



Frequency of Folate and Vitamin B12 Deficiency among Patients with Crohn's Disease

Ammar Farooq¹, Jahangir Anjum², Talat Zafar¹, Umer Farooq Khurshid¹

¹Department of Medicine, DHQ Teaching Hospital, Mirpur, AJK, Pakistan.

²Department of Medicine, MBBS Medical College, Mirpur, AJK, Pakistan.

ARTICLE INFO

Keywords: Crohn's Disease, Vitamin B12 Deficiency, Folate Deficiency, Micronutrients, Socioeconomic Factors.

Correspondence to: Ammar Farooq, Department of Medicine, DHQ Teaching Hospital, Mirpur, AJK, Pakistan.

Email: ammar_farooq1@hotmail.com

Declaration

Authors' Contribution

All authors equally contributed to the study and approved the final manuscript

Conflict of Interest: No conflict of interest.

Funding: No funding received by the authors.

Article History

Received: 03-02-2025 Revised: 10-04-2025
Accepted: 19-04-2025 Published: 30-04-2025

ABSTRACT

Background and Objectives: Crohn's Disease (CD) is associated with a high risk of micronutrient deficiencies due to chronic inflammation and malabsorption. The frequency and risk factors for Vitamin B12 and Folate deficiency in CD patients within low-middle-income countries (LMICs) like Pakistan remain poorly characterized. Aim of this study is to determine the frequency of Vitamin B12 and Folate deficiency and identify associated demographic and clinical factors in a cohort of Pakistani patients with CD. **Methods:** This descriptive cross-sectional study was conducted in the Department of Medicine at Divisional Headquarter Teaching Hospital, Mirpur, Azad Jammu and Kashmir. 121 adult patients (aged 18-60 years) with confirmed Crohn's disease (CD) were enrolled after informed consent. Folate deficiency (<3 ng/mL) and vitamin B12 deficiency (<125 pg/mL) were determined through biochemistry analysis of blood serum. Data were analyzed using SPSS v25.0. **Results:** The prevalence of Vitamin B12 deficiency was 20.7% (n=25), while Folate deficiency was less common at 6.6% (n=8). Stratified analysis revealed that Vitamin B12 deficiency was significantly more prevalent in females (92.0% of deficient cases, p<0.001), older patients aged 46-60 years (92.0%, p<0.001), and those with no income (84.0%, p<0.001). In contrast, Folate deficiency showed a significant association with older age (75.0% in 46-60 years, p=0.023) and an unexpected link with overweight/obese BMI status (75.0%, p=0.011). No significant associations were found for either deficiency with disease duration. **Conclusion:** Vitamin B12 deficiency is highly prevalent in Pakistani CD patients, with risk disproportionately concentrated among older women from low socioeconomic backgrounds. Folate deficiency, while less common, presents a distinct profile associated with overweight. These findings highlight the critical need for proactive, targeted screening and supplementation strategies to mitigate the burden of micronutrient malnutrition in CD.

INTRODUCTION

Crohn's disease (CD) is a chronic inflammatory bowel disorder characterized by transmural inflammation that can affect any segment of the gastrointestinal tract. Common symptoms include abdominal pain and persistent diarrhea, accompanied by systemic manifestations such as fever, anorexia, weight loss, and malaise.¹ CD exhibits a progressive and destructive course, with its global incidence on the rise.² Annual incidence rates vary from 3 to 15 per 100,000 individuals worldwide, with relatively lower rates observed among South Asian populations.^{3,4} Although the precise etiology remains elusive, emerging evidence implicates a dysregulated innate immune response in genetically susceptible individuals⁵ CD predominantly involves the terminal ileum and proximal colon, where the associated inflammation is typically sporadic, patchy, and segmental,

spanning the full thickness of the affected intestinal wall. Inadequate management of uncontrolled inflammation can exacerbate intestinal strictures, perforations, abscesses, and/or fistulae, necessitating hospitalization and surgical interventions to restore intestinal integrity and function.⁶

