in the International Journal of Cancer. The Consensus should have been redrafted then, but its momentum, financed by government and World Health Organisation funds, has proved to be unstoppable. Until recently, few skin cancer experts were prepared to recognise the probable role of vitamin D in preventing other cancers, there was little understanding of how important vitamin D is for prevention of other diseases, nor were skin experts prepared to concede that regular sunbathing or use of supplements is needed to provide adequate levels of vitamin D in our climate.

"It is safe to say that the cost of vitamin D deficiency is billions of dollars. How many billions is the issue," says Professor Robert Heaney of Creighton University, Omaha, Nebraska, who has made many studies of vitamin D and disease.

The cost of disease believed to be caused or exacerbated by vitamin D deficiency has been estimated by William Grant to be some 50 billions of dollars in the United States. The cost to the UK National Health Service of just one disease, diabetes type 1, which can probably be prevented by vitamin D supplements, runs to £500m a year or

about 1 per cent of the NHS budget. The total cost of D deficiency disease to the UK must certainly be calculated in billions of pounds.

"This is money that really could be saved if people generally took supplements of vitamin D or sunbathed regularly," says Professor Heaney.

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How Sunlight Can Save Your Life
Part 2
Diseases Caused By Vitamin D Deficiency
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Experts hotly debate which diseases may truly be caused by vitamin D deficiency. Nevertheless the extent of the evidence and its consistency makes a powerful case for D-deficiency being an important cause of over a dozen chronic diseases and almost as many cancers. Other important factors such as obesity, lack of exercise, or a diet containing too many calories, are also known to increase the risk of many of these diseases. But both obesity and lack of exercise are linked with D-deficiency and so the evidence is confused. Vitamin D, is stored in fat and becomes 'lost' in obese people, while people who take exercise often spend more time outdoors in the sun.

Nervous system diseases

Last year Professor John McGrath and others at the University of Queensland found that pregnant rats deprived of vitamin D give birth to baby rats with serious brain abnormalities. This work will eventually be seen to be as important as the discovery that folic acid deficiency during pregnancy causes severe spinal deformities (spina bifida) in offspring, or that thalidomide given to pregnant animals causes abnormalities of the limbs. The importance of their article published in *Neuroscience* (volume 118, pp641-653) has not yet been appreciated but it provides a means of understanding several neurological diseases which have puzzled doctors for more than a century.

Multiple sclerosis (MS), Schizophrenia, and Parkinson's disease - people with these diseases are more likely to have winter or spring birthdays. MS and Parkinson's diseases

are more common in northern countries or states of America. People with MS have worse symptoms in winter and brain scans show an increase in damage to the brain of MS people in winter. Supplements of vitamin D given to babies may prevent MS and schizophrenia. A very severe form of Parkinson's disease occurs in people with dark skin living in the UK.

Alzheimer's disease and Amyotrophic lateral sclerosis (motor neurone disease) are believed by some neurologists to be similar in the way they develop to Parkinson's disease but affecting different parts of the brain or nervous system. These diseases are several times more common in black people living in United States than in black people living in traditional societies in the Tropics. In northern countries there are more births of these two diseases in winter.

Autism - people with autism have winter birthdays more often than would be expected. The cause of the disease is a mystery, but increased winter birthdays could be an important clue suggesting that vitamin D deficiency in pregnancy is a cause, at least in a proportion of cases.

Autoimmune diseases

These are diseases in which the body is attacked by its own immune system. Such attacks are generally thought to be triggered by infection, but deficiency of vitamin D causing abnormal proliferation of cells and changes in the immune system may be a key factor. There are many of these diseases and some are quite rare. Only a few have been studied in depth.

Diabetes type 1 - a classic autoimmune disease. It is more common in northern countries and an increase in winter birthdays have been found in some places. Vitamin D supplements in pregnancy or first year of life protects against the disease and vitamin D may also delay progress of the disease after it has begun to cause problems.

Multiple sclerosis - another classic autoimmune disease - see details above.

Rheumatoid arthritis - people with this disease commonly have low levels of vitamin D in their blood. The more severe the disease the lower their vitamin D. Taking vitamin D has been found to reduce disease activity and relieve pain, as recently confirmed by results from the Iowa Women's Health Study.

Crohn's and other inflammatory bowel diseases - people with these diseases generally have low vitamin D. These diseases are more common in northern states of USA. Patients with these diseases often also have osteoporosis. Poor absorption of fat may make it difficult for people with these diseases to absorb vitamin D. Sunlight could be the best answer.

