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RESEARCH ARTICLE

VITAMIN DEFICIENCY AND FOOD SUPPLEMENTS

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Abstract

Vitamins are a heterogeneous group of organic compounds that help ensure the human body's wellbeing and function. This paper introduces the importance of all vitamins, both water-soluble and fat-soluble, as well as problems deriving from their deficiency. Additionally, vitamin supplements as part of treating vitamin deficiency, and possible harmful effects on the human body areshowcased. The main focus of the paper is on the vitamin B complex, and vitamin B12 specifically. The benefits of vitamin B12, as well as its action in the human body and the noxious effects of any lack of vitamin B12 in the human body, are also discussed. Some of the health conditionsan individual may need to face when they have vitamin B12 deficiency include neural tube defects, Alzheimer's disease, depression, and megaloblastic anaemia, which are also introduced and further discussed, in terms of symptomatology, causes and suggested treatment. The toxicity of vitamin B12 is also introduced, and possible causes for vitamin B12 deficiency are showcased.

Introduction:-

According to the Food and Agriculture Organization of the United Nations Corporate Document Repository, vitamins are defined as a "heterogeneous group of organic compounds" that are necessary for the growth and maintenance of human and animal life (FAO). The human body is incapable of synthesizing the largest group of vitamins, and, in cases it does, the human's needs cannot be met sufficiently (FAO). Vitamins are different from the main nutrients found in food, because, unlike proteins, carbohydrates, and lipids, vitamins are not chemically bound with one another (FAO). The human body requires a specific amount of vitamins and minerals, according to the Recommended Dietary Allowance, which demonstrates how much of each vitamin an individual should intake on a daily basis. However, another indicator that should also be taken into account when trying to determine how much of vitamins is enough is the Tolerable Upper Intake Level, or UI, which reflects the maximum amount of a vitamin an individual should consume daily, so they avoid vitamin deficiency effects. Of course, in the absence of individual vitamins, the human body demonstrates a wide array of various signs and disease that relate to vitamin deficiency; some of which could be very severe, and even fatal, if left untreated.

Until now, a total of 15 vitamins are known, and their significant is dependent on the animal species, "the growth rate of the animal, feed composition, and the bacterial synthesizing capacity of the gastro-intestinal tract of the animal" (FAO).

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Classification of Vitamins

Fat-Soluble Vitamins

According to their solubility, vitamins are largely categorized in two groups, including fat-soluble vitamins and soluble vitamins (See Table 1). Those that the gastrointestinal tract can absorb whenever fat is present fall under the fat-soluble vitamins' list (FAO). If the total intake exceeds the demands of the metabolic system, then the body's fat reserves store the fat-soluble vitamins. The greater the storage of fat-soluble vitamins, the greater the risk of developing toxicity, a toxic condition, referred as hypervitaminosis.

Retinol (Vitamin A), Vitamin K, Tocopherol (Vitamin E) and Vitamin D are all fat-soluble vitamins (Bellows and Moore).

Retinol (Vitamin A)

Vitamin A helps the body in a number of ways. Firstly, retinol helps in tooth development, cell division, and bone growth, and it also helps regulate the immune system (Tanumihardjo). Moisture in the nasal area, the throat, the mouth, lungs, skin and eyes are all the outcome of the presence of Vitamin A in one's body. In addition, retinol is believed to act preventively on specific cancers, mainly due to its antioxidant functions (Bellow and Moore). It can be found in dairy products, liver, carrots and fish, among others.

The daily recommended amount of vitamin A varies between 700mcg-900mcg for adult females and males respectively, and 400 mcg for children up to 8 years old (Institute of Medicine). Vitamin A deficiency, is quite rare in developed countries; however, whenever an individual is undernourished or does not feed properly runs the risk of xerophthalmia, a disease that may take up to two full years to develop as retinol is stored in the liver (Combs). Impaired vision, skin dryness or roughness, difficulties to see, teeth that do not develop properly, dropped immune resistance to infections and bone growth that is not considered normal could be signs of Vitamin A deficiency (Bellow and Moore).

Some multi-vitamin supplements are believed to lead to Vitamin A toxicity, due to the high doses of retinol in them. Symptoms include headaches, skin dryness and itchiness and loss of appetite (Bellow and Moore). However, in higher levels, the individual may experience dizziness and troubled vision, and also run increased risk of having their hips fractured (Bellow and Moore).

Vitamin K

Vitamin K is essential for blood clotting and assisting in producing the right amount of proteins for the kidneys, bones and blood (Bellow and Moore). It also ensures proper and good growth of the bones. It is intestine-bacteria produced.

Vitamin K is naturally produced by the bacteria in the intestines, and plays an essential role in normal blood clotting, promoting bone health, and helping to produce proteins for blood, bones, and kidneys. It is found in green, leafy-vegetables, and soybean oil, among others.

