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ARTICLE

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The importance of vitamin B12 supplementation in bariatric patients: prevention of megaloblastic anemia and associated health risks

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Abstract

Introduction: Obesity is a chronic condition linked to various diseases and high mortality. With the increase in cases in Brazil, bariatric surgery has been an effective alternative for weight loss and control of comorbidities. However, this procedure can cause nutritional deficiencies, especially of vitamin B12, whose absorption is impaired. A lack of this vitamin can lead to megaloblastic anemia, affecting neurological and hematological health. For this reason, adequate supplementation in the post-operative period is essential. This study highlights the importance of vitamin B12 in preventing anemia and promoting public health. **Objective**: To analyze the importance of vitamin B12 in patients undergoing bariatric surgery **Methodology:** This study is based on qualitative and exploratory research through a literature review, with the objective of analyzing the importance of vitamin B12 supplementation in patients undergoing bariatric surgery, especially in the prevention of megaloblastic anemia. Data was collected from books, specialized journals and scientific articles available on databases such as Pubmed, SciELO, LILACS and Google Scholar**. Results:** Vitamin B12 is essential for metabolic and neurological functions and is mainly obtained from animal foods. After bariatric surgery, its absorption can be impaired, resulting in deficiency and the risk of megaloblastic anemia. This condition compromises the production of red blood cells and affects the nervous system. Adequate B12 supplementation is therefore essential to prevent complications and maintain patients' health. **Conclusion:** The analysis of the data concluded that vitamin B12 supplementation is essential for the prevention of megaloblastic anemia in bariatric patients, due to the anatomical and physiological changes that compromise its absorption. Cobalamin is essential for the synthesis of DNA, the production of red blood cells and neurological functioning, requiring individualized monitoring in the post-operative period. Route choice should reflect clinical severity and absorption.

1. INTRODUCTION

Obesity is a chronic condition characterized by excessive accumulation of body fat. It is associated with increased mortality and several health complications, including diabetes mellitus, hypertension, dyslipidemia, cardiovascular disease, and cancer (Paniz et al., 2005). According to a study presented at the 2024 International Congress on Obesity, within 20 years 48% of Brazilian adults older than 18 years will have obesity and 27% will have overweight, totaling 75% of the adult population. By 2044, 130 million Brazilians are projected to be above a healthy weight: 83 million with obesity and 47 million with overweight (Garcia, 2024).

In this concerning context, bariatric surgery is an important therapeutic option for obesity. The procedure reduces food intake and/or nutrient absorption, thereby supporting weight loss, improving control of comorbidities, and enhancing quality of life (Souza et al., 2020). Despite its benefits, it may cause immediate or late complications. Anorexia, diarrhea, and dumping syndrome are among the most frequent adverse effects. Long-term complications may include ulcers, osteoporosis, protein malnutrition, and deficiencies of nutrients such as calcium, iron, and vitamin B12 (Kwon et al., 2014).

Vitamin B12 deficiency is one of the most concerning nutritional problems after bariatric surgery. The vitamin is absorbed in the terminal ileum, and this process may be impaired by procedure-related anatomical changes. Reduced gastric production of intrinsic factor further decreases absorption and increases the risk of deficiency. Vitamin B12 deficiency may lead to megaloblastic anemia, characterized by ineffective red blood cell production, and may cause fatigue, weakness, paresthesia of the extremities, and cognitive difficulties (Stabler, 2013).

Megaloblastic anemia is the most common form of macrocytic anemia and may result from vitamin B12 and/or folate deficiency. Both nutrients have essential coenzyme functions in reactions required for DNA synthesis (Green & Miller, 2005). Vitamin B12 is water soluble and is synthesized exclusively by microorganisms. In the human diet, it is found primarily in animal-derived foods such as meat, milk, and eggs. In the body, adenosylcobalamin is
stored mainly in the liver; its coenzyme forms are crucial to cellular metabolism and maintenance of the nervous system (Paniz et al., 2005).

Given this risk, vitamin B12 supplementation is particularly important for patients undergoing bariatric surgery because it helps maintain adequate body stores (Barbosa & Deuner, 2024). Replacement may involve high-dose oral supplementation or intramuscular injections, depending on the severity of deficiency. Supplementation is essential to prevent neurological and hematological complications and to support metabolic health during the postoperative period (Carvalho et al., 2012).

B-complex vitamins, including vitamin B12, perform essential physiological functions, including roles in nucleic acid and protein synthesis, phosphatidylcholine production, and nervous system function (Barbosa & Deuner, 2024). Adequate supplementation and nutritional supervision are therefore necessary to prevent complications and support recovery and quality of life after bariatric surgery (Kwon et al., 2014).

Bariatric surgery is a medical intervention for severe obesity, particularly when strategies such as dietary modification and physical activity have not produced clinically meaningful weight loss. Its main objective is to reduce gastric volume and/or modify digestion, limiting caloric intake and absorption and thereby promoting weight loss. Bariatric surgery has been successful in several clinical contexts (Sociedade Brasileira de Cirurgia Bariátrica e Metabólica, 2015). In addition to surgery, successful weight management requires adherence to postoperative vitamin replacement, staged dietary

progression, changes in eating patterns, regular physical activity, and attendance at scheduled follow-up visits (Kwon et al., 2014). Accordingly, this study addresses the importance of vitamin B12 supplementation after bariatric surgery, focusing on the prevention of megaloblastic anemia and its health effects. It seeks to inform education, clinical practice, and awareness of postoperative nutritional care and to emphasize the public health relevance of this issue.

To analyze the importance of vitamin B12 supplementation in preventing megaloblastic anemia in patients undergoing bariatric surgery, with emphasis on its health implications.

- To investigate the prevalence of vitamin B12 deficiency in patients undergoing bariatric surgery, with attention to the surgical procedures performed;
- To analyze the effects of regular vitamin B12 supplementation on the prevention of megaloblastic anemia associated with deficiency.
- To evaluate the effectiveness of different supplementation protocols (oral, intramuscular, and sublingual) used in the postoperative follow-up of these patients.

1.2 RATIONALE

This topic warrants investigation because the effects of vitamin B12 deficiency in patients who have undergone bariatric surgery require clearer understanding. These individuals remain under treatment for obesity, and their care must account for both the underlying disease and the importance of vitamin B12 supplementation. Emphasizing megaloblastic anemia and its health consequences helps clarify the clinical relevance of the subject.

Despite the benefits of bariatric surgery, postoperative physiological changes may lead to nutritional deficiencies, many of which are related to the procedure performed. These changes may have substantial effects on health and frequently require nutrient supplementation. If untreated, nutritional deficits may worsen or contribute to disorders such as iron-deficiency anemia, megaloblastic anemia, and bone disease (Kwon et al., 2014).

According to Paniz et al. (2005), vitamin B12 is an essential micronutrient that supports multiple cellular and enzymatic functions. As methylcobalamin, it serves as a coenzyme in the remethylation of homocysteine to methionine in the cytoplasm, a metabolic pathway that is important for DNA synthesis.

Nutritional deficiencies after bariatric surgery are therefore diverse and may produce a range of clinical and biological manifestations depending on the procedure performed (Kwon et al., 2014). Against this background, the present study examines bariatric surgery and the implications of vitamin B12 deficiency for the prevention of megaloblastic anemia.

2. METHODS

This qualitative, exploratory literature review examines the relevance of vitamin B12 supplementation in patients who have undergone bariatric surgery, focusing on the prevention of megaloblastic anemia and its potential health risks.

The literature was examined to identify concepts relevant to the topic. Information was obtained from books, scientific journals, and articles indexed in bibliographic databases, including PubMed/MEDLINE, SciELO (Scientific Electronic Library Online), LILACS (Latin American and Caribbean Health Sciences Literature), and Google Scholar.

The following descriptors were used: vitamin B12; nutritional supplementation; bariatric surgery; and megaloblastic anemia.

The inclusion criteria comprised studies published within the previous 10 years,

with exceptions for seminal authors, in Portuguese or other languages, provided that they were theoretically relevant to the topic. Studies that did not address the research topic were excluded.

The findings were analyzed in light of the scientific evidence to answer the guiding question: "What is the importance of vitamin B12 supplementation in bariatric patients for preventing megaloblastic anemia and its health effects?" The discussion was organized to emphasize the consequences of vitamin B12 deficiency and the effectiveness of supplementation strategies.

3. RESULTS AND DISCUSSION

3.1 Vitamin B12 and its role in the body

Cobalamin, commonly known as vitamin B12, is a water-soluble vitamin synthesized exclusively by microorganisms. It belongs to the corrinoid family, whose compounds contain a cobalt atom at the center of their structure. Its molecular architecture includes a ribose moiety, a phosphate group, and a nitrogenous base (5,6-dimethylbenzimidazole) linked to the corrin ring (Paniz et al., 2005).

Because vitamin B12 is synthesized only by bacteria, it occurs naturally in animal-derived foods, particularly foods that have been fermented or exposed to B12-producing microorganisms. In animals, cobalamin accumulates in tissues after being obtained through the intestinal microbiota, provided that sufficient dietary cobalt is available. Production is especially efficient in ruminants because adequate cobalt supports microbial synthesis in the rumen. Consequently, ruminant tissues contain higher B12 concentrations than those of nonruminant species. Meat, milk, eggs, and their derivatives are therefore the main natural dietary sources, whereas unfortified plant foods generally provide negligible amounts.

Vitamin B12 is essential to normal human physiology and participates in several metabolic pathways (Wong et al., 2015). It has two principal coenzyme functions: methylcobalamin supports the remethylation of homocysteine to methionine, a pathway required for DNA synthesis, whereas 5-deoxyadenosylcobalamin supports conversion of L-methylmalonyl-CoA to succinyl-CoA, an important step in mitochondrial energy metabolism (Stabler, 2013). Deficiency disrupts both pathways and may produce diverse clinical signs and symptoms (Wong et al., 2015).

Cobalamin absorption is a complex process that depends on the integrity of the gastrointestinal tract. Vitamin B12 is initially bound to dietary proteins and is released in the stomach by gastric acid and pepsin. It then binds to haptocorrin, a protein secreted by the salivary glands and gastric mucosa, and is transported to the duodenum. Pancreatic enzymes degrade haptocorrin, releasing vitamin B12, which subsequently binds to intrinsic factor, a glycoprotein produced by gastric parietal cells (Čabarkapa et al., 2007).

In patients who have undergone bariatric surgery, reduced gastric acidity, decreased functional gastric surface area, and limited contact between food and digestive secretions may impair successive stages of this process. Risk varies according to the surgical technique, time since surgery, preoperative stores, and adherence to supplementation (Kwon et al., 2014; Paniz et al., 2005).

The vitamin B12-intrinsic factor complex travels through the small intestine to the terminal ileum, where it is recognized and absorbed by specific receptors, including cubilin, in a calcium-dependent process (Paniz et al., 2005). Within enterocytes, lysosomes release cobalamin, which is transported in plasma by specific binding proteins. Approximately 70%-80% circulates bound to haptocorrin, whereas 10%-30% is bound to transcobalamin, the biologically available fraction delivered to cells (Paniz et al., 2005).

The adult human body stores approximately 2-5 mg of vitamin B12, about 80% of

which is concentrated in the liver (Carmel, 2000). Excretion occurs mainly through biliary and renal routes. Approximately 65%-75% of the vitamin secreted in bile is reabsorbed in the intestine through enterohepatic circulation, which also depends on intrinsic factor (Paniz et al., 2005).

Cobalamin has several essential physiological roles. It supports red blood cell production and thus oxygen transport. Deficiency may cause megaloblastic anemia, characterized by large, functionally ineffective erythrocytes. In the nervous system, vitamin B12 contributes to the formation and maintenance of myelin, which surrounds neurons and facilitates nerve impulse conduction (Stabler, 2013).

Vitamin B12 is also required for DNA synthesis and repair, cellular renewal, and tissue maintenance. It participates in the metabolism of carbohydrates, proteins, and lipids and thereby supports energy production for vital functions (Paniz et al., 2005).

Studies have associated vitamin B12 status with cognitive performance, including concentration and memory. Insufficient levels have been associated with greater neurological impairment in conditions such as Parkinson disease, including advanced Hoehn-Yahr stages, with accelerated motor and cognitive decline (Viana et al., 2022).

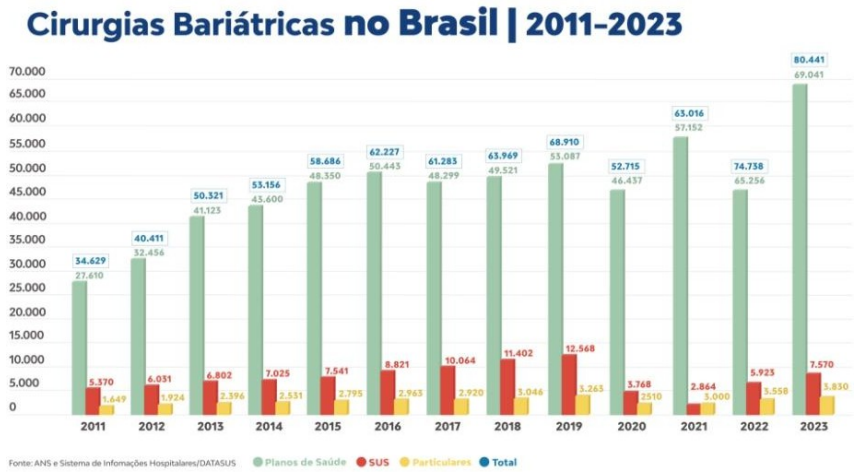
Although animal-derived foods are the richest natural sources, foods fortified with synthetic vitamin B12, including soy, rice, or oat beverages, breakfast cereals, and plant-based milk alternatives, may help prevent deficiency, particularly in vegetarian or vegan diets (Herrmann & Geisel, 2002).

Vitamin B12 deficiency may also produce anxiety-like symptoms, including irritability, agitation, impaired concentration, and fatigue, owing to central nervous system involvement (Stabler, 2013). If untreated, it may progress to more severe neurological manifestations, including paresthesia of the extremities, memory deficits, and depression. Other possible findings include jaundice, vertigo, tremor, hair loss, gastrointestinal disturbances such as diarrhea or constipation, glossitis, and stomatitis (Stabler, 2013; Viana et al., 2022).

3.2 Bariatric surgery and vitamin B12 deficiency

In 2023, 80,441 bariatric procedures were performed in Brazil, although an estimated 8,239,871 people met criteria for surgery. This indicates that only 0.097% of Brazilians with class I, II, or III obesity, or who otherwise met national treatment guidelines, had access to bariatric and metabolic surgery during that period (Sociedade Brasileira de Cirurgia Bariátrica e Metabólica, 2024).

Chart 1 - Bariatric procedures performed in Brazil from 2011 to 2023.



Source: Sociedade Brasileira de Cirurgia Bariátrica e Metabólica (2024).

Despite its benefits, bariatric surgery may lead to several clinical complications over time. Common adverse effects include anorexia, nausea, and dumping syndrome (Carvalho et al., 2012). Later complications may include ulcers, osteoporosis, protein-calorie malnutrition, and impaired absorption of essential nutrients such as calcium, iron, and vitamins. Anemia is a frequent complication of micronutrient deficiency, especially deficiencies of iron, folate, and vitamin B12 associated with gastric resection (Kwon et al., 2014).

Nutritional deficiency is therefore a major postoperative concern. Even when dietary supplements are administered, many patients continue to exhibit clinically relevant deficiencies. Bariatric surgery can affect serum vitamin B12 concentrations over time. A Swiss survey reported deficiency in approximately 17% of patients during the first 12 months after gastric bypass (Kwon et al., 2014).

These findings are supported by Carvalho et al. (2012), who identified reduced vitamin B12 concentrations in 23.1% of the patients evaluated. Among those with normal preoperative values, 15.4% developed deficiency six months after surgery. Of 21 patients with preoperative abnormalities, 15 achieved normal levels after surgery and six remained deficient. Mean serum vitamin B12 decreased from 509.6 +/- 330.2 pg/mL before surgery to 298.2 +/- 148.4 pg/mL at six months. Although the difference was not statistically significant because postoperative time was excluded as a variable, the downward trend was evident.

Vitamin B12 absorption involves release of the nutrient in the stomach by gastric acid, binding to intrinsic factor produced by parietal cells, and subsequent absorption of the complex in the terminal ileum. Procedures such as the Fobi-Capella technique may directly disrupt this mechanism. Studies indicate that more than 30% of operated patients may develop vitamin B12 deficiency between the first and ninth postoperative years (Kwon et al., 2014). Achlorhydria, intolerance of meat and dairy products, and reduced intrinsic factor production contribute substantially to this deficiency.