Several studies have documented vitamin and mineral deficiencies in CD patients, which can profoundly impair quality of life and clinical outcomes.⁷ Numerous clinical manifestations, including malabsorption syndromes that compromise the uptake of folate and vitamin B12, are attributable to CD. Moreover, evidence from multiple investigations suggests that serum levels of vitamin B12 and folate influence the onset of inflammatory bowel disease (IBD).⁸ Citrus fruits and leafy green vegetables serve as primary dietary sources of folate, supplemented by fortification in many cereals and endogenous

production by gut commensal bacteria. In contrast, animal products constitute the principal source of vitamin B12. These two cofactors fulfill distinct yet complementary roles in cellular metabolic regulation. Consequently, hypovitaminosis and chronic inflammatory conditions may precipitate deficiencies in folate and vitamin B12, particularly when disease progression impairs absorption.⁹ A recent study by Park YE reported vitamin B12 deficiency in 13.7% of patients and folate deficiency in 5.3% of those with CD.⁷

Prior international research on this topic has revealed substantial variability in findings, with folate deficiency prevalence ranging from 2.9% to 37%^{7,10,11} and vitamin B12 deficiency from 20% to 36.9%^{7,10,11} among CD patients. Furthermore, there is a paucity of local literature addressing folate and B12 deficiencies in this specific cohort of inflammatory bowel disease patients. Given the profound implications of folate and B12 deficiencies for the health of CD patients, this study seeks to ascertain the burden of these nutritional deficiencies within our local population. Our findings will inform the development of targeted guidelines to mitigate these deficiencies, encompassing routine early screening of these biomarkers in all CD patients, as well as the judicious prescription of appropriate supplements for those affected. Ultimately, prompt detection and management of folate and vitamin B12 deficiencies in these individuals will contribute to reducing overall morbidity and mortality.

MATERIAL AND METHODS

This descriptive cross-sectional study was conducted in the Department of Medicine at Divisional Headquarter Teaching Hospital, Mirpur, Azad Jammu and Kashmir (AJK), over a duration of six months from August 2024 to January 2025. Crohn's disease (CD) was diagnosed at the time of presentation to the hospital among patients presenting with chronic diarrhea, fever, recurrent abdominal pain, and elevated C-reactive protein (CRP >10 mg/L), confirmed through computed tomography (CT) and labeled as positive if CT showed any three of the following signs—mural hyperenhancement, fat halo sign, bowel wall thickening (1-2 cm), comb sign, perienteric fat stranding, affected bowel loops separated by focal/regionally increased fat, strictures and fistulae with upstream dilatation and/or mesenteric/intra-abdominal abscess or phlegmon formation. Folate deficiency was diagnosed in all CD patients and labeled as positive if folate levels were less than 3 ng/mL, while vitamin B12 deficiency was diagnosed in all CD patients and labeled as positive if serum vitamin B12 levels were less than 125 pg/mL.

The sample size was calculated using the WHO sample size calculator for specified absolute precision, incorporating a confidence level of 95%, an absolute precision required of 4%, and an anticipated population proportion of 5.3% (as described by Park YE et al 2021), resulting in a calculated sample size of eighty-nine patients (n=89). Non-probability, consecutive sampling was employed for participant selection. Inclusion criteria encompassed all patients with a confirmed diagnosis of Crohn's disease, both male and female patients, and those aged 18 to 60 years. Exclusion criteria included patients

taking B12 or folate supplements, those with established anemia, pregnant or lactating mothers, and patients with a history of gastric or intestinal surgery.