A lack of vitamin K increases the risk of a hemorrhaging event (Bellow and Moore). People that take antithrombics, thrombolytics, and fibrinolytics, to prevent blood clotting, or antibiotics may experience vitamin K deficiency. Excessive quantities of vitamin K can lead to red blood cell breakdown and damage to the liver (Bellow and Moore).

Vitamin E (Tocopherol)

Vitamin E functions protectively towards the red blood cells, and vitamins A and C, and also as an antioxidant (Bellow and Moore). It is also believed that vitamin E may help prevent cancer and heart disease; however, reliable facts that back up this claim are not yet found. A variety of studies have shown that an individual can benefit from the antioxidant function of vitamin E by embracing a diet rich in vegetables and fruits, instead of opting for food supplements rich in vitamin E (Bellow and Moore). Vegetable oil, grains and seeds, among others, are also great sources of vitamin E.

Vitamin E deficiency is rather unlikely. However, premature births are ascribed to vitamin E deficiency (Bellow and Moore). Individuals that do not sufficient amounts of vegetable oils may run the risk of vitamin E deficiency. Any supplemental vitamin E intake is not proven to add health benefits and also increase, if taken in large doses, the risk

of those on blood-thinning medication to jeopardize to their condition. People that take their daily vitamin E from food, do not usually run any toxicity-related risk (Bellow and Moore).

Vitamin D

"Vitamin D functions in the body through both an endocrine mechanism (regulation of calcium absorption) and an autocrine mechanism (facilitation of gene expression)" (Heaney). It is important in forming and maintaining bones, by elevating the phosphorous and calcium quantities that are absorbed from the intestine (Bellow and Moore). Cell growth is monitored, and the immune system is enforced with vitamin D, which is why children of all people, should have sufficient quantities of vitamin D in their daily dietary intake to have healthy and strong teeth and bones (Bellow and Moore). Dairy products, oily fish and cod liver oil are all rich in vitamin D. The skin also produces vitamin D, in order to shield itself against sunlight (Bellow and Moore).

The last published suggested vitamin D quantities are 200 IU/d for children and 400 IU/d for people up to 50 years old (Food and Nutrition Board). The amounts of recommended vitamin D increase as people get older because vitamin D synthesis usually decrease with age (Holick).

Rickets and back-skull flattening are symptoms of vitamin D deficiency in children while adults may experience osteomalacia and osteoporosis which both affect the bones (Bellow and Moore). Vitamin D deficiency is believed to link with cancer, hypertension and infectious disease, among others.

Supplements should be provided to those at risk, including infants that breast-feed only, people with dark or covered skin, the elderly, and individuals with inflammatory bowel disease (Bellow and Moore). Care should be taken when consuming excessive amounts of vitamin D supplements as they may lead in liver problems, even signs of poisoning (Jacobus et.al). An individual's both physical and mental development is slowed, and people feel nausea and the need to vomit due to vitamin D toxicity (Bellow and Moore).

Table 1:- Upper Intake Levels for Fat-Soluble Vitamins.

LifeStageGroup	Vitamin A (mcg/d)	Vitamin D (mcg/d)	Vitamin E (mg a-TE)	Vitamin K*
Infants[1]				
0 - 6mo	600	25	ND[2]	ND
6mo - 12mo	600	38	ND	ND
Children				
1 - 3y	600	63	200	ND
4 - 8y	900	75	300	ND
Males/Females				
9 - 13y	1700	100	600	ND
14 - 18y	2800	100	800	ND
19 - 70y	3000	100	1000	ND
>70y	3000	100	1000	ND
Pregnant and Lactating				
<18	2800	100	800	ND
19 - 50y	3000	100	1000	ND

[2]ND = Not Determinable due to lack of solid evidence and sufficient data

Obviously, people require more quantities of vitamins as they get older. Also, pregnant women are in need of increased amount of vitamins. Individuals of all ages seem to need more of Vitamin A than any other of the other fat-soluble vitamins.

Taken from: http://www.ext.colostate.edu/pubs/foodnut/09315.html

Water-Soluble Vitamins

Unlike fat-soluble vitamins, water-soluble vitamins do not usually induce toxicity as they are not stored in the body; at least, not in considerable amounts (FAO). The stored quantities are usually used up by the system when there are no sufficient amounts of water-soluble vitamin sources to feed the system.

Water-soluble vitamins are:

Thiamine
Thiamide takes the role of a coenzyme in carbohydrate metabolism and is found in glandular meals, dried brewers' yeast, green leafy corps, and wheat bran, among others.

Riboflavin
Rivoflavin is important for energy metabolism and helps metabolize fats, carbohydrates and proteins. It is found in chicken egg white, dried torula yeast, dried fish and liver meals, among others.

