The Health Challenges in Cold Countries

Dr. Ahmed Omar Abdi (AhmedBashi)

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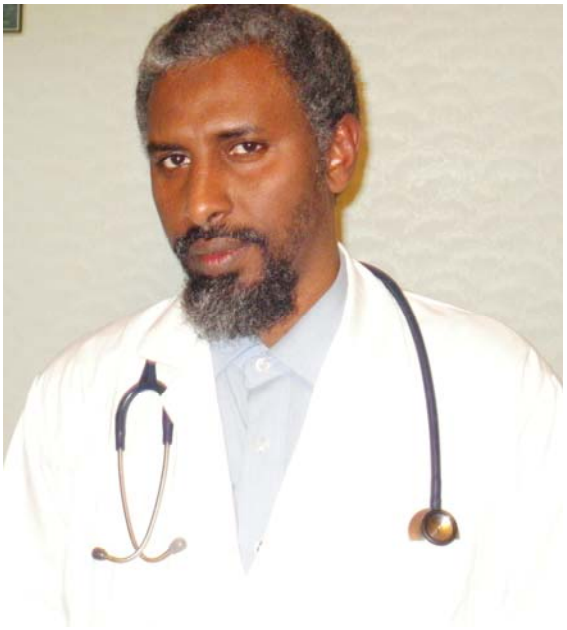
Part I: The Role of Vitamin D in Health and Autism

Introduction

It is difficult to cover all the problems in one article, so I selected interrelated issues which are most alarming ones and these are the consequences of vitamin D deficiency and Autism.

Although historians state that rickets (disease from vitamin D deficiency) occurred in humans as early as the 2nd century AD, the disease was not considered a significant health problem until the industrialization of northern Europe. In the 17th century, Whistler, DeBoot and Glissen independently recognized that many of the children who lived in the crowded and polluted cities in northern Europe developed a severe bone-deforming disease characterized by enlargement of the ends of long bones and ribs, bowing of the legs, bending of the spine, and weak and toneless muscles. The incidence of this debilitating bone disease increased dramatically in northern Europe and North America during the industrial revolution; for example in Britain and Netherland it has effected 90% of the children. The disease was especially devastating for young women of childbearing age who often had a deformed pelvis, resulting in a high incidence of infant and maternal morbidity and mortality. This has led to the development and widespread use of cesarean sections in Great Britain.



Dr. Ahmed Omar Abdi (Ahmedbashi)

In 1822, Sniadecki observed that children living in Warsaw had a high incidence of rickets, whereas children living in rural areas outside Warsaw did not. Based on this observation he advocated exposure of sunlight as a mean of curing this disease. Little attention was given, however, on the environment as the cause of this disorder. In 1889, the British Medical Society conducted an epidemiological survey and confirmed previous observations. Unfortunately, they were unable to relate the lack of exposure to sunlight with their observation. One year later, Palm carried out extensive epidemiological survey throughout British Empire and Orient (China, Japan and India), and felt the importance of sun exposure. He urged systematic sunbathing as preventive and therapeutic measure in rickets and other diseases. Unfortunately, little attention was paid to the insightful observations of Sniadecki and Palm, and another 30 years passed before

Huldschinski demonstrated that exposure of rachitic children to radiation from a mercury vapor arc lamp was effective in curing this bone disease.

Initially, cod liver oil was used as a common folklore medicine for the prevention and cure of rickets until 1920 when McCollum et al. separated vitamin D from cod liver oil. Later, the radiation of various foods showed effective treatment and prevention of rickets, which revolutionized its prevention and elimination. In 1930s, it was concluded that vitamin D3 is synthesized in the skin by ultraviolet radiation of the sun (UVB).[1]

So it is clear it took centuries to understand the existence of vitamin D and now new realities of vitamin D and sunshine has emerged, which has been evolving over a century before they are accepted. Some nutritionists called the year 2008 as the year of vitamin D, according to the number of evidences and researches which had been carried out.

