

# Vitamin C in Various Diets

Subjects: Others

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Recent research studies have shown that vitamin C (ascorbic acid) may affect bone mineral density and that a deficiency of ascorbic acid leads to the development of osteoporosis. Patients suffering from an inflammatory bowel disease are at a risk of low bone mineral density. It is vital to notice that patients with Crohn's disease and ulcerative colitis also are at risk of vitamin C deficiency which is due to factors such as reduced consumption of fresh vegetables and fruits, i.e., the main sources of ascorbic acid. Additionally, some patients follow diets which may provide an insufficient amount of vitamin C. The entry contains information about vitamin C content and impact of various diets- Mediterranean diet, vegetarian diets, low-carbohydrates diets and low-FODMAP diet- on bone mineral density and inflammatory bowel disease course.

Keywords: vitamin C ; inflammatory bowel disease ; osteoporosis ; diet ; Diet, low-FODMAP ; Diet, Mediterranean ; Diet, Vegetarian

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## 1. Mediterranean Diet

The Mediterranean diet (MD) is a dietary habit characteristic for the inhabitants of the Mediterranean region. A high intake of cereal products (couscous, pasta, bread), olives and olive oil, as well as grapes and wine is characteristic for this diet. Additionally, the consumption of fruits, vegetables, nuts, legumes, dairy products (yogurt, cheese), fish and meat (limited quantities) is in the usual range<sup>[1]</sup>.

The study showed that the concentration of vitamin C increased when patients suffering from neoplasms have been on a Mediterranean diet. Moreover, the level of vitamin C was higher in the MD group than in the control group which is consistent with the guidelines of Cancer Society guidelines on nutrition and physical activity for cancer prevention<sup>[2]</sup>. A study by Hagfors L. et al. also indicated that individuals following the Mediterranean diet presented a higher amount of vitamin C than the control group<sup>[3]</sup>. It is vital to notice that MD patients consumed more fruits, although the amounts of vegetables and fruit juice were not significantly higher<sup>[4]</sup>. Thus, a higher consumption of vitamin C in subjects following MD is due to a high intake of vegetables and fruits which are the main sources of AA.

Diets including a high intake of sugar, sweetened beverages and a low intake of vegetables constitute a risk factor of UC<sup>[5]</sup>. It is possible that MD may protect from developing UC due to a high intake of vegetables. Tomasello G. et al. reported that the Mediterranean diet—rich in vegetables, fruits, olive oil and fish—may prevent from dysbiosis which is considered a risk factor for IBD<sup>[6]</sup>. Additionally, a high supply of vitamin C correlated negatively with the risk of CD development<sup>[7]</sup>. In fact, Marlow et al. reported that CRP decreased among patients with CD following six weeks of MD. Researchers noted the tendency (without significant changes) in growth and expression of *Bacteroidetes*, cluster IV and cluster XIVa and a decreased amount of cluster XIVa and Bacillaceae<sup>[8]</sup>.

Adherence to the MD was associated positively with BMD of the femoral neck and lumbar spine<sup>[9]</sup>. Moreover, better MD-adherence was related with a lower risk of bone fracture<sup>[10]</sup>. Silva T. et al. reported that a better MD-adherence among women from the non-Mediterranean region also was associated with a higher BMD of the lumbar spine<sup>[11]</sup>.

On the other hand, MD is considered to be a well-balanced diet and probably other nutritional factors may additionally affect bone tissue. The suggestion that proper intake of vitamin C is responsible for bone health and prevention IBD is virtