

## Prevalence of Vitamin B12 among Indian populations

Dr. Meena Kumari Patangay(Head of the Department),  
Mrs.Y. V. PhaniKumari(Lecturer)&Mrs.Hannah Jessie Francis.T(Lecturer)  
BurlaSahithi,ChaitanyaTottalla,D.PersisMyrtle,M.SrinityaReddy,SanjanaApsingekar, V.Aneesha  
Reddy

Department of Nutrition,St.Ann's college for women Hyderabad

### ABSTRACT

This study was conducted to assess the prevalence, health consequences and causes of Vitamin B12 deficiency among Indian populations. The sample of 51 reviewed articles were randomly chosen. All the reviewed articles were about the various etiological factors for Vitamin B12 deficiency. Among 51 reviewed articles the prevalence of Vitamin B12 was observed in pregnant women (41.4%), Infants(57%), Adolescents (49.76%), Adults Male (18.33%), Adults Female (15.83%), Geriatric individuals (16%). Results from the reviewed articles concludes that rate of Vitamin B12 deficiency is highly prevalent among Infants, Adolescent boys, Pregnant women, Cigarette smokers, Alcoholics and predominantly in Vegetarians.

Key words:

Vitamin B12, Vegetarianism, Pregnancy, Diabetes, Geriatrics, Malabsorption, RDA.

### **Introduction:**

Micronutrient deficiency is a global health burden, especially among developing countries (1).Vitamins and minerals constitute micro nutrients in the food. Among various vitamins, Vitamin B12 deficiency has been a fairly common and a well-known public health problem that could affect many millions of people throughout the world(2) and its deficiency is widespread(3). Our understanding of vitamin B12 is incomplete, but one thing is certain that B12 deficiency is extremely common in the Indian subcontinent, due to lack of regular consumption of a balanced diet(4), mal-absorption of vitamin B12, infections of gastrointestinal diseases (Allen 2008), high body weight as well as high plasma glucose concentrations. Other causes include high food insecurity leading to prolonged breast feeding resulting in vitamin B12 deficiency (5).

Vitamin B12 also referred to as Cyanocobalamin, is one of the most essential water soluble vitamin from B-Complex family (6). It is termed as Cobalamin due to presence of cobalt group (7). The role of vitamin B12 in our body is to regulate cell division(8) and it is also crucial for normal neurological function, red blood cell production and DNA synthesis(9) .

Vitamin B12 deficiency is characterized by megaloblastic anemia, fatigue, weakness, constipation, loss of appetite, and weight loss. Neurological changes, such as numbness and

tingling in the hands and feet, are unspecific and can be irreversible. Additional symptoms include difficulty in maintaining balance, depression, confusion, dementia, poor memory, and soreness of the mouth or tongue (10). B12 deficiency affects all age groups (11).

The gastrointestinal environment of the animals (mostly ruminant) favors the growth of B12 synthesizing microbial flora. B12 thus produced is absorbed in the tissues like liver, muscle, and milk of animals which when consumed by humans gain entry into the human food chain (12). Animal origin food products provide 3 to 22 micrograms B12/day whereas vegetarian food provides 0 to 0.25 micrograms/day (13).

Prevalence of Vitamin B12 deficiency has limited data earlier, but the upcoming literature describes about the various studies performed in different areas of India and statistics of population deficient in Vitamin B12.

### **OBJECTIVES:**

- The primary objective of the current study is to review the status of vitamin B12 levels in people of different age groups considering various factors like culture, economy, gender, age, demography, epidemiology and dietary intake.
- To assess the prevalence of vitamin B12 deficiency in India and in different parts of the world.
- To study the health consequences and causes of vitamin B12 deficiency.
- To gauge the influence of vegetarianism.

### **Review on methodology and sampling-**

Through the reviewed articles different methods were used to identify the prevalence of vitamin B12, most commonly carried methods are prospective analysis(14), retrospective study(15), selective literature review(16,17), serum levels of individual at different stages have recorded using an electro-chemiluminescence immunoassay(18,19,20), for prevalence of vitamin B12 among different age groups cross sectional data(21,22,23,24,25) from electronic medical research was extracted, chemiluminescent enzyme immunoassay among medical college employees and students was carried out in north west India(26), case control studies were performed on 300 people with type 2 diabetes, urinary methylmalonic acid and holo trans cobalamin methods were used which are more accurate(27).