In some cases, vitamin B12 deficiency is not detected during the first postoperative months, possibly because of supplement use or the short interval since surgery. Nevertheless, the literature indicates that deficiency may persist over the long term. Although surgery can improve cholesterol, triglyceride, and glucose concentrations, it may also cause important deficiencies such as vitamin B12 deficiency and therefore requires ongoing surveillance (Souza et al., 2020).

Cobalamin is a water-soluble micronutrient required for multiple biological processes, including cellular growth and maturation, particularly erythropoiesis. Deficiency may result in megaloblastic anemia, characterized by ineffective red blood cell production and reduced oxygen-carrying capacity (Gomes et al., 2024).

Vitamin B12 deficiency is recurrent among bariatric patients and appears to be most pronounced preoperatively and during the first postoperative year, with a tendency toward stabilization between the fifth and tenth years. A higher incidence has also been reported among women. Continuous nutritional follow-up and periodic measurement of serum cobalamin are therefore important for preventing or correcting deficiency (Gomes et al., 2024).

This pattern may reflect adaptation to the altered gastrointestinal anatomy, changes in dietary habits, and possible improvement in nutrient absorption over time. Continued absorption of the intrinsic factor-vitamin B12 complex after resection of portions of the digestive tract may indicate some functional adaptation to the new anatomy (Souza et al., 2020).

These results should be interpreted in light of heterogeneity across studies. Reported deficiency rates vary according to laboratory cutoffs, supplementation protocols,

follow-up duration, and the clinical profile of the sample. A lower prevalence at particular time points therefore does not eliminate the need for lifelong surveillance (Gomes et al., 2024; Kwon et al., 2014).

3.3 Megaloblastic anemia: definition and risks

Anemia is characterized by reduced hematocrit, hemoglobin concentration, or circulating red blood cell count. Reference thresholds vary according to age, sex, and geographic factors such as altitude (Failace & Fernandes, 2009). Anemia may be identified by changes in erythrocyte number, hemoglobin content, or red blood cell size. Its causes include genetic disorders, nutritional deficiencies such as iron, vitamin B12, or folate deficiency, hemorrhage, infection, chronic disease, and neoplasia.

Anemias are commonly classified according to erythrocyte size and morphology in peripheral blood as microcytic, macrocytic, or normocytic (Rodrigues, 2016; Hoffbrand & Moss, 2013). They may also be classified by hemoglobinization: microcytic anemia is typically hypochromic, whereas normocytic and macrocytic anemias are generally normochromic (Kumar et al., 2016).

Megaloblastic anemia is characterized by macrocytic red cells with nuclear-cytoplasmic asynchrony, abnormalities of leukocytes and platelets, and epithelial changes, particularly in the oral cavity and gastrointestinal tract (Pontes et al., 2009). Morphological classification uses red cell indices such as mean corpuscular volume (MCV) and mean corpuscular hemoglobin (MCH). Anemias may be microcytic and hypochromic (low MCV and MCH), macrocytic and normochromic (high MCV and normal MCH), or normocytic and normochromic (normal MCV and MCH) (Cançado, 2007; Souza & Filho, 2003). In vitamin B12- or folate-deficiency anemia, MCV may exceed 110 fL and reticulocytosis is absent, a pattern consistent with megaloblastic anemia.

Diagnosis of megaloblastic anemia requires evaluation of characteristic morphological abnormalities in peripheral blood and bone marrow and accurate identification of the underlying vitamin deficiency. Distinguishing vitamin B12 deficiency from folate deficiency is essential to appropriate treatment (Navarro & Paz, 2006; Zago et al., 2001).

A classic finding is nuclear hypersegmentation involving the erythroid, granulocytic, and megakaryocytic lineages (De Paz & Hernández-Navarro, 2006; Garay & Garcia, 2006). Peripheral blood smears may show macro-ovalocytes, anisocytosis, poikilocytosis, schistocytes, dacrocytes, Howell-Jolly bodies, Cabot rings, erythroblasts, and megaloblasts, depending on severity. The complete blood count may reveal pancytopenia resulting from reduced erythrocytes, leukocytes, and platelets. Megaloblastic anemia may become more severe as the disorder becomes chronic (Grotto, 2010).