Pyridoxine
Protein metabolism occurs mainly due to the coenzymic function of pyridoxine. It also plays a vital role in metabolizing carbohydrates and tryptophan. It can be found in dried delactose whey, dried brewer's yeast and others.

Pantothenic acid
One of the roles of pantothenic acid is to help release energy from food nutrients, assist in acetylation reactions, and function as a key-substance when metabolizing protein, fat and carbohydrate. It is also present in the synthesis of steroids, cholesterol and fatty acids. It can be found in dried torula yeast, the glandular meals and dried delactose whey, among others.

Nicotinic acid
The synthesis of cholesterol and fatty acids, as well as tissue oxidation, owe their function to nicotinic acid. It helps release energy from fats, carbohydrates and proteins and can be found in rice bran, wheat mill run and green leafy vegetables, among others.

Biotin
Fat and carbohydrates metabolize because of biotin. All tissue reactions that involve carbon dioxide-transfer take place thanks to biotin. There are claims that biotin also plays a role in protein and purine synthesis, but the precise function of biotin in the aforementioned is still not clearly defined. Biotin is found in dried brewers' yeast, sunflower seed meal and cottonseed meal, among others.

Folic acid
Methyl, formyl, or any other single-carbon unit needs to be transferred, folic acid functions as the coenzyme that helps get one compound conveyed to another. All mushrooms, dark green leafy vegetables and dried brewers grains, among others, are rich in folic acid.

Cyanocobalamin
The presence of cyanocobalamin is essential to help maintain the nerve tissue and form red blood cells. Despite the fact that the exact role ofcyanocobalamin is still undetermined, it is closely linked with that of the folic acid's, given that they both contribute to metabolizing one-carbon units. It can be found in liver, meat and kidney, among others.

Inositol
Inositol is responsible for the good function of the skeletal, the brain and heart tissue. Furthermore, it is believed to contribute to RNA synthesis and the growth of bone marrow cells and the liver, as well as the transportation of cholesterol. It can be found in fish mean and liver, among others.

Choline
Cell structure is sustained due to the presence of choline. Also, nerve impulses could not have been efficiently transmitted, and lipids could not be transported within the body, unless for choline. Rapeseed meal, lung meal, and white fish meal are some of the dietary sources that are rich in choline.

Ascorbic acid
Ascorbic acid is responsible for maintaining all bone tissues, blood vessels, connective tissue and wound tissue untacked. Folic acid also requires the presence of ascorbic acid for metabolic reasons. Citrus fruits, liver meals, and blackcurrants are in the long list of ascorbic acid-rich dietary sources.

Table 2:- Vitamin Classification.

Water-solublevitamins	Fat-solublevitamins
Thiamine (vitamin B1)	Retinol (vitamin A)
Riboflavin (vitamin B2)	Cholecalciferol (vitamin D3)
Pyridoxine (vitamin B6)	Tocopherol (vitamin E)
Pantothenicacid	Phylloquinone (vitamin K)
Nicotinicacid (niacin)	
Biotin	
Folicacid	
Cyanocobalamin (vitamin B12)	
Inositol	
Choline	
Ascorbicacid (vitamin C)	

Taken from: http://www.fao.org/docrep/field/003/ab470e/ab470e05.htm

Vitamin B complex

General overview

Vitamins of the B complex are responsible for helping the body's process to make (or get) energy from food intake and for blood cell formation (Medline Plus).

The vitamin B complex includes:

1. Thiamine (B1)
2. Rivoflavin (B2)
3. Niacin (B3)
4. Pantothenic Acid (B5)
5. B6
6. Biotin (B7)
7. B12
8. Folic Acid

Food containing proteins, such as eggs, fish, dairy products and meat, as well as leafy green vegetables and cereals, are all vitamin B carriers. Any insufficient amount of any of the vitamin B complex can lead to diseases, such as anemia that is caused by lack of vitamins B6 or B12 (Medline Plus).

For the purposes of this paper, vitamin B12 will be further researched, in terms of food supplement, absorption in the stomach, action in the body, and deficiency and toxicity effects. In addition, four common diseases related to B12 and their treatment will be introduced and analyzed.

Vitamin B12

The body's blood and nerve cells maintain healthy with the help of vitamin B12, which is a nutrient that also assists in creating the cell genetic material, known as DNA (National Institutes of Health). What is more, people that feel fatigue and weakness probably have a specific type of anaemia, namely megaloblasticanaemia, because they lack vitamin B12 (National Institutes of Health).

It requires a teo-phase procedure, in order for the body to be able to absorb sufficient amounts of vitamin B12 from food intake. To begin with, vitamin B12 that is included in the foods must be separated and enter the blood stream. This can occur only if vitamin B12 is separated from the protein it is attached. For that reason, hydrochloric acid is produced in the stomach and performs the task already mentioned (National Institutes of Health). Then, vitamin B12 is absorbed by the large intestine of the body after it has combined with a stomach-made protein, called intrinsic factor. There are cases when individuals fail to produce intrinsic factor and suffer from pernicious anaemia; hence, cannot easily absorb vitamin B12 from food supplements or food intake (National Institutes of Health).