On the other hand, Somalia (like many other countries) lies in the equator and has sunshine throughout the year, and its people are considered one of most active and intelligent people in Africa. But since the mass migration of African refugees especially Somalis to the world of northern hemisphere, some changes are appearing in their characters with more diseases which were uncommon or rare before migration like body-ache, weakness, depression, schizophrenia , other mental disorders (for adults); autism or autism spectrum disorder (ASD), attention deficit, poor performance (for children). They are also superseding white skinned people in diseases which are more common in these countries, like diabetes, hypertension, stroke, etc. No doubt the environment is playing a major role but the real cause is still not agreed, although new evidences are emerging, especially the importance of sunshine vitamin (vitamin D).

After reviewing the latest researches on the main issues of these problems, I realized that the scientists are recognizing some of the underlying causes, and

some steps have been taken for last years to curb these diseases. But unfortunately, these communities are unaware of the causes of their misery, so I decided to write this article which is designed just for increasing awareness and sharing the available facts.

Vitamin D and Its Deficiency

The vitamin D exists mainly in two forms, vitamin D2 (Ergocalciferol) and D3 (Cholecalciferol), which are found from plants and animals respectively. Although vitamins are defined as a group of organic nutrients, required in small quantities for a variety of biochemical functions that, generally, cannot be synthesized by the body and must therefore be supplied in the diet; the vitamin D is considered a hormone, as it is mainly produced by the body itself, except for those don't have enough sunshine. It is a substance which is essential for metabolism of calcium, phosphorus, bone growth and muscle power. And recently it is becoming evident that it is also plays major role in growth and normal functioning of nerve system and body defense system.

Sources

It is produced in response to ultraviolet radiation from sun striking on the skin, a photochemical cleavage occurs which results in the formation of vitamin D from 7-dehydrocholesterol. Ninety percent of human vitamin D stores come from skin production, not oral intake. For adequate vitamin D production you need about twenty to thirty minutes of sun exposure (without sunscreen) on your hands and face two to three times per week. But this varies according to color of the skin. As the dark-coloured people have more melanin in their skin, which decreases the

penetration of sunrays deep into skin, they need more exposure (about 5 times) to get adequate amount of vitamin D comparatively. For example, when fair-skinned adults sunbathe in the summer (one, full-body, minimal erythemal dose of ultraviolet light), for 20 minutes, they deliver about 20,000 units (0.5 mg) of vitamin D to their systemic circulation within 24 hours.[2]

The other source of vitamin D is from food especially some fishes (sardines and salmon), eggs, cheese and fortified milk, cereals and margarine.

Causes of Vitamin D Deficiency

The three causes of vitamin deficiency are decreased intake, decreased absorption, or impaired its metabolism[3]

a) **Decrease production and intake:** this can be decreased sun exposure, use of sunblock creams or dietary insufficiency. The last decades there was increasing advice of avoiding sun exposure and using the sunblock creams as a result of the mounting concern about the relationship between solar exposure and the development of skin cancer, and this has led to increased reliance on dietary sources for vitamin D, which is not sufficient unless supplemented. So vitamin deficiencies become prevalent in developed countries especially in Europe and North America. The elderly people and the babies who are kept indoors and women wearing hijab are most severely affected.
b) **Decreased absorption:** this mainly results from intestinal diseases and worm infestation. And also in elderly people, the effective production of vitamin D from skin and its absorption from intestine is impaired by aging process.
c) **Impaired vitamin D metabolism:** this include impaired activation, which occurs in patients with severe liver and kidney diseases; accelerated losses in patients taking drugs like barbiturates, phenytoin, and rifampin; and resistance to the biological effects of vitamin D in patients with genetic defects in vitamin D receptors (VRD)

Main factors determine your vitamin D status:

- Degree of skin pigmentation
- Sunlight exposure
- Dietary contribution (<10% total)
- Latitude (location on the earth)
- Season / time of year and angle of sun's rays
- Use of sunscreen or protective or full clothing
- Outdoor exposure
- Body Mass Index (more body mass, less circulating vitamin D as fat serves as a vitamin D reservoir)

Effects of Vitamin D Deficiency

Low serum vitamin D concentrations are associated with an increased risk of several chronic diseases including rickets, osteoporosis, muscle pain & weakness, cancer, diabetes, autoimmune disorders, hair loss, pre-eclampsia, hypertension, atherosclerosis, rheumatoid arthritis, obesity and seasonal influenza. Clinical data also suggest that vitamin D_3 insufficiency is associated with an increased risk of several central nerve system (CNS) diseases, including multiple sclerosis, Alzheimer's and Parkinson's disease, psychiatric diseases (depression, seasonal affective disorder and schizophrenia). In line with this, recent animal and human studies suggest that vitamin D insufficiency is associated with abnormal development and functioning of the CNS of the new born. Overall, imbalances in the vitamin D system appear to cause abnormal function, including premature aging, of the CNS.[4]

Serum values of 25(OH)D in the children with autism of some studies classified them as being "vitamin D inadequate," which lends support to the hypothesis that autism is a vitamin D deficiency disorder.[5]

A review by Allan Kalueff, 2007, based on more than 20 studies of animals and humans—concluded that vitamin D during gestation and early infancy was essential for "normal brain functioning.[6]

The common symptoms of vitamin D deficiency are deformity of long bones in children, body ache, muscle weakness, increased fracture of bones, increased hair loss and low mood.

Autism

Autism is a lifelong neurodevelopmental disorder that disproportionately affects male children (roughly, 5 males per 1 female). Autism is neurologic disorder characterized by (1) qualitative impairments in social interaction; (2) qualitative impairments in communication; and (3) restricted repetitive and stereotyped patterns of behavior, interests, and activities. It becoming epidemic, for example in UK is 1 in every 88 children have autism.[7]
Children with autism are often not diagnosed until age 3 to 4 years when their disturbances in reciprocal social interaction and communication become more apparent. But the three most striking characteristics during the first year are a consistent failure to orient to one's name, failure to regard people directly, and failure to develop speech.

Up to now no specific cause is identified although it has been suggested that there is an environmental trigger for autism among genetically vulnerable children that is positively associated with precipitation.[8]

As early as 1991, a researcher from the National Institute for Occupational Safety and Health (NIOSH) of the US CDC, reported "organic mercury" was among the "established" "human behavioural teratogens," and according to this researcher, the resulting human behavioural disorders might "…include seizure disorders, autism, childhood schizophrenia, early onset emotional disturbances and attention deficit disorders".[9]

Relation Between Autism and Environment

(Vaccination, Mercury and Vit D)

Role of Mercury (Hg)

Since the extensive use of vaccination in last decades, it has been paralleled by increase incidence of autism. On the other hand this disease is very common in countries away from equator and tropicals. This has raised important questions!

It is also known that most vaccines contain Thimerosal, which is used as preservative, and it is a precursor of mercury (Hg), and in the body it is converted into methylethyl-mercury or diethyl-mercury which are toxic to immune and nerve systems. In many studies in animal and human beings shows that mercury exposure is capable of causing autism spectrum disorder (ASD).[10]

Mercurials may be found in drugs for the eye, ear, nose, throat, and skin; in bleaching creams; as preservatives in cosmetics, tooth pastes, lens solutions, vaccines, allergy test and immunotherapy solutions; in antiseptics, disinfectants, and contraceptives; in fungicides and herbicides; in dental fillings and thermometers; and many other products.
When this substance (mercury) enters into mother's body (mainly through vaccination and medication), it can easily cross the placenta and blood brain barrier, so it can reach the reach the growing nerve system of the fetus and damage it unless there is strong defense system for removing this material.