A community based cross sectional study was conducted in an urban setup in south India, where plasma concentration of B12 and folic acid were analyzed by 24 hour recall method(28). Retrospective study analyzing hospital record for a period of 1 year was carried out on patients of geriatric age group with neuropsychiatric symptoms (29) and cross sectional study was conducted to assess the health status exclusively of breast fed infants aged 1 to 6 months and

their mothers (30)and lacto-ovo vegetarian diets consuming adults ,vitaminB12 levels were determined using radio immunoassay technique in East Indian Punjabi Canadian immigrants(31).

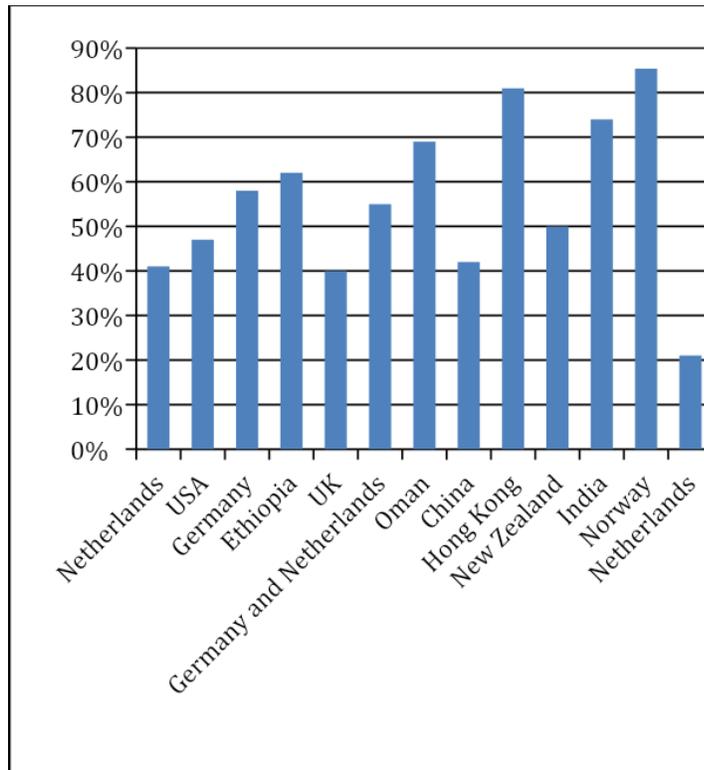
**RESULTS:**

EPIDEMOLOGY: Deficiency of vitamin B12 is highly prevalent in South Asia predominantly Indian sub-continent. Rate of deficiency of vitamin B12 in India (age-27-55 years) is 75%/ (Refsumet.al)(32)

Country	Participants	Rate of deficiency	Reference
Netherlands	N=73, age range:9-15years	41%	Dhonukshe, Ruttenet.al
USA	N=49, mean age:55 years	47%	Donaldson
Germany	N=71, mean age:53- 51years	58%	Geisel et al.
Ethiopia	N=99, mean age: 27.8 years	62%	Gibson et al.
UK	N=65, mean age:42.8yrs	40%	Gilsing et al.
Germany and Netherlands	N=111, mean age: 46years	55%	Hermann et al.
Oman (German and Asian. Indian immigrants)	N=96, mean age: 50 years	66% of German and 69% of Indians	Hermann et al.
China	N=119, mean age :>55years	42%	Kwok et al.
Hong Kong	N=113, mean age :>55years	81%	Kwok et al.
New Zealand	N=6 9-11 years	50%	Rush et al.
India	N= 78, (27-55years)	75%	Refsum et al.
Norway	N= 41, Infants: (11.4-21.9 months)	85.4%	Schneede et al.
Netherlands	N=73, adolescent(9- 15 years)	21%	Van Dusseldorp et al.