The research proposal was presented to the hospital research ethical committee before enrollment. Following an explanation of the objectives and protocol of this study, written consent to participate was obtained from each participant. A detailed clinical history was taken, followed by a thorough physical examination conducted by the trainee researcher. Using aseptic technique, 5 mL of blood was drawn by a phlebotomist from all enrolled patients via a vacuum blood sample tube and sent to the hospital laboratory for analysis. Laboratory results were collected, and folate and vitamin B12 deficiencies were diagnosed according to the criteria outlined previously.

Data were entered and analyzed using computer software SPSS version 25.0. Mean and standard deviation were calculated for quantitative variables and frequencies and percentages were computed for qualitative variables. Study confounders were controlled through stratification. Post-stratification Chi-square testing was applied, with a p -value ≤ 0.05 considered statistically significant.

RESULTS

A total of 121 patients were enrolled for this study. The study population had a mean age of 37.55 ± 12.61 years. The mean Vitamin B12 level was 444.47 pg/mL , while the mean Folate level was 9.34 ng/mL . Furthermore, patients had a prolonged mean disease duration of approximately 66.33 weeks (± 37.27), suggesting a study population with established disease. The study sample was almost equally distributed by gender (49.6% female, 50.4% male). Age was evenly distributed across the three predefined groups. Regarding nutritional status, half of the patients (50.4%) had a normal BMI, while a significant proportion (20.7%) were underweight, highlighting a concern for malnutrition in this population. The majority of patients (60.3%) had a disease duration exceeding one year (>52 weeks), confirming the chronic nature of the studied group. Socioeconomically, a plurality of patients (43.0%) reported no personal income source, and over 60% identified as middle class. Detailed analysis of quantitative and qualitative clinic-demographic variables are illustrated in table 1 and table 2.

Vitamin B12 deficiency was observed in 20.7% (n=25) of patients. In contrast, folate deficiency was less common, affecting 6.6% (n=8) of the study population. The prevalence of vitamin deficiencies are summarized in table 3. A strong and statistically significant association was found between Vitamin B12 deficiency and gender, age, and income source. The deficiency was markedly more prevalent in females compared to males ($p < 0.001$). An overwhelming majority (92.0%) of B12 deficient patients were in the oldest age group (46-60 years), indicating a strong positive association with increasing age ($p < 0.001$). Furthermore, patients with no source of income constituted 84.0% of the deficient group, showing a significant socioeconomic link ($p < 0.001$). No significant associations were found with BMI category, disease duration, or broader financial status. Folate deficiency was also significantly associated with age and BMI. Similar to B12, folate deficiency was more common in older patients

($p=0.023$). A notable finding was the association with BMI; 75.0% of folate-deficient patients were overweight or obese, a proportion significantly higher than in the non-deficient group ($p=0.011$). No other factors, including gender, income, financial status, or disease duration, showed a significant association with folate deficiency. Detailed stratification analysis is illuminated in table 4 and table 5.

Table 1

Descriptive statistics of quantitative variables (N=121)

Variable	Minimum	Maximum	Mean	Std. Deviation
Age (Years)	18.00	60.00	37.55	12.61
Vitamin B12 Level (pg/mL)	87.00	786.00	444.47	218.46
Folate Level (ng/mL)	1.04	15.93	9.34	3.85
Disease Duration (Weeks)	1.00	130.00	66.33	37.27

Table 2

Frequency Distribution of Categorical Variables (N=121)

Variable	Category	Frequency	Percentage (%)
Gender	Female	60	49.6
	Male	61	50.4
Age Group	18-30 years	41	33.9
	31-45 years	42	34.7
	46-60 years	38	31.4
BMI Category	Normal (20-25)	61	50.4
	Overweight/Obese (>25)	35	28.9
	Underweight (<20)	25	20.7
Disease Duration	≤ 24 Weeks	18	14.9
	25-52 Weeks	30	24.8
	> 52 Weeks	73	60.3
Source of Income	Business	32	26.4
	Job	37	30.6
	Nil	52	43.0
Financial Status	Middle Class	73	60.3
	Poor	28	23.1
	Rich	20	16.5