And after birth, the infants receive multiple jabs of vaccinations which contain Thimerosal, and it builds up gradually in the body, especially in the nerve system. Especially, in the U.S., the prevalence of autism became endemic with an increase of about 5 in 10,000 to 60 in 10,000 after three additional thimerosal-containing vaccines were introduced for newborns in the early 1990s, whereas in most other countries with much lower autism prevalence, like Germany or Denmark, thimerosal in vaccines was reduced at the same time. In California, the autism rate increased by 634% between1987 and 2002, which cannot be attributed to

shifts in the interpretation of diagnostic criteria, migration or improved diagnostic accuracies.[11] Other developmental and behavioural disorders like attention deficit disorders (ADD) or attention deficit hyperactivity disorders (ADHD) have also increased up to 1 out of every 6 children in the U.S.[12]

The vaccines which contain Hg are diphtheria-tetanus-pertussis (**DTP**) vaccine (25 µg Hg/dose) routinely administered at 2, 4, 6, and 18 months of age, *Haemophilus Influenza* type b (**Hib**) vaccine (25 µg Hg/dose) was recommended for routine administration at 2, 4, 6 and 18 months of age, **Hepatitis B** vaccine (12.5 µg Hg/dose) was recommended for routine administration at birth, 2 and 6 months.

Additionally, during this time, infants may have incurred additional Hg exposure through breast milk if they were born to mothers with amalgam tooth fillings and/or blood group Rh-negative mothers, who receive Rho (D)-immune globulin formulations, contained Thimerosal (10.5 to > 50 µg Hg/ dose) and which is routinely recommended for administration to these mothers in last weeks of gestation and/or within 72hrs of birth. Nowadays' flu vaccines also contain Thimerosal.

As a result, in 1990s, an infant could have received a cumulative dose of 237.5 µg of Hg during the first 18 months of life, which is higher than the toxicity level.

Many researchers found that the type of neurological damage (micro & macro) and symptoms in autism and mercury intoxication (in adults) are same. So mercury exposure has been implicated in development of autism. Consequently since 2001, US have recommended reduced Thimerosal (preservative free) vaccines for children less than 6 years.

Taken together, all the above mentioned data from experimental, clinical and partly from epidemiological studies appear to show that repetitive mercury exposure during pregnancy (through thimerosal and dental amalgam), and after

birth, through thimerosal containing vaccinations in genetically susceptible individuals is one potential pathogenetic factor in autism.

Role of Vitamin D in removing the heavy metals like mercury

The removal of heavy metals, like mercury, from the body is mainly done in a process known as oxidative-reduction, which is mediated mainly by glutathione. It is an antioxidant and also acts as a chelating agent for removing the heavy metals. Autistic patients show oxidative stress and poor-functioning glutathione system. Furthermore it is found that vitamin D is essential for the proper functioning oxidative-reduction system of the body, especially for glutathione.

On the other hand, it has been found that almost every autistic patient have vitamin D deficiency, and at same time have more mercury in their body. So there is strong evidence that this coincidence can be the trigger of autism.

Some medical experts advocate that vitamin D deficiency alone can cause autism and autistic spectrum disorders, based on the evidences showing the importance of vitamin D for development of brain, and structural similarities between the brain of autistic patients and experimental animal.[13]

Evidences that vitamin D deficiency or/and mercury can cause Autism

1) From the limited data available, it appears autism is more common in people living in poleward latitudes. The disorder is less common at more sunny equatorial latitudes. Recent Centre of Disease Control (**CDC)** study done in USA about autism prevalence from 14 states showed the state with the highest prevalence, New Jersey, was the second most northern; Alabama, with the lowest prevalence, was the most southern of the 14 states surveyed.[14] Furthermore there is a strong effective latitudinal (related to wintertime solar ultraviolet B radiation) increase in Infantile

Autistic Disorder (IAD) prevalence. As there is no doubt that the higher latitude has less vitamin D, these findings are consistent with maternal vitamin D deficiency's being a risk factor for IAD, possibly by affecting fetal brain development as well as possibly by affecting maternal immune system status during pregnancy. Although the vaccines are used in tropical countries, the autism is far less common than cold areas as there may be more vitamin D.