Heart and circulatory diseases

High blood pressure (hypertension) - a disturbance of calcium metabolism is often associated with high blood pressure. Vitamin D supplements and exposure to ultra-violet light have been found to reduce raised blood pressure.

Heart disease - low vitamin D levels in blood are associated with an increased risk of heart disease. Vitamin D may soon join the classic risk factors such as smoking and high fat diet. Risk of heart attacks and other symptoms is greatest in winter in the UK when vitamin D is lowest. Heart disease is low in alpine regions where high altitude provides greater exposure to ultra-violet light. Eskimos (Inuit) have less heart disease despite poor sunlight in the Arctic but they eat oily fish high in vitamin D every day.

Diabetes type 2 - low levels of vitamin D increase the risk of diabetes which is four or five times more frequent in Asian immigrants in the UK than in others. People who are overweight are at much increased risk of diabetes partly because they have low vitamin D.

Cancer

A number of cancers are more common in northern countries of Europe and/or in northern states of the USA. These include cancer of the breast, ovary, womb, prostate, bowel, bladder, stomach, kidney, non-Hodgkin's lymphoma, and Hodgkin's lymphoma. Additional studies strongly support D-deficiency being a cause of breast, bowel and ovary cancer. In the UK some 20,000 people a year are estimated to die of cancer caused by vitamin D deficiency. Vitamin D seems to prevent cancer by preventing proliferation of cells and causing malignant cells to self-destruct.

Interesting fact: A study of 8596 women in the US found that those who had frequent exposure to the sun, either during work or recreation, had two thirds the risk of breast cancer compared with women who never exposed themselves to the sun. In Hawaii, the sunniest US state, only 9% of white women who get breast cancer die in the subsequent five years as compared with 16% dying within five years in other states.

Bone diseases

These are the diseases that every medical student knows are connected with vitamin D deficiency.

Rickets - once thought to be conquered, is now re-appearing. Immigrant groups are particularly vulnerable, but so are children of mothers who breast feed for long periods because breast milk is generally deficient in vitamin D whereas bottle milk is supplemented. Sun avoidance through fear of skin cancer has also been blamed by Professor Nick Bishop of Sheffield University. Children with rickets have been found to be three times more likely than others to develop diabetes type 1.

Osteoporosis, osteomalacia - vitamin D deficiency has long been accepted as a classic risk factor for these diseases. A trial has recently shown that a very large vitamin D supplement (100,000 international units) given every four months will protect old people against fractures. Osteoarthritis has also been linked to D deficiency. Dental decay - Tooth decay is more severe in northern countries and in northern parts of the UK. Vitamin D reduces tooth decay in mice and rats. Vitamin D and calcium in pregnancy and early years when teeth are formed may be just as important as fluoride, tooth brushing and avoidance of too many sweet items, but somehow it has been forgotten.

Pain - nonspecific pain in muscles and skeleton, rheumatism, and low back pain, which are all very common in old people, may be the result of low vitamin D according to Gregory Plotnikoff of Minnesota Medical School (see Mayo Clinic Proceedings 2003;78:1463-1470).

Other diseases

Psoriasis - an unpleasant disease of the skin which is now treated with creams containing vitamin D or related substances and by exposure to sunlight or sunbeds.

Polycystic ovary disease - about one in five women of child bearing age suffer from this condition which causes abnormal periods, unwanted body hair and infertility. Seven of 14 women treated with vitamin D and calcium by Dr Susan Thys-Jacobs at St Lukes-Roosevelt Hospital recovered normal periods and two became pregnant. Dr Thys-Jacobs has also found that women with pre-menstrual syndrome including migraines are deficient in vitamin D and may respond to supplements plus calcium.

Infections - vitamin D enhances the activity of the immune system. Some evidence suggests that vitamin D protects against respiratory infections including pneumonia and tuberculosis. Could possibly protect against winter flu as well.

Safe sun bathing

Expose yourself to strong direct sun everyday when possible for at least 10 minutes provided you do not feel any unpleasant burning or baking sensation. The power of the sun varies greatly with the time of day, the time of year and the cloud cover. And so in cloudy weather or at off peak times a longer time, half an hour or even an hour or more, should be spent in the sun (in a bathing suit when possible) for optimum vitamin D synthesis in the skin. Avoiding the sun completely by covering up with clothes, covering up with suncream or always seeking the shade will cause vitamin D deficiency and risks serious disease.