Signs and symptoms of megaloblastic anemia include loss of appetite, asthenia, abdominal pain, nausea, diarrhea, painful oral and pharyngeal ulcers, skin changes, hair loss, fatigue, low energy, and soreness of the mouth and tongue. During pregnancy, it may be associated with preterm birth and fetal malformations; in children, it may contribute to growth retardation and delayed puberty (Zago et al., 2001).

Clinical manifestations of vitamin B12 deficiency range from mild to severe and may include neurological symptoms; weakness, glossitis, and neuropsychiatric changes form a characteristic triad (Garay, 2006). Deficiency may cause optic neuropathy, sensorimotor neuropathy, and autonomic neuropathy involving the myenteric plexuses and autonomic innervation of the bladder, potentially resulting in neurogenic bladder. These conditions may improve or resolve with vitamin B12 replacement (Neto, 2008).

Folate deficiency may cause glossitis with burning, pain, and a red, smooth or "bald" tongue, as well as cheilitis, diarrhea, loss of appetite, and megaloblastic anemia. Unlike

vitamin B12 deficiency, however, folate deficiency does not usually produce the characteristic neurological changes of cobalamin deficiency, an important distinction in differential diagnosis. Other reported effects include skin hyperpigmentation, infertility, reduced bactericidal activity, and reduced lymphocyte subpopulations (Barros & Ramírez, 2009; Zago et al., 2001).

During early pregnancy, folate deficiency may cause neural tube defects such as myelomeningocele, hydrocephalus, and anencephaly because folate is required to meet the needs of the developing fetus, particularly those of the nervous and hematopoietic systems (McDonald et al., 2003; Melere, 2010).

Vitamin B12 has a molecular mass of approximately 1.355 kDa. The term "vitamin B12" refers to a family of compounds containing a tetrapyrrolic ring surrounding a central cobalt atom, a nucleotide group with a 5,6-dimethylbenzimidazole base, and phosphorylated ribose esterified with 1-amino-2-propanol (Fairbanks et al., 1998; Henry, 1999; Klee, 2000). This group is collectively termed cobalamin and includes methylcobalamin, hydroxocobalamin, aquacobalamin, cyanocobalamin, and deoxyadenosylcobalamin. The biologically active forms are methylcobalamin in the cytosol and adenosylcobalamin in mitochondria (Fairbanks et al., 1998; Klee, 2000).

Several vitamin B12 assays measure these forms after conversion to cyanocobalamin, the industrially synthesized form (Herrmann & Geisel, 2002). Vitamin B12 is heat stable but decomposes when exposed to light or alkaline conditions (Silva, 2002).

Serum vitamin B12 should be interpreted together with the complete blood count and clinical presentation. When values are borderline or clinical suspicion remains high, methylmalonic acid and homocysteine testing may improve diagnostic accuracy. Holotranscobalamin may also indicate early depletion, although testing is less widely available (Čabarkapa et al., 2007; Langan & Goodbred, 2017; Stabler, 2013).

Vitamin B12 is released during digestion of animal-derived proteins and binds to haptocorrin, also called transcobalamin I, which is produced in saliva and the stomach (Herrmann & Geisel, 2002). Pancreatic proteases subsequently degrade this complex, allowing vitamin B12 to bind intrinsic factor (IF), a glycoprotein produced by gastric parietal cells. The cobalamin-IF complex protects the vitamin from intestinal proteolytic enzymes and enables absorption in the terminal ileum (Paniz et al., 2005). Intrinsic factor itself is not absorbed and is excreted unchanged (Paniz et al., 2005).

Megaloblastic anemia results from vitamin B12 and/or folate deficiency and is characterized by abnormally large, immature red blood cells. Symptoms range from fatigue to irreversible neurological injury in severe cases. By disrupting DNA synthesis, the disorder primarily affects tissues with high cell turnover, including the hematopoietic and nervous systems (Green & Miller, 2005).