2) Although there is some contradictory report in studies about the relation between autism and season-of-birth, several studies show extensive autism births in winter, especially in March when the vitamin D levels are at their lowest.[15]

3) The autism is more common in dark-skinned communities living in Europe and North America, who have much less vitamin D in their body, even though the disease is rare in their original countries. For example the incidence of autism in Goteborg, Sweden, for children born to mothers who emigrated from Uganda, was 15%, about 200 times higher than in the general population.[16,17] Although about 90% of black people in these areas are vitamin D deficient, a more specific research shows that 45% of the pregnant black women, but only two percent of the pregnant white women, are severely vitamin D deficient in USA. Prenatal vitamins containing vitamin D (400 units or 10 mcg) offered little protection for mother or infant, 90% of these women in the study reported taking them. [18]

4) The researchers found that mothers and patients of autism have less vitamin D than their counterpart. Several studies indicate black mothers are more likely to give birth to infants who weigh less and die shortly after birth[19]. The low birth weight and preterm births are clear risk factors for autism,[20] and these are also consistent with vitamin D deficiency.[21] Furthermore, multivitamins containing vitamin D reduced the risk of preterm and low birth weight infants.[22] Twelve hundred units (30 mcg) per

day of vitamin D in the third trimester significantly increased birth weights while 600,000 units (15 mg) given in both the 7th and 8th month of pregnancy increased birth weights even more.[23]

5) The CDC and others report black children have significantly higher rates of mild mental retardation than white children do and socioeconomic factors could not explain all the differences.[24]
6) However, if vitamin D was involved in autism, then symptoms might improve in the summer, when vitamin D levels are the highest. Some studies found some improvement of symptoms of autism, if the patient is moved to where there is more sunshine. Furthermore, significant improvements in autistic behaviors occurred after a summer camp program that included swimming, hiking, boating, and other outdoor activities that would increase brain levels of calcitriol.[25]
7) Children with vitamin D metabolism deficiency have hypotonia, decreased activity, developmental motor delay, listlessness, failure to thrive, and other autistic markers which also similar to common vitamin D deficient rickets.
8) Vitamin D deficiency impairs glutathione metabolism, which may explain the link between autism and oxidative stress, as well as autism and mercury accumulation. Consumption of vitamin D containing fish during pregnancy reduces autistic symptoms in children, although these fishes also have mercury.
9) Severe maternal vitamin D deficiency leads to rat pups with increased brain size and enlarged ventricles, abnormalities similar to those found in autistic children.
10) Calcitriol down-regulates production of inflammatory cytokines in the brain, which have been associated with autism.

Vitamin D and Chronic Diseases [26]

There are many studies suggesting that vitamin D deficiency is associated by many chronic diseases like osteoporosis, cancers, diabetes, cardiovascular diseases (hypertension, atherosclerosis, heart attack and stroke), autoimmune diseases, rheumatoid arthritis, and others. Sometimes these are called the urban diseases, and they are far more common in developed countries, although the specific cause is not determined yet but the lifestyle plays a role.

In order to understand the relationship between vitamin D deficiency and those chronic diseases, some researchers investigated the incidence of cancer and hypertension in the world, and they found the incidence increases as you go away from the equator (to cold areas), which means less sunshine and less vitamin D, and this is same with all diseases mentioned above. On the other hand it is found that there is higher rate of total cancer mortality among African-American and the overweight and obese people (which are associated with lower level of vitamin D)[27]. Likewise the most common cases of type 1 diabetes mellitus (which affects the children) occurs in Finland, and recently it has been noticed that it is ten times more common in children of African origin in Finland as well as in United States(which is also compatible with vitamin D deficiency). These and many other evidences are becoming the basis for the discovery of importance of vitamin D.