Table 3

Prevalence of Vitamin B12 and Folate Deficiency in Crohn's Disease Patients (N=121)

Vitamin Deficiency	Frequency (n)	Percentage (%)
Vitamin B12 Deficiency		
No	96	79.3
Yes	25	20.7
Folate Deficiency		
No	113	93.4
Yes	8	6.6

Table 4

Association between Patient Characteristics and Vitamin B12 Deficiency

Confounding Variables		Vitamin B12 Deficient (n=25)	Non-Deficient (n=96)	p-value
Gender	Female	23 (92.0%)	37 (38.5%)	<0.001
	Male	2 (8.0%)	59 (61.5%)	
Age Group	18-30 years	1 (4.0%)	40 (41.7%)	<0.001
	31-45 years	1 (4.0%)	41 (42.7%)	
	46-60 years	23 (92.0%)	15 (15.6%)	
Source of Income	Business	2 (8.0%)	30 (31.3%)	<0.001
	Job	2 (8.0%)	35 (36.5%)	
	Nil	21 (84.0%)	31 (32.3%)	
BMI Category	Normal	15 (60.0%)	46 (47.9%)	0.485
	Overweight/Obese	5 (20.0%)	30 (31.3%)	

Disease Duration	Underweight	5 (20.0%)	20 (20.8%)	0.592
	≤ 24 Weeks	5 (20.0%)	13 (13.5%)	
	25-52 Weeks	7 (28.0%)	23 (24.0%)	
Financial Status	>52 Weeks	13 (52.0%)	60 (62.5%)	0.164
	Middle Class	17 (68.0%)	56 (58.3%)	
	Poor	7 (28.0%)	21 (21.9%)	
	Rich	1 (4.0%)	19 (19.8%)	

Table 5

Association between Patient Characteristics and Folate Deficiency

Confounding Variables		Folate Deficient (n=8)	Non-Deficient (n=113)	p-value
Age Group	18-30 years	1 (12.5%)	40 (35.4%)	0.023
	31-45 years	1 (12.5%)	41 (36.3%)	
	46-60 years	6 (75.0%)	32 (28.3%)	
BMI Category	Normal	1 (12.5%)	60 (53.1%)	0.011
	Overweight/Obese	6 (75.0%)	29 (25.7%)	
	Underweight	1 (12.5%)	24 (21.2%)	
Gender	Female	5 (62.5%)	55 (48.7%)	0.450
	Male	3 (37.5%)	58 (51.3%)	
Source of Income	Business	1 (12.5%)	31 (27.4%)	0.478
	Job	2 (25.0%)	35 (31.0%)	
	Nil	5 (62.5%)	47 (41.6%)	
Financial Status	Middle Class	3 (37.5%)	70 (61.9%)	0.174
	Poor	4 (50.0%)	24 (21.2%)	
	Rich	1 (12.5%)	19 (16.8%)	
Disease Duration	≤ 24 Weeks	1 (12.5%)	17 (15.0%)	0.981
	25-52 Weeks	2 (25.0%)	28 (24.8%)	
	>52 Weeks	5 (62.5%)	68 (60.2%)	

DISCUSSION

The principal findings of our study reveal a high prevalence of vitamin B12 deficiency (20.7%), contrasting with a relatively lower rate of folate deficiency (6.6%). The observed prevalence for B12 deficiency aligns with the well-established pathophysiology of Crohn's disease. Vitamin B12 absorption occurs exclusively in the terminal ileum, a segment frequently affected in Crohn's disease. Inflammation, surgical resection (e.g., ileocectomy), or bacterial overgrowth can severely compromise its absorption.^{12,13} Our finding underscores that even without specific data on disease location or surgical history, B12 deficiency remains a pervasive issue in this population. The mean disease duration of over one year in most patients (60.3%) provided ample time for chronic inflammation to impair physiological absorption, contributing to this high frequency.