(33)

**\*Graphical representation vitamin B12 deficiency across the world summary\***



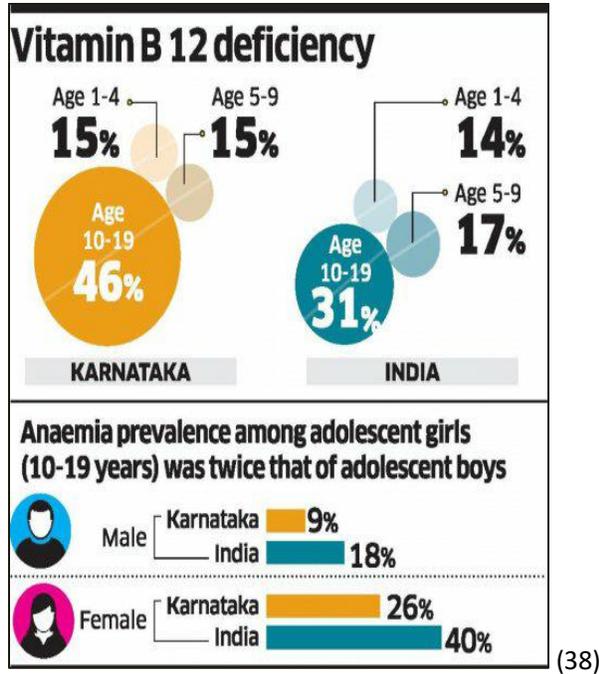
**Prevalence of B12 among different parts of India:**

In South India: The overall prevalence of folate deficiency was 12%. While the overall prevalence of B12 deficiency was 35%, it was significantly higher in the 21-40 (44%) and 41-60 age groups (40%) when compared with the >60 group (30%). B12 deficiency was higher in vegetarians (54%) compared to those consuming mixed diet (31%).[34]

3% children were prominently effected and 14% were marginally effected in Mysore children subject (35).

A survey conducted in Karnataka on adolescents reveals that, 46% of children between years 10 and 19 years have a deficiency of Vitamin B12. In India, an average of 31% of children in this age group have this deficiency, found in the survey. The study also indicated that B12 deficiencies are improved by consumption of egg, fish or meat in the past 24 hours in children aged 1-4 years and at least once in the past week in 5-9 and 10-19-year-olds (36).

Vitamin B12 deficiencies are caused by its low intake, abnormal absorption or inborn errors of transport and metabolism. Across the country, Vitamin B12 deficiency ranged from 14% to 31% in 1-19 years of age and was highest among adolescents (37).



In North-west India: In a medical survey 53.6% of 50 subjects were having low B12 levels where as 16.3% were severely deficient in north-west India (39) 34% patients were deficient in Vitamin B12 levels in the survey conducted in Western Maharashtra (40)

East Indian Punjabi Canadian immigrants: Median serum B<sub>12</sub> in males was 358 pg/ml, Corresponding value for females was 345 pg/ml. A large percentage of Punjabi subjects, especially the females, had serum vitaminB<sub>12</sub> levels below those observed for healthy omnivorous populations (41).

### **VITAMIN B12 ACROSS LIFE COURSE:**

**Adults:-**Studies in Pune, India have reported a high prevalence of vitamin B12 deficiency in adults( Refsum et al. 2001) (42). Across-sectional study was conducted in the Department of Medicine at Government medical college, Kota, Rajasthan and was carried out for a period of one year. All the 210 subjects underwent a clinical diagnosis of serum vitamin B12. Serum vitamin B12 levels (normal range 211- 946 pg/ml) were estimated by (Automated Chemi Luminescent Immuno Assay ARCHITECT-i1000 PLUS). In this study Prevalence of B12

deficiency in male and female were 18.33% (22) and 15.83% (19) respectively. B12 deficiency was more in male than female, but data was statically not significant(43)

In socioeconomic class of Bhuj 44% were deficient and the age group between 21-40 years were severely deficient .(44)

**\*serum vitamin B12 distribution according to gender\***

Gender	B12<197pg/ml N(%)	B12>197pg/ml N(%)	Total N(%)
Male	22(18.33)	30(25.00)	52(43.33)
Female	19(15.83)	49(49.83)	68(56.66)
Total	41(34.16)	79(65.83)	120(100)

(45)

**Pregnancy:**

Pregnant women achieved less than 50% of Estimated Average Requirement (EAR) for vitamin B12 (Torheimet.al 2010).(46)