It will be too long to discuss all chronic diseases related to vitamin D deficiency one by one in this brief review, so for further interest you can find many articles in the literature which strongly suggesting the correlation between these diseases and vitamin D. It is worthwhile to mention that recent studies suggested that women who are vitamin D deficient have a 253% increased risk for developing colorectal cancer, and women who ingested 1500 mg/d calcium and 1100 IU/d vitamin D_3 for 4 years reduced risk for developing cancer by >60%[28].

Some other studies have reported an inverse relation between vitamin D intake and the risk of breast cancer, improvements in survival after a diagnosis of breast

cancer in women with higher levels of vitamin D, and association of vitamin D insufficiency in up to 75% of women with breast cancer[29]. There is also a significant association between vitamin D deficiency and low physical activity, low mood and influenza infection; because these problems are more evident in winter when the sun exposure is low and ineffective. On the other hand these problems improve after taking good doses of vitamin D.

Some studies in Unites States comparing the association between the vitamin D level to medical illnesses in their population, showed those with the lowest (<15ng/ml) are more likely to have 30% more elevated blood pressure, 47% more elevated lipids, 98% more diabetes, and 129% more obesity.[30]

Especially in women with vitamin D deficiency can develop pelvic bone deformity and during pregnancy abnormal fetal bone growth and preeclampsia, all which can precipitate to caesarian section, which its increment coincide with that of vitamin D deficiency. It is also associated with low birth weights and intrauterine growth retardation.[31,32]

It is well known the relation between rickets and respiratory infection, and some studies in 1994 demonstrated that respiratory infections in children with elevated alkaline phosphate level were eliminated by supplementing them with 60,000IU vitamin D/week for a period of 6 weeks[33]. From different studies we can conclude that the deficiency of vitamin D during fetal and infant development is associated with 1) higher risk of maternal preeclampsia, 2) impaired fetal growth, 3) impaired dentition, 4) increased risk of gingivitis, periodontal diseases and other chronic diseases.

Overall the consequence of have severely affected in black and muslim communities. For example in Denmark, 88% of arab woman muslims complain muscle weakness and pain due to vitamin D deficient. So the frequency of the diseases we mentioned above and their poor outcome is more in these communities.

Vitamin D and Mental Illnesses

It is proposed that vitamin D plays a role in mental illness based on the following five reasons:[34]

1. Epidemiological evidence shows an association between reduced sun exposure and mental illness.
2. Mental illness is associated with low 25-hydroxyvitamin D [25(OH)D] levels.
3. Mental illness shows a significant comorbidity with illnesses thought to be associated with vitamin D deficiency.
4. Theoretical models (in vitro or animal evidence) exist to explain how vitamin D deficiency may play a causative role in mental illness.
5. Studies indicate vitamin D improves mental illness.

So any one having mental illness should his vitamin D level checked and corrected especially black patients and those have no sun exposure.
Interestingly it shown that there is association between vitamin D and cognition, which can suggest that vitamin D deficiency per se impairs cognition, as there is some improvement after supplementation.[35,36]

Somalis and Autism and Vitamin D Deficiency

There's some evidence Somali children in Minnesota might have a higher rate of autism than the general population. A Minnesota Health Department study published in 2009 looked at school records for 3 to 4 year olds, and found that over a three-year period from 2005 to 2008, the proportion of Somali kids receiving autism services was as much as seven times higher than non-Somali children.[37]

In the Swedish study, involving 17 children, the prevalence of autism was found to be three to four times higher in the Somali community than the non-Somali one.[38] This means they are even more common than other black community.

On the other hand, the Somalis in Somalia enjoy with good sunshine throughout the year, and they hardly heard the disease called Autism in their home land, and in fact there is no Somalian word for it. But after migrating to northern hemisphere they become the leading society experiencing with this disease. This has raised the eyebrows of many scientists and severely questioned the old strong theory about autistic cause that says that this disease is basically a genetic, as this genetic disease cannot manifest itself in Somalia. Then I can argue that this scenario has led to the new discoveries and alternative hypothesis of this disease.