According to facts from the National Institute of Health, the amount of recommended vitamin B12 daily micrograms is age-dependent as illustrated in the following table:

Table 3:- Recommended Daily Vitamin B12 Quantities per Age Groups.

LifeStage	RecommendedAmount
Birthto 6 months	0.4 mcg
Infants 7–12 months	0.5 mcg
Children 1–3 years	0.9 mcg
Children 4–8 years	1.2 mcg
Children 9–13 years	1.8 mcg
Teens 14–18 years	2.4 mcg
Adults	2.4 mcg
Pregnantteens and women	2.6 mcg
Breastfeedingteens and women	2.8 mcg

Taken from: http://ods.od.nih.gov/factsheets/VitaminB12-QuickFacts/

According to the table, as people get older, their need for daily vitamin B12 amount increases.

Vitamin B12 Supplements

Animal foods are natural carriers of vitamin B12, and there are alsosome foods that are enriched with vitamin B12, meaning they have been added vitamin B12 while processing so to replace any lost vitamin B12 (National Institutes of Health). Plantfoods do not have any traces of vitamin B12 (unless, of course enriched); which is why people that rely solely on vegan diets may run into vitamin B12 deficiencies due to the gradual depletion of vitamin B12 (Cousens). In lactovegetarians, the tissue and blood levels of vitamin B12 are higher, so they usually do not run any vitamin B12 deficiency risk (Cousens). On the other hand, "Most vegans, however, do not eat primarily live foods, a dietary approach which conserves the B12 in the food because there is no loss from cooking" (Cousens).

Many people require vitamin B12 supplements, both meat-eaters and vegetarians. Individuals under physical or mental stress are often observed to have B12 depletion and require a B12 shot, and the same usually applies to people that have contracted hepatitis (Cousens). Also, there have been cases that people with borderline mental conditions or psychosis, have been benefited from B12 shots (Cousens). Indicatively, Dr. John Domissee, a Virginia-based respected orthomolecular psychiatrist, treats PTSD (Post traumatic Stress Disorders) with vitamin B12 shots with impressive results (Cousens).

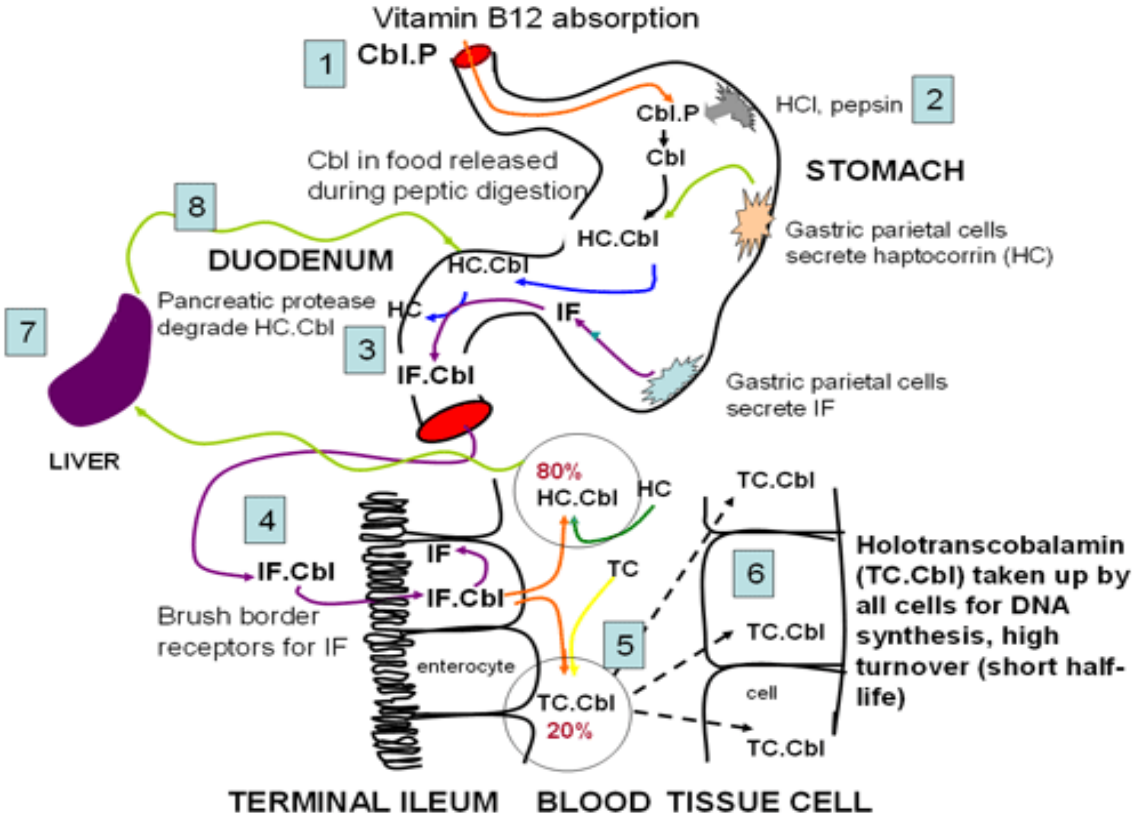
Absorption of Vitamin B12 (Bound B12)