The most compelling findings of this study are the profound associations between B12 deficiency and specific demographic factors such as gender, older age and socioeconomic link. The overwhelming predominance of deficiency in females (92% of deficient cases) is a critical

finding that demands explanation. In many Pakistani households, gendered feeding practices persist, where women, especially mothers, may prioritize nutrient-rich foods for male earners and children, inadvertently compromising their own nutritional intake. This "self-sacrificing" behavior, combined with the increased nutritional demands of repeated pregnancies and lactations, could create a baseline suboptimal B12 status, which is then severely exacerbated by the malabsorptive effects of Crohn's disease.¹⁴ The strong correlation between older age (46-60 years) and B12 deficiency is multifactorial. Firstly, Crohn's disease is a progressive condition. Older patients within this cohort likely have long-standing disease, potentially with more extensive ileal involvement or a history of resections. Secondly, age-related physiological changes, such as atrophic gastritis and reduced intrinsic factor production, can compound the disease-related absorption issues. This creates a double jeopardy for older Crohn's patients, making them exceptionally vulnerable.¹⁵ The finding that 84% of B12 deficient patients had no personal income powerfully highlights the role of socioeconomic status. B12 is primarily found in animal-based foods (meat, eggs, dairy), which are more expensive. Lack of personal income translates to limited financial agency and reduced access to these nutrient-dense foods. This forces a greater reliance on a B12-poor, plant-based diet, making adequate intake nearly impossible without supplementation, which is often unaffordable or inaccessible.^{16,17}

The lower rate of folate deficiency (6.6%) can be explained by its different absorption pathway. Folate is absorbed primarily in the jejunum, which is less commonly the primary site of severe inflammation in Crohn's compared to the ileum. Furthermore, the Pakistani diet, largely based on wheat and pulses, is often fortified with folic acid or naturally contains folates, providing a dietary buffer.^{18,19} However, the significant association with overweight/obesity is paradoxical and intriguing. Traditionally, malnutrition in Crohn's is associated with underweight status. Our finding suggests a shift towards "hidden malnutrition" in patients with higher BMI. This could be attributed to a "Westernized" dietary pattern emerging in urban Pakistan, characterized by high energy intake from processed foods and sugary drinks that are calorie-dense but micronutrient-poor. These patients may have adequate or excessive caloric intake, satisfy energy needs but fail to meet micronutrient requirements, leading to conditions like folate deficiency despite an overweight status. This association warrants further investigation into the dietary quality of different patient subgroups.^{20,21}

REFERENCES

1. Tulsı, R., Iqbal, Z., Abbas, S. S., Shah, S. F., Akhtar, N., & Asif, M. (2021). Complicated Crohn's disease is associated with adverse outcomes in patients hospitalized for acute abdominal pain. *Pakistan Journal of Medical and Health Sciences*, 16(6), 869-870. <https://doi.org/10.53350/pjmhs22166869>
2. Roda, G., Chien Ng, S., Kotze, P. G., Argollo, M., Panaccione, R., Spinelli, A., Kaser, A., Peyrin-Biroulet, L., & Danese, S. (2020). Crohn's disease. *Nature Reviews Disease Primers*, 6(1). <https://doi.org/10.1038/s41572-020-0156-2>
3. Park, S. H. (2022). Update on the epidemiology of inflammatory bowel disease in Asia: Where are we now? *Intestinal Research*, 20(2), 159-164. <https://doi.org/10.5217/ir.2021.00115>
4. Anıwan, S., Santiago, P., Loftus, E. V., & Park, S. H. (2022). The epidemiology of inflammatory bowel disease in Asia and Asian immigrants to western countries. *United European Gastroenterology Journal*, 10(10), 1063-1076. <https://doi.org/10.1002/ueg2.12350>
5. Petagna, L., Antonelli, A., Ganini, C., Bellato, V.,

The findings of this study carry profound implications for managing Crohn's disease in Pakistan's resource-constrained healthcare setting. Relying on clinical symptoms alone for detecting deficiencies is inadequate, as they are often non-specific and overlap with active disease. Our data strongly advocate for a protocol of universal and regular screening for vitamin B12 and folate in all Crohn's disease patients.