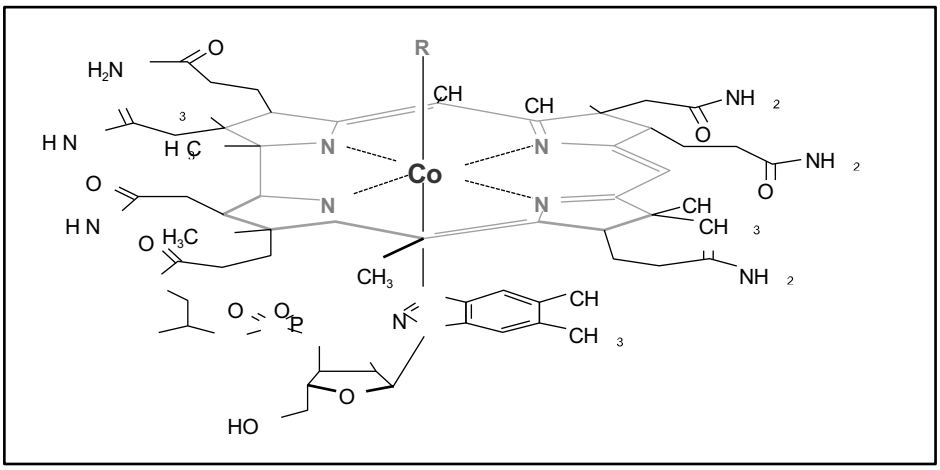
3.4 Importance of vitamin B12 supplementation

Vitamin B12 deficiency impairs regeneration of methionine and tetrahydrofolate, thereby increasing homocysteine. In parallel, reduced activity of L-methylmalonyl-CoA mutase impairs conversion of methylmalonyl-CoA to succinyl-CoA and causes accumulation of methylmalonic acid (MMA), a functional marker of deficiency (Ramos, 2019; Stabler, 2013).

Gastric parietal cells produce hydrochloric acid and intrinsic factor, a glycoprotein required for physiological absorption of vitamin B12 in the terminal ileum. During digestion, vitamin B12 is released from animal-derived proteins and initially binds to haptocorrin, also known as R protein, which is produced by the salivary glands and gastric mucosa (Pereira et al., 2014).

Binding of vitamin B12 to intrinsic factor creates a complex that resists proteolytic enzymes in the intestinal lumen. The complex subsequently binds specific receptors on epithelial cells of the terminal ileum, where vitamin B12 is absorbed, transferred to a plasma carrier, and released into the circulation (Paniz et al., 2005).

Figure 1 - Structure of vitamin B12



Source: Pereira et al. (2014).

Vitamin B12 supplementation is fundamental to correcting deficiency and preventing adverse clinical outcomes. It may be administered orally, sublingually, or by injection according to the severity of deficiency and clinical assessment. Patients with symptoms or risk factors should be referred for medical evaluation to ensure safe, individualized treatment (Costa & Souza, 2022).

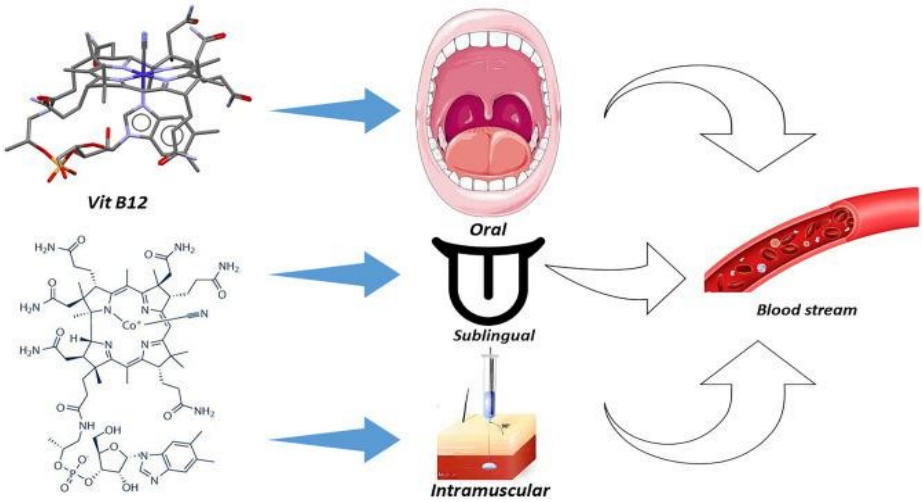
According to the consensus of the Brazilian Association of Nutrology (ABRAN), intramuscular administration is indicated primarily for severe deficiency, gastrointestinal malabsorption, including after bariatric surgery, or when rapid replacement is required. Oral and sublingual routes are considered effective for mild to moderate deficiency when adherence is adequate.