Bacteria, among other microorganisms, are solely responsible for manufacturing vitamin B12. It is believed that those bacteria live in the digestive tracts of animals (usually attached with a protein), soil, and water. Consequently, when people eat animal foods, they receive vitamin B12 attached with a protein. When the complex of B12 and the protein reaches the stomach, B12 is separated from the protein with the enzymes and acids secreted in the stomach (Scalabrino). After that, B12 is again attached to a different protein, namely R-protein and the new complex leaves the stomach and travels all the way to the small intestine (Scalabrino). Human body fluids, including saliva, are R-protein carriers (Herbert). Also, R-protein can collect corrinoids, which, when attached to the R-proteins, get in the small intestine and then become separated again from the R-proteins, due to the pancreatic enzymes (Herbert).

Stomach secretions also have B12 in them; however, apart from that, the stomach is assigned to produce the already mentioned protein called intrinsic factor. Not all separated corrinoids attach to intrinsic factor. In fact, only cobalamins are carried to the ileum, where they are protected against degradation (either digestive, enzymatic or bacterial), by the intrinsic factor (Messina).

A more detailed description of the B12 absorption is shown in Graph 1 as followed:

Figure 1:- Vitamin B12 Absorption.



Taken from: http://www.active-b12.com/content/vitamin-b12-absorption

The graph shows all the process of B12 absorption. It starts with B12 attached to proteins (1), stomach acids separate B12 from proteins (2), B12 is set free and attaches to R-protein due to gastric cells that produce haptocorrin (3), until B12 is released to intrinsic factor and travels all the way to the ileum (4). Then B12 enters blood stream attached to another protein and creates a new complex, called holotranscobalamin, the majority of which are bound to haptocorrins (5). Holotranscobalamin makes sure B12 is delivered to all human body cells (6). As soon as B12 is absorbed in the intestine, it travels to the liver (7), only to be transferred to the duodenum afterwards (8).

Absorption of Vitamin B12 Supplements (Unbound B12)

Unlike vitamin B12 from foods, B12 in supplements is not protein-bound; hence, the process where the stomach secretes enzymes and acid to separate B12 from a protein is unnecessary. The only case that stomach acids are required is when an individual has taken B12 tablets that need to be dissolved (Markle).

Evidence, although preparatory, shows that B12 taken from supplements, when in mega doses, can surpass intrinsic factor defects, and, when mixed with an absorption fortifier, can be absorbed directly from the membranes positioned under the human tongue (Markle).

Vitamin B12 Action in the Body

Vitamin B12 has various mechanism of actions in the human body that all contribute to one's wellbeing. Vitamin B12 functions as a "cofactor for enzymes in metabolism of amino acids (including folic acid) and fatty acids; required for new cell synthesis, normal blood formation, and neurological function (Encyclopaedia Britannica). Vitamin B12 helps maintain the good overall health of myelin (TNA). Myelin functions as a nerve-cell insulator and helps send electric impulses via the nervous system (Hartline and Colman). Without proper function of myelin, the nervous system suffers. The Linus Pauling Institute mentions that myelin production is greatly affected by gene methylation, and vitamin B12 can control the activity of gene methylation; hence, is important in feeding the myelin

in the human body. If myelin breaks down, nerve damage occurs and humans experience burning in their limbs, as well as dementia and depression.

Vitamin B12 is vital to the central and peripheral nervous system, as well as the bone marrow function (Medscape).

Vitamin B12 deficiency

Hypocobalaminemia, or most commonly known as Vitamin B12 deficiency, is a condition when levels of vitamin B12 in the blood are low, even though vitamin B12 deficiency can occur at practically every serum level (Andrès et.al). In other words, an individual may have vitamin B12 deficiency, regardless of the fact they have macrocytosis, or anaemia, or not, which are both conditions that derive from B12 deficiency (Lindenbaum et.al). Because the exact reasons why vitamin B12 deficiency occurs are not yet determined, it is highly likely that the deficiency is diagnosed late, and, for that reason, it is common within all age groups (Lindenbaum et.al). Although hematologic symptoms are the most indicative of B12 deficiency, there are cases when other signs (neurological and psychiatric) come first and may indicate vitamin B12 deficiency (Lindenbaum et.al).