Limitations

Despite various strengths and clinical implications of this study, the interpretations of our findings must be tempered by an acknowledgment of the study's limitations. The most significant limitation is the lack of data on disease phenotype, specifically the location (e.g., ileal vs. colonic) and behavior, as well as a history of prior ileal resections. This information is crucial for definitively explaining the B12 deficiency rates, as ileal disease is the strongest predictor. In this study, we lacked data on current medications (e.g., sulfasalazine which can impair folate absorption) or previous surgical history, which are key confounders. Furthermore, the cross-sectional nature of this study identifies associations but cannot establish causality. While we infer dietary practices, the absence of a validated food frequency questionnaire or detailed dietary intake data is a limitation. The small absolute number of patients with folate deficiency (n=8) means that the associations found for this outcome, while statistically significant, must be interpreted with caution and require validation in larger studies. In the last, the findings from a single center may not be fully generalizable to the entire Pakistani population or other LMICs with different cultural and dietary practices.

CONCLUSION

This study demonstrates a high prevalence of Vitamin B12 deficiency among Crohn's disease patients of our local population, disproportionately affecting older, female, and low-income individuals. The distinct risk profile of folate deficiency, linked to overweight status, highlights a shift toward hidden malnutrition. These findings underscore that micronutrient deficiency is not merely a biochemical anomaly but a core complication of Crohn's disease, profoundly influenced by local sociodemographic factors. Consequently, a standardized care model must integrate proactive nutritional screening and targeted supplementation, moving beyond symptom control to address this critical determinant of long-term patient outcomes in resource-limited settings.