In an analysis of patients with type 2 diabetes who were receiving metformin, Castro (2023) reported that 1 mg of sublingual methylcobalamin for three months effectively corrected serum vitamin B12 levels and produced favorable results compared with intramuscular administration. The author emphasized that the route should be selected according to individual needs and accompanied by continuous clinical and laboratory monitoring.

Ramos (2019) further observed that oral vitamin B12 supplementation after bariatric surgery produced a greater increase in serum levels from the second month than injectable supplementation. Methylmalonic acid concentrations, however, remained unchanged in both groups, suggesting that both routes were functionally effective.

The sublingual route has also been investigated as a potential alternative in malabsorption, although the available evidence remains insufficient for definitive inclusion in clinical guidelines. A systematic review and network meta-analysis by Abdelwahab et al. (2024) evaluated oral, sublingual, and intramuscular routes and found that all increased serum vitamin B12 without statistically significant differences between routes. Although intramuscular administration had the highest statistical ranking, the difference was not clinically meaningful. Hematological measures and homocysteine concentrations likewise did not differ significantly among routes.

Figure 2 - Vitamin B12 absorption process



Source: image reproduced from Abdelwahab et al. (2024).

According to Hunt et al. (2014) and Stabler (2013), serum vitamin B12 concentrations below 200 pg/mL (148 pmol/L) indicate deficiency and are associated with hematological and neurological abnormalities. Deficiency may reduce proliferation of hematopoietic and epithelial cells and lead to accumulation of MMA and propionic acids, compromising the integrity of myelin sheaths. It may also increase serum homocysteine, a risk factor for cardiovascular disease (Carmel, 2000).

Clinically, vitamin B12 deficiency may present as macrocytic megaloblastic anemia, leukopenia, thrombocytopenia, and, in severe cases, pancytopenia (Langan & Goodbred, 2017; Langan & Zawistoski, 2011). Neurological and psychiatric manifestations include areflexia, peripheral neuropathy, gait disturbance, loss of proprioception, reduced vibration sensation, cognitive impairment, including dementia- or psychosis-like syndromes, and irritability. Glossitis may also occur (Stabler, 2013).

Failure to identify and appropriately treat vitamin B12 deficiency may therefore have severe, persistent consequences. Continuous monitoring of serum vitamin B12, particularly in vulnerable populations, and selection of the supplementation strategy on the basis of clinical and laboratory evidence are essential to treatment safety and effectiveness.

For bariatric patients, the safest approach combines preoperative assessment, continuous supplementation, and individualized clinical and laboratory monitoring. A normal complete blood count or absence of macrocytosis does not exclude deficiency, particularly when paresthesia, gait abnormalities, loss of proprioception, or cognitive impairment is present (Associação Brasileira de Nutrologia, 2025; Hunt et al., 2014; Stabler, 2013).

Comparisons among routes must account for differences in dose, formulation, treatment duration, and study population. Statistical ranking should not be interpreted as universal clinical superiority. In severe deficiency, neurological manifestations, or substantial malabsorption, intramuscular therapy enables more rapid replacement; in stable, adherent patients, high-dose oral therapy may be effective (Abdelwahab et al., 2024; Langan & Goodbred, 2017).

4. CONCLUSION

The evidence reviewed indicates that vitamin B12 supplementation is essential to prevent megaloblastic anemia, particularly after bariatric surgery. Procedure-related anatomical and physiological changes, especially those associated with gastric bypass, may impair intestinal and gastric handling of the vitamin. Replacement must therefore be monitored because vitamin B12 is required for DNA synthesis, erythropoiesis, and neurological function. Postoperative deficiency should be assessed in light of each patient's clinical characteristics, and continuous individualized follow-up is fundamental to monitoring clinical status.

Although vitamin B12 is commonly prescribed, its effectiveness depends on appropriate administration and, above all, continuity of treatment. Intramuscular therapy may be more appropriate in severe deficiency or substantial malabsorption, whereas oral therapy may be a viable alternative for patients with partially preserved gastrointestinal function when rigorous follow-up is available. Effective supplementation therefore requires patient education, selection of an appropriate route, and continuous laboratory surveillance to preserve clinical benefits.

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