With background knowledge of the role vitamin D and mercury in development of autism, the susceptibility of Somalis to this disease has been further aggravated by firstly, most of Somali women wear hijab and stay indoor as religious duty, and secondly, the lack of awareness of the importance of vitamin D supplementation.

Conclusion

After this discussion it is evident that vitamin D is essential for normal growth and function of human body and prevention of large number of diseases, and it has a large safety margin, but unfortunately, its intake is hindered by unnecessary fears of its side effects, lack of sun exposure and lack of awareness of its benefits.
The recent studies have explored the real picture of this hormone and got some answers for reasons behind many environmentally related diseases. So this is the time to realize the importance of this issue, and it should not be too late for many people to the consequences of vitamin D deficiency.
Many countries are acting hypocritical way in response to autism and vitamin D deficient, as the consequences inflicts mainly on immigrants, and handling these

problems would cost them. So they preferred to be silent, and even avoided to publish the demographic distribution of these problems, like Canada where a lot of Somalis are suffering.

The old definition of vitamin D deficient level in the blood which was <15ng/ml (or <37nmol/L), has been widely condemned, as this is related to only the rickets and osteomalacia, but the prevention of other diseases needs a higher level of 25(OH)D_3 which is >40ng/ml (or >80nmol/L), although some researchers suggest that the optimal level is around 60ng/ml (or 120nmol/L). So to maintain the level of 40ng/ml, the person may need to take 75 IU/Kg body weight per day or more; which is an average of 5,000IU/day in adults. But if the patients are already deficient they will need to take more doses to recover from deficiency. On the other hand as in many studies, it is shown that taking up to 30,000IU per day for long time does not cause any side effects and toxicity occurs at levels of 500 nmol/L or higher. [39]

The worst consequences of vitamin D deficiency affect children, as this capable inflicting irreversible brain damage, especially during their life in pregnancy, and mothers will be responsible if that could be prevented by taking vitamin D (as I believe). For the breast feeding infants the best way to supply vitamin D is to give their mothers at least 5000IU/day or supplement like other children. Hollis and Wagner discovered that breast milk is always a rich source of vitamin D – enough to maintain healthy levels in infants – as long as the lactating mothers took 4,000 units (100 mcg) per day.[40] So mothers should take the high dose of vitamin D or get exposed to sunshine during pregnancy and lactation for both her benefit and her baby.

The epidemiologists suggest that the genetics is only predisposition not the absolute cause of autism. Those same epidemiologists suggest that vitamin D deficiency during pregnancy and childhood may contribute to autism. If that is true, and to the extent it is true, the disease is iatrogenic, brought on by medical advice to avoid the sun, advice that failed to compensate for the consequent "epidemic of vitamin D deficiency."[41]

Dr. Ahmed Omar Abdi (AhmedBashi)

Email: drahmedbashi@hotmail.co.uk

SUGGESTION

1) Everyone, regardless the age, living the high latitude area should take vitamin D supplement of 75 IU/kg/day after correcting the deficiency or 200,000IU once every 2 months.
2) Everyone should try for sun exposure and avoid the sunblock creams.
3) All women wearing hijab living in temperate area must also take vitamin D supplement.
4) You can buy the vitamin D directly without prescription, but you may not find the proper dose from the chemists (pharmacy), usually you can get from natural medical stores, example search www.naturesplus.com , I am recommending to buy VITAMIN D3 4000 IU DROPS, and for adults they can take 2-3 drops/day =4000-6000 IU, and for children 1-2 drops/day= 2000-4000 IU.
5) The institutions of these communities should participate or conduct researches in this field.
6) If you want further information, there are many articles published, some of them mention in the reference, and even many video lectures are available in YouTube under vitamin D. example go to www.vitamindcouncil.org . This field needs further research and increasing public awareness.

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