Unattended and untreated vitamin B12 deficiency, for a period longer than half a year, may cause damage the nervous tissue (Medline Plus-"Anemia"). Pernicious anaemia is a serious autoimmune condition that can even lead to deathif left untreated. It destroys the cells in the stomach that are responsible for secreting intrinsic factor, called parietal cells (Stöppler). If, on the other hand, B12 deficiency is identified and treated, there are great chances the blood levels get back to normal. However, there are times that medication given is not aligned with the doses required to treat anaemia, leaving the nerve cells to continue deteriorating (Voet and Voet). Anaemia is incurable; so, it is necessary the individual with anaemia gets continuous treatment.

It is estimated that pernicious anaemia is found in two percent of people older than 60 years (Linus Pauling Institute). It comprises the last stage of the stomach's fight against itself, which leads to the stomach cells' destruction, using the antibodies of the individual that has aneamia (Linus Pauling Institute). With the stomach cells destroyed, the required enzymes and acids are not produced, and food-bound vitamin B12 cannot be released. "Antibodies to intrinsic factor (IF) bind to IF preventing the formation of the IF-B12 complex, further inhibiting vitamin B12 absorption" (Linus Pauling Institute).

Studies indicate that there is a genetic tendency and that about a quarter of people with pernicious anaemia have relatives that also have anaemia (Linus Pauling Institute). In order to help an individual with pernicious anaemia, vitamin B12 injections are recommended, or, alternatively, the patient can consume high doses of vitamin B12, orally or intramuscular, and allow B12 absorption to occur via passive diffusion (Linus Pauling Institute).

Vitamin B12 malabsorption (food-bound)

In food-bound vitamin B12 malabsorption, protein-bound or food-bound vitamin B12 cannot be absorbed and is common among the elderly. It is believed to be the outcome of the chronic stomach inflammation, called atrophic gastritis (Linus Pauling Institute). The stomach's lining is affected and gradually leads to stomach-glands' atrophy and lower production of the stomach acid, which is responsible for releasing B12 from food proteins. Consequently, vitamin B12 absorption is decreased, and anaerobic bacteria find a welcoming environment in the stomach (Linus Pauling Institute).

Unlike with pernicious anaemia, in vitamin B12 malabsorption, vitamin B12, as found in supplements, is not protein-bound, and, since the intrinsic factor is not damaged, vitamin B12 absorption is not reduced (Linus Pauling Institute). That is the reason people with vitamin B12 malabsorption do not need vitamin B12 in large doses; they only require dietary supplements and foods enriched with B12.

Atrophic gastritis

Another cause of vitamin B12 deficiency is atrophic gastritis. It is a condition that connects to bacteria-related infections and affects 10%-30% of individuals over the age of 60 (Linus Pauline Institute). The bacteria that cause deficiency are called heliobacter pylori and causes chronic stomach inflammation that may lead to a number of other conditions, including gastric cancer, atrophic gastritis and peptic ulcer disease (Linus Pauline Institute).

Other causes of vitamin B12 deficiency
Intestine parasites, chronic infections, malaria, cancer, gastrointestinal tract diseases, and, overall poor digestion, among others, are also responsible for vitamin B12 deficiency (Cousens). Also, a diet distinguished by high levels of proteins and the consumption of contaminated meat, fish, or poultry may cause pathogenic bacteria to block B12 uptakes (Cousens).

Overcooking food and drug intake, including alcohol and tobacco, as well as large doses of vitamin C, and low iron and B6 levels may decrease serum vitamin B12 levels (Cousens).

People with excess fat, thyroid disease, and after a surgery may increase an individual's need for B12. Pregnancy and lactation can lead to vitamin B12 depletion (Caousens).

Symptomatology of vitamin B12 deficiency
In vitamin B12 deficiency, homocysteine levels may increase, and the same applies to the levels of methylmalonic acid (Linus Pauline Institute). Despite the increase of the pre-mentioned levels, symptomatology may not be evident in individuals with mild deficiency.

Tiredness and fatigue are leading symptoms of B12 deficiency. Cells find it hard to reproduce and function, and the nerve cells are among the first that B12 deficiency affect (Cousens). Other symptoms may include "progressive poor sense of balance, clumsiness, loss of the sense of joint position orientation, cutaneous pain upon light touching, and decreased reflexes" (Cousens).

Increased irritability, memory loss, inability to focus and concentrate, and personality changes could also be the outcome of vitamin B12 deficiency (Cousens). Interestingly enough, 30 percent of people with neuropsychiatric changes do not demonstrate changes in the blood picture (Cousens). Finally, B12 deficiency in infants include speech impairment, reduced development (both physical and mental), appetite loss and lethargy (Cousens). The basic test to determine vitamin B12 deficiency is a serum B12 test.