**\* Prevalence of low serum vitamin B12 in pregnant women in India\***

(Duggan et.al 2014)	51%
(Katreet.al 2010)	73%
(Krishnaveniet.al 2009)	43%
(yajnsket.al 2008)	71%
Pathaket.al 2007)	74%
(Yusufjiet.al 1973)	52%

(47)

Several studies have reported that low maternal folate and vitamin B12 concentration and high homocysteine concentration predict smaller new born size.(48)

Vitamin B12 deficiency was present in 41.4% of the women, while only 4% had folate deficiency and hyperhomocysteinemia (49)

### **Infancy**

The prevalence of B12 deficiency in infants was found to be 57%. Forty-six percent of mothers were deficient. There was a positive correlation between the B12 levels of the infants and their mothers(50).

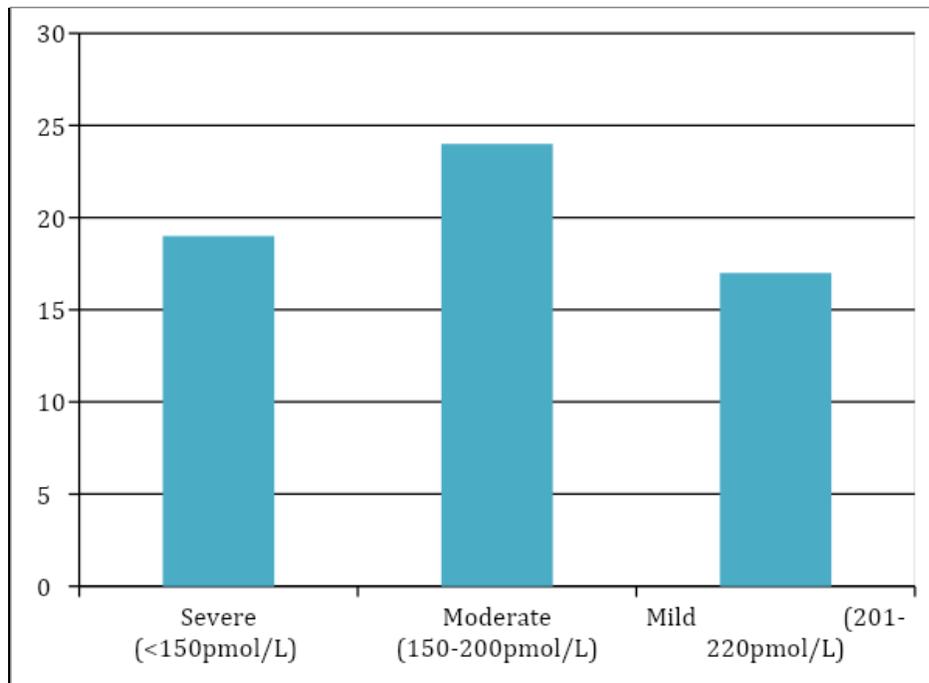
In a study conducted in 27 infants aged 6 to 24 months with vitamin B12 deficiency also known as infantile tremor syndrome in India, all were exclusively breast fed by vegetarian mothers and it was found that low serum vitamin B12 level was present in 12 of 27 infants.(51)

At baseline ( $\leq 14$  weeks of gestation), 51% of mothers were vitamin B12 deficient (vitamin B12 $<150$  pmol/l) and 43% had impaired vitamin B12 status (vitamin B12 $<150$  pmol/l and MMA $>0.26$   $\mu$ mol/l); 44% of infants were vitamin B12 deficient at 6 weeks of age. After adjusting for vitamin B12 supplementation, higher vitamin B12 concentrations in each trimester were associated with increased infant vitamin B12 concentrations and lower risk of vitamin B12 deficiency in infants. (52)

### **Adolescence:-**

Cross sectional hospital based observational study of 211 adolescents (10 -18 years) was conducted. Socio demographic characteristics like age, sex, education of mother & patient, socio- economic class, dietary history were noted for each patient. Vitamin B<sub>12</sub> deficiency was seen in 49.76%.(53)