- Campanelli, M., Divizia, A., Efrati, C., Franceschilli, M., Guida, A. M., Ingallinella, S., Montagnese, F., Sensi, B., Siragusa, L., & Sica, G. S. (2020). Pathophysiology of Crohn's disease inflammation and recurrence. *Biology Direct*, 15(1). <https://doi.org/10.1186/s13062-020-00280-5>
6. Lamb, C. A., Kennedy, N. A., Raine, T., Hendy, P. A., Smith, P. J., Limdi, J. K., Hayee, B., Lomer, M. C., Parkes, G. C., Selinger, C., Barrett, K. J., Davies, R. J., Bennett, C., Gittens, S., Dunlop, M. G., Faiz, O., Fraser, A., Garrick, V., Johnston, P. D., ... Hawthorne, A. B. (2019). British Society of Gastroenterology consensus guidelines on the management of inflammatory bowel disease in adults. *Gut*, 68(Suppl 3), s1-s106. <https://doi.org/10.1136/gutjnl-2019-318484>
 7. Park, Y. E., Park, S. J., Park, J. J., Cheon, J. H., Kim, T., & Kim, W. H. (2021). Incidence and risk factors of micronutrient deficiency in patients with IBD and intestinal Behçet's disease: Folate, vitamin B12, 25-OH-vitamin D, and ferritin. *BMC Gastroenterology*, 21(1). <https://doi.org/10.1186/s12876-021-01609-8>
 8. Pan, Y., Liu, Y., Guo, H., Jabir, M. S., Liu, X., Cui, W., & Li, D. (2017). Associations between folate and vitamin B12 levels and inflammatory bowel disease: A meta-analysis. *Nutrients*, 9(4), 382. <https://doi.org/10.3390/nu9040382>
 9. Vaccaro, J. A., Qasem, A., & Naser, S. A. (2023). Folate and vitamin B12 deficiency exacerbate inflammation during mycobacterium avium paratuberculosis (MAP) infection. *Nutrients*, 15(2), 261. <https://doi.org/10.3390/nu15020261>
 10. Li, X., Hu, Y., Shi, X., Zhu, X., & Liu, F. (2022). Prevalence and relevant factors of micronutrient deficiencies in hospitalized patients with inflammatory bowel disease. *Nutrition*, 99-100, 111671. <https://doi.org/10.1016/j.nut.2022.111671>
 11. Akbulut, S. (2022). An assessment of serum vitamin B12 and folate in patients with Crohn's disease. *Medicine*, 101(50), e31892. <https://doi.org/10.1097/md.00000000000031892>
 12. Ward, M. G., Kariyawasam, V. C., Mogan, S. B., Patel, K. V., Pantelidou, M., Sobczyńska-Malefora, A., Porté, F., Griffin, N., Anderson, S. H., Sanderson, J. D., Harrington, D. J., & Irving, P. M. (2015). Prevalence and risk factors for functional vitamin B12 deficiency in patients with Crohn's disease. *Inflammatory Bowel Diseases*, 21(12), 2839-2847. <https://doi.org/10.1097/mib.0000000000000559>
 13. Headstrom, P. D., Rulyak, S. J., & Lee, S. D. (2008). Prevalence of and risk factors for vitamin B12 deficiency in patients with Crohn's disease. *Inflammatory Bowel Diseases*, 14(2), 217-223. <https://doi.org/10.1002/ibd.20282>
 14. Shafiq, A., Hussain, A., Asif, M., Jameel, A., Sadiq, S., & Kanwel, S. (2021). Determinants of gender disparity in nutritional intake among children in Pakistan: Evidence from PDHS. *Children*, 9(1), 7. <https://doi.org/10.3390/children9010007>
 15. Marchi, G., Busti, F., Lira Zidanés, A., Vianello, A., & Girelli, D. (2020). Cobalamin deficiency in the elderly. *Mediterranean Journal of Hematology and Infectious Diseases*, 12(1), e2020043. <https://doi.org/10.4084/mjihid.2020.043>
 16. Niklewicz, A., Smith, A. D., Smith, A., Holzer, A., Klein, A., McCaddon, A., Molloy, A. M., Wolffenbuttel, B. H., Nexø, E., McNulty, H., Refsum, H., Gueant, J., Dib, M., Ward, M., Murphy, M., Green, R., Ahmadi, K. R., Hannibal, L., & Warren, M. J. (2022). The importance of vitamin B12 for individuals choosing plant-based diets. *European Journal of Nutrition*, 62(3), 1551-1559. <https://doi.org/10.1007/s00394-022-03025-4>
 17. Obeid, R., Heil, S. G., Verhoeven, M. M., Van den Heuvel, E. G., De Groot, L. C., & Eussen, S. J. (2019). Vitamin B12 intake from animal foods, biomarkers, and health aspects. *Frontiers in Nutrition*, 6. <https://doi.org/10.3389/fnut.2019.00093>
 18. Steger, G. G., Mader, R. M., Vogelsang, H., Schöfl, R., Lochs, H., & Ferenci, P. (1994). Folate absorption in Crohn's disease. *Digestion*, 55(4), 234-238. <https://doi.org/10.1159/000201153>
 19. Onal, I. K. (2013). Folate deficiency in Crohn's disease. *Scandinavian Journal of Gastroenterology*, 49(2), 253-254. <https://doi.org/10.3109/00365521.2013.865260>
 20. Mercantepe, F. (2023). Relationship of vitamin B12 levels with different degrees of obesity and diabetes mellitus. *Cureus*. <https://doi.org/10.7759/cureus.47352>
 21. Soysal, P., Smith, L., Capar, E., Kalan, U., Arik, F., & Isik, A. T. (2019). Vitamin B12 and folate deficiencies are not associated with nutritional or weight status in older adults. *Experimental Gerontology*, 116, 1-6. <https://doi.org/10.1016/j.exger.2018.12.007>