Toxicity of Vitamin B12 and its effects
There are no proven harmful side effects from taking up too much vitamin B12, either from supplements or food. In order to treat pernicious anaemia 1mg-doses of vitamin B12 are usually recommended, and there are no known ill effects, as of now (Insel et.al).

If any cases of vitamin B12 overdose are reported, they come mainly from B12 supplements and, in those rare cases, symptoms include numbness and itchiness in various body parts, headaches on a regular basis, absent-mindedness and irregular heart functioning (New Health Guide).

People with pernicious anaemia, are believed to run elevated risk of leukaemia, if they overdose B12, and there are indications that B12 toxicity is linked with cancer development (New Health Guide). However, there are no substantial evidence to support those claims.

Common Diseases that Relate to B12 and their Treatment
Although solid evidence to explain why vitamin B12 relates to certain diseases is not yet clear, it is believed that vitamin B12 can lead to:

Alzheimer's disease and dementia
Statistics:
According to recent facts and statistics, Alzheimer's disease is the sixth cause of mortality among people older than 18 years if age (Xu et.al). Although estimates vary, it is believed that more than 5 million people over their 65th year have Alzheimer's, in the US alone, and, by the end of 2050, those numbers are expected to be more than double (Xu et.al).

People with low levels of vitamin B12 may run the risk of having Alzheimer's disease. The exact reason vitamin B12 associates with Alzheimer's disease is not determined; however, a study has shown that people that had Alzheimer's disease had reduced levels of B12 in their blood (Linus Pauline Institute). Maybe, B12 deficiency leads to reduced S-adenosylmethionine and methionine synthesis that affect methylation reactions, which in turns are

responsible for metabolizing the nerve cells' components and the neurotransmitters (Linus Pauline Institute). Homocysteine levels increase and it all leads to dementia and Alzheimer's disease. Indicatively,

A study conducted in 370 elderly individuals that had Alzheimer's disease has demonstrated the association of reduced levels of vitamin B12 in serum with Alzheimer's (Linus Pauline Institute). Results showed that those people with vitamin B12 levels lower than 150 pmol/L run twice the risk of developing Alzheimer's disease. Another study of 1,092 individuals that had no dementia and increased levels of plasma homocysteine also had an elevated risk of suffering from dementia and Alzheimer's disease (Linus Pauline Institute).

Treatment:
hyperhomocysteinemia is treated with vitamin B supplements, and it is believed that the cognitive performance of people taking vitamin B supplements was untacked, despite the fact that their plasma homocysteine concentrations may be lower than expected (Linus Pauline Institute).

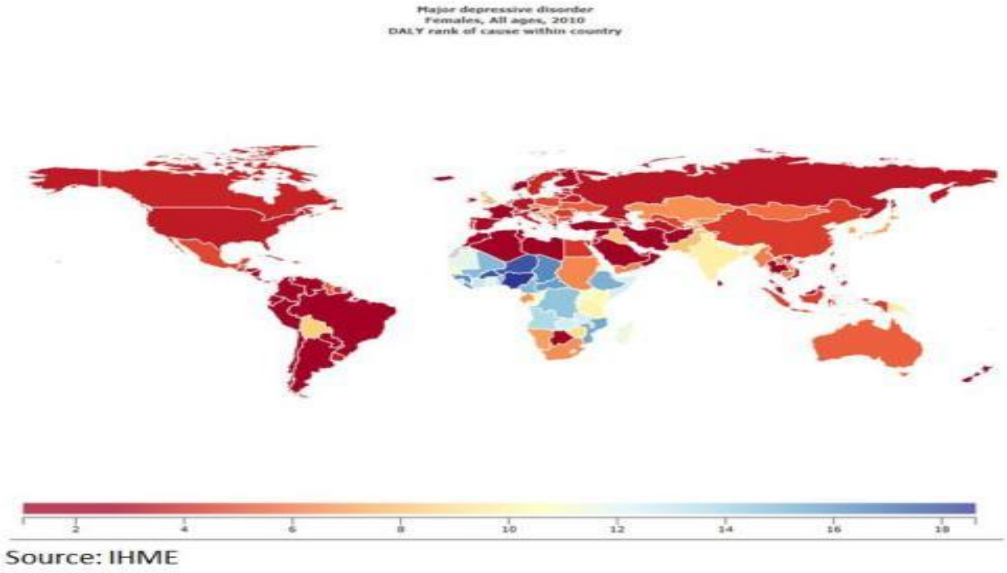
Neural tube defects (NTD)
Statistics:
More than 300,000 births the world over are affected by neural tube defects, which are birth defects (National Center on Birth Defects and Developmental Disabilities). Indicatively, about 1,500 births per year are affected by Spina Bifida, in the US only, while "the total lifetime cost ofcare for a child born withspina bifida is estimated tobe $706,000" (National Centre on Birth Defects and Developmental Disabilities).