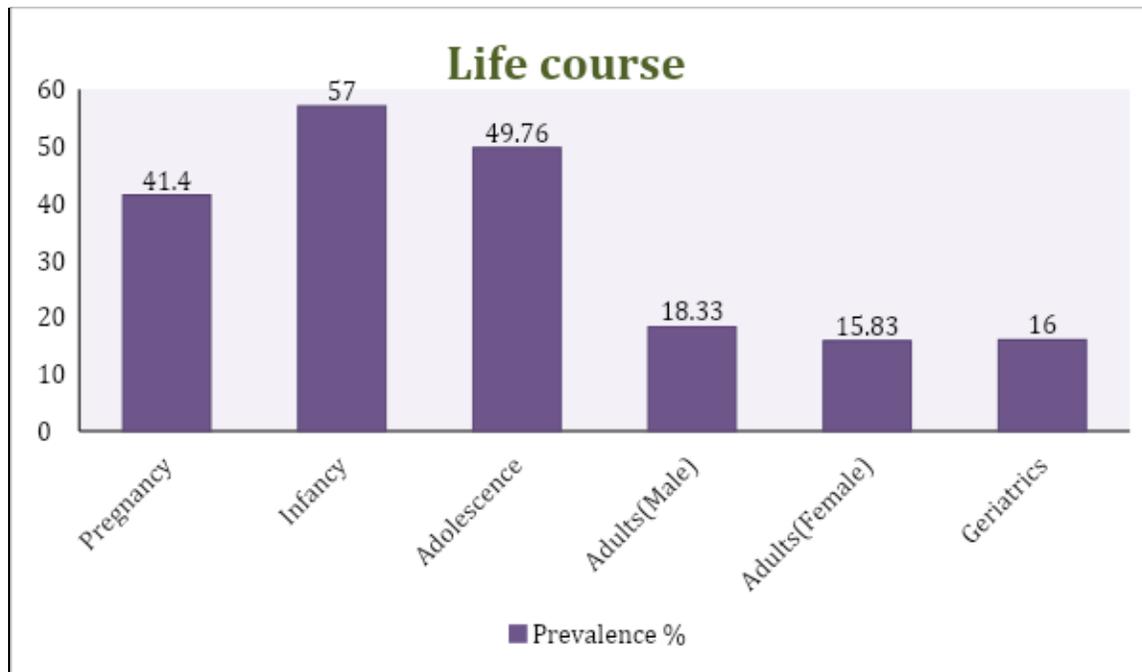
### **Geriatrics:-**



The prevalence of sarcopenia (the loss of skeletal muscle mass and strength as a result of ageing) and dynapenia (loss of muscle strength, rather than muscle mass) was 24.8% and 32.0%, respectively. In the patients with sarcopenia, mean age, osteoporosis and frailty were higher, and MMSE (Mini-Mental State Examination) and instrumental ADL (Activities of Daily Living) scores were lower than the patients without sarcopenia. The frequency of sarcopenia and dynapenia were 31.6% and 35.4%, respectively, in patients with vitamin B12 levels < 400 pg/mL. In addition lean body mass, total skeletal mass and skeletal muscle mass index were lower in the patients with vitamin B12 levels < 400 pg/mL compared to higher than 400 pg/mL. Sarcopenia, which results in lots of negative clinical outcomes in older adults, might be related to vitamin B12 deficiency.(54)

Among 259 patients of geriatric age group (>60 years) who had neuropsychiatric manifestations, 16% (n = 60) had Vitamin B12 deficiency (<220 pmol/L). Among 60 patients, the Vitamin B12 levels were <150 pmol/L (severe), 150-200 pmol/L (moderate), and 201-220 pmol/L (mild) in 19, 24, 17 patients, respectively.(55)

\*Graphical representation of vitamin B12 deficiency across Lifecourse summary:

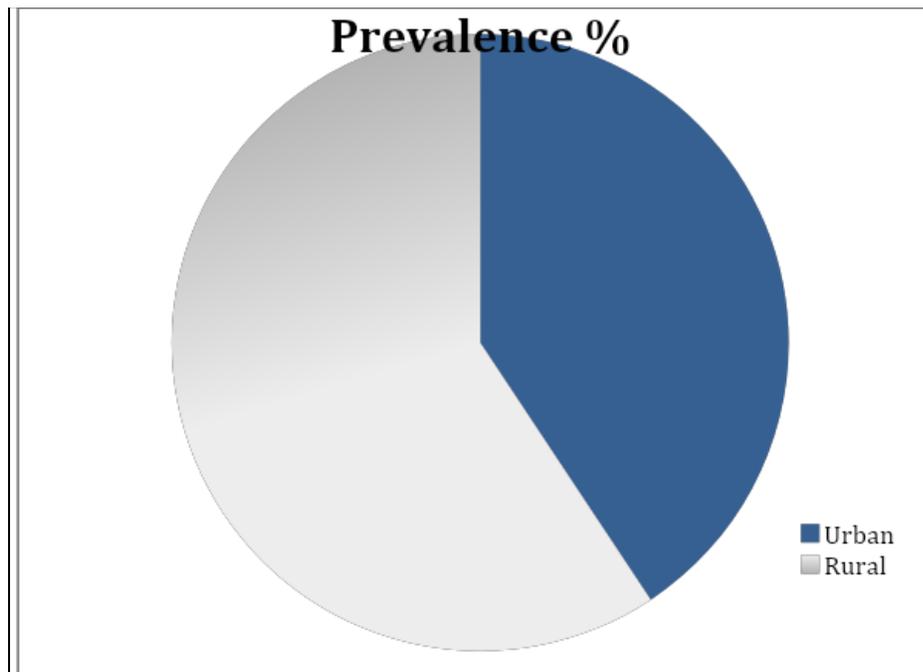
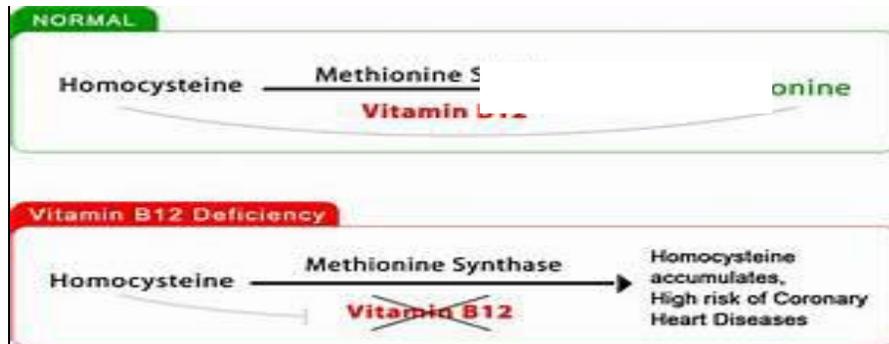


## Economy-

The prevalence of vitamin B<sub>12</sub> deficiency in the total study population was 32.4% (rural: 43.9% versus urban: 30.1%,  $P < 0.001$ ; male: 34.4% versus female: 31.0%,  $P < 0.05$ .) More than half (51.2%) of obese adolescents were vitamin B<sub>12</sub> deficient. On multiple linear regression analysis, serum B<sub>12</sub> in rural adolescents was associated with age ( $\beta = -0.12$ ,  $P < 0.05$ ). Among urban adolescents, serum B<sub>12</sub> was associated with BMI ( $\beta = -0.08$ ,  $P < 0.05$ ) and adjusted dietary vitamin B<sub>12</sub> intake ( $\beta = 0.14$ ,  $P < 0.001$ ). Serum vitamin B<sub>12</sub> levels were found to be lower in rural females ( $\beta = -0.12$ ,  $P = 0.030$ ) and urban males ( $\beta: 0.11$ ,  $P < 0.001$ ) compared to their respective contemporaries. (56)

There is a inverse correlation between vitamin b12 and homocystiene levels. A survey conducted in Pune, Maharashtra revealed that 67% of men had low vitamin -b12

concentrations(<150pmol/L), among which 58% had hyperhomocysteinemia (>15micromol/L). (57)



### Demography-

The prevalence of vitamin B12 deficiency in people with T2DM was 11.2% (95% Confidence Interval (CI) 8.2%-14.1%). The odds of vitamin B12 deficiency in patients receiving a metformin dose of 2 grams/day were 4 times higher compared to those receiving  $\leq 1$  gram/day, after adjusting for oral B12 supplementation (odds ratio 4.2; 95% CI 1.5-11.8). The odds of vitamin B12 deficiency in those taking metformin and receiving oral vitamin B12 supplementation were lower compared to those on metformin and not receiving vitamin B12 supplementation (58)