The sun is strongest for two hours around solar midday (1pm in summer). People who have seldom or never sunbathed before should begin cautiously with just a few minutes exposure. Regular exposure will naturally lead to a tan which should not be a cause for any worry. A tan reduces the amount of sunlight penetrating the skin by about half and so a person who is tanned will be able to stay out safely in the sun for longer. People

with a dark skin will need to stay in the sun for longer anyway - up to an hour or even more in full sun to get an optimum amount of vitamin D. But a dark or black skin can burn if it has not been regularly exposed to the sun in the past so care must be taken at first.

A person with a white skin will have made the maximum amount of vitamin D that can be made in one day after about 20 minutes in full sun. (This may take up to two hours or more for a person with a dark or black skin.) So after 20 minutes (or longer for darker skin) it is advisable to cover up, seek shade or use a high factor suncream - cover up earlier of course if the skin begins to get at all red or uncomfortable.

Pregnant women should sunbathe in this way at least three times a week if they can, but in the British climate it is only for a few weeks each year that there is clear sunshine enabling people to sunbathe at their convenience - so it is advisable to take a supplement too (see below). Babies can be safely taken into weak sunlight (avoiding 11am to 3pm) in only their nappies (no suncream) for between 5-10 minutes a day, according to Professor Nick Bishop of Sheffield University. A total of 30 mins per week may be sufficient to give them adequate vitamin D. If the child is taken into the sun fully clothed without a hat or gloves then two hours per week is needed to obtain adequate vitamin D. A baby with dark skin will need longer in the sun.

Experts disagree about older children. Some suggest allowing children to run around freely in weak sunlight but put on suncream, full clothes and hat from 11 am, taking care to avoid full sun during the four hours round midday. Others believe that for optimum health children should be fully exposed in a swimsuit to full midsummer sunlight for some 15 - 30 minutes a day without any suncream, so long as they do not burn.

How to prevent vitamin D deficiency year round

Sunlight is too weak in the UK to provide any useful vitamin D between about October and the end of March, and summer stores of the vitamin are used up quickly, dwindling by half within about six weeks. We obtain small amounts of vitamin D from margarine, butter, eggs, liver, a few breakfast cereals and from oily fish. But most people do not eat oily fish and many do not eat much of the other items either. So about 90% of our vitamin D comes from the sun unless we take a supplement. A vitamin D supplement is advisable year round for most people in the UK except regular sunbathers who should still take a winter supplement.

Existing recommendations on vitamin D supplements are based on guesswork and what can now be seen as faulty science. They are totally outdated. Natural exposure to sunlight produces in excess of 20,000 international units (iu) of vitamin D in the body in one day and supplements of 10,000iu per day have been taken for five months without any problems. Several experts in the United States agree that a supplement of 2,000iu per day is needed to maintain summer levels of vitamin D through the winter.

Pregnant and nursing mothers: Substantial supplementation of pregnant and nursing mothers is needed in the UK climate for optimum health of babies. But how much

vitamin D they should take is a matter of debate. Dr Bruce Hollis and Dr Carol Wagner of the Department of Pediatrics at Medical University of South Carolina, Charleston, which is on the same latitude as North Africa, believe that pregnant or breast-feeding women should take at least 2000iu per day and they recommend 4,000iu for breast-feeding mothers. They say this is the minimum needed to provide adequate amounts of vitamin D in mothers' milk. However Professor Nick Bishop suggests following the more cautious official British recommendation of 400 units a day for ethnic minority women and says he is not sure whether women with white skins need take a supplement. Cod liver oil is not suitable for pregnant women in larger than recommended doses because of its high vitamin A content.

Children: Babies aged 0-6 months are advised by UK government guidelines to take 340 iu of vitamin D per day as NHS vitamin drops. This is particularly important if the mother is breast feeding because bottled milk is supplemented with vitamin D while breast milk is generally deficient especially in winter. UK government guidelines suggest 280iu/day for infants aged 6 months to three years. Less than is recommended for babies which is not logical. Dr Hollis recommends 4-500iu per day for children up to five years old. But Professor Nick Bishop suggests the American Academy of Pediatrics recommendation of 200iu per day for children under five between mid-October and mid-April. A large teenager should probably take an adult dose of 2,000iu except when outdoors regularly in full summer sun.

Old people are almost always seriously deficient in vitamin D especially when living in institutions. 2000iu per day is advised by several American experts. Dr Peter Selby of Manchester Royal Infirmary prescribes 800iu per day, taken as vitamin D plus calcium tablets, for his patients with osteoporosis but this may be taken as a minimum.

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