Neural tube defects could lead to severe and sometimes even fatal birth defects. Birth defects usually happen at a time when women have not yet been informed of their pregnancy, meaning between the 21st and 27th day after they have conceived (Linus Pauline Institute).

Treatment:
It is believed that if women have sufficient folic acid intake about 30 days before and after they have conceived, they run a reduced risk of neural tube defects. Evidence that keeps solidifying in time indicate that folic acid and vitamin B12 intake helps reduce the homocysteine-lowering effect; hence, the risk for neural tube defects (Linus Pauline Institute).

Depression
Depression, especially among women, is one of the most serious and most commonly met diseases. According to statistics of the Institute for Health Metrics and Evaluation, approximately 63 percent of women globally, suffer from depression. The following map shows the depression rankings of each country the world over.

Figure 2:- Depressive Disorder Global Rankings.



Taken from: Institute for Health Metrics and Evaluation

The closer a country to red, the higher its rank. The map shows that women living in seven countries of South Africa and the Middle East, two countries of Latin America and a country in Europe, suffer more of depression disorder, compared to the rest of the world.

Vitamin B12 deficiency may conclude to depression. Studies have shown that about a third of people being hospitalized for depression had lower levels of vitamin B12 in the serum (Linus Pauline Institute). It is also indicated that individuals with vitamin B12 deficiency run twice the risk of experiencing depressive feelings of a severe type, compared to people that have no B12 deficiency. Another study that has been conducted among elderly people, both males and females, concluded that those with vitamin B12 deficiency were almost 70 percent more prone to show signs of depression as opposed to the elderly with normal vitamin B12 levels (Linus Pauline Institute). For once more,the reason B11 deficiency may lead to dementia and Alzheimer's disease is not clear. However, it is believed that it has to do with S-adenosylmethionine that needs B12 to synthesize and metabolize neurotransmitters related to depression (Linus Pauline Institute).

Treatment:
When older individuals are about to be evaluated by a healthcare professional for depression, it is recommended that the individuals also screen their vitamin B12 deficiency.

Megaloblastic aneamia
Statistics:
According to the Office of Rare Diseases of the National Institutes of Health, megaloblastic anemia is a rare disease; hence, affects less than 200,000 US citizens (Right Diagnosis).

Megaloblastic anemia is defined as a group of heterogeneous disorders with almost identical morphological traits (Schick). The megaloblast, a big cell with elevated cytoplasmic and nuclear ratio, is the morphological distinctive characteristic of megaloblastosis. Megaloblastosis affects the gastrointestinal cells, among other fast-growing cells, mainly due to impaired DNA synthesis (Schick). Vitamin B12 deficiency is among the most significant reason that causes megaloblastosis.

When individuals are affected by megaloblastosis, they may experience depression, memory loss, personality changes, and peripheral neuropathy, as well as weakness, and loss of vibratory senses (Schick).

Treatment:
Megaloblastic anaemia, if left untreated, could turn into a permanent condition. Proper therapy for vitamin B12 is recommended according to each case; however, patients are more susceptible to hypokalaemia and heart conditions that relate to anaemia, during their therapy (Schick).

Conclusion:-

Vitamins play a significant role is an individual's wellbeing as they help maintain the good function of the entire human body. Any lack of vitamins leads to vitamin deficiency and can cause from minor to great problems to the individual with the vitamin deficiency. Some deficiencies are more severe than others. However, they all need immediate treatment so they do not deteriorate into more serious conditions.

Vitamins are categorized in two groups: the water-soluble and the fat-soluble. Of the water-soluble vitamins, the main focus was on vitamin B12 that appears to be essential to help: create the cell genetic material, the DNA, as well as the central and peripheral nervous system, and the bone marrow function.

They ensure the health of the blood and nerve cells, and, through a complex process, vitamin B12 is absorbed in the human body. Vitamin B12 deficiency may lead to a type of anaemia, called megaloblastic anaemia, which is common among people that have low levels of vitamin B12 in their serum. When the human body is in need of more vitamin B12, some people take supplements, though untreated vitamin B12 deficiency, for longer than six months, may cause damage the nervous tissue.

Vitamin B12 deficiency can occur due to various reasons, including vitamin B12 malabsorption, atrophic gastritis, intestine parasites, gastrointestinal tract diseases, consumption of contaminated food, drug use, overcooking and thyroid disease, among others.

Despite the fact that the reasons and the exact way vitamin B12 deficiency leads to a specific disease are not yet clearly been clarified, some of the most common diseases that are believed relate to vitamin B12 deficiency include Alzheimer's disease, depression, neural tube defects and megaloblastic anaemia. They all have treatments that an individual should follow in order to ensure the wellbeing and health of their mental and physical condition.

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