Vitamin B12 deficiency is a common condition causing neurologic, cognitive, psychiatric and mood symptoms. In a study conducted out of 259 patients who had vitamin B12 deficiency, 60 had neuropsychiatric symptoms, 21 were diagnosed with posterior dementias, 20 with frontotemporal dementia, 7 with schizophrenia, 4 each with parkinson's disease and alcohol dependent syndrome, 3 with bipolar affective disorder and 1 with CreutzfeldtJakob disease. 8 patients also had hypothyroidism. (59)

### **LIFESTYLE PRACTICES:**

Ill practices like alcohol consumption and cigarette smoking increases serum homocysteine levels (tHcy) and reduces vitamin b12 concentration. (60)

In alcohol consumption, according to a random cross over intervention study approved by the Ethics Committee of Queens University, Belfast. Male participants aged 21-70yrs were subjected to alcohol consumption of 30ml/day, followed by collection of blood samples resulted in lowering B12 levels by 5% and raised tHcy by 3%. (61)

In cigarette smoking, according to a study conducted by Plath Diagnostics Private Limited, Udaipur about 300 subjects of 50-60 were evaluated by collecting blood samples. The data showed that homocysteine levels were almost double i.e. 103% higher than non-smokers and vitamin B12 level was 27.9% lower. (62)

WEIGHT:- A cross-sectional study led by CSIR- Institute of Genomics and Integrative Biology showed a significantly higher prevalence of vitamin B12 deficiency among overweight (39.8%), obese (51.2%) compared to normal weight (28.1%) adolescent (63).

### **DIETARY INTAKE: MALABSORPTION**

The elderly persons often have difficulty in absorbing vitamin B12 from animal-source foods. Causes of the deficiency include, most frequently, food-cobalamin malabsorption syndrome (> 60% of all cases) (64). Malabsorption in the elderly (>60 years) is usually due to gastric atrophy or to Helicobacter pylori infection and was found to be (30%) (65)

Vegetarians have 4.4 times higher risk for developing vitamin B12 deficiency (66). Prevalence of B12 deficiency in vegetarian and non-vegetarian were 28.33% and 5.83% respectively according to the study conducted at Government Medical College, Kota (67). In addition to the prevalence

of vitamin B12 deficiency in vegetarians from birth, the deficiency is also seen in those who adopted different types of vegetarian diets later in life. This is because vegetarian sources of B12 include milk which has 0.3-0.4pg/100ml and has an absorption rate of about 65%, where as cheese has 20-60% that of milk. But B12 can be destroyed while boiling milk(30-50%)(68).

**\*Serum vitamin B12 distribution according to diet\***

<b>Diet</b>	<b>B12197pg/ml N (%)</b>	<b>B12197pg/ml N (%)</b>	<b>Total</b>
Vegetarian (70.00)	34 (28.33)	50 (41.66)	84
Non vegetarian (30.00)	7 (5.83)	29 (24.16)	36
Total (100)	41 (34.16)	79 (65.83)	120

**The Recommended Dietary Allowances for various age group are:**

Age	Male	Female	Pregnancy	Lactation
0-6 months*	0.4 mcg	0.4 mcg		
7-12 months*	0.5 mcg	0.5 mcg		
1-3 years	0.9 mcg	0.9 mcg		
4-8 years	1.2 mcg	1.2 mcg		
9-13 years	1.8 mcg	1.8 mcg		
14+ years	2.4 mcg	2.4 mcg	2.6 mcg	2.8 mcg

\* Adequate Intake \*

**Conclusion :**

By reviewing the articles, prevalence of Vitamin B12 deficiency was observed more in pregnant women and lactating mothers which led to deficiency in infants. Males were more prone to this deficiency when compared to females.

Rural areas are more affected with B12 deficiency when compared to urban. Vegetarian diet stood first in the etiology of vitamin B12 deficiency. Homocysteine and Vitamin B12 have an inverse correlation, an increase in homocysteine levels results in deficiency of vitamin B12. Even

life style practices like smoking and alcohol consumption can reduce the B12 levels. Vitamin B12 deficiency can be considered as one of the etiology factor for neuropsychiatric conditions also.

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Author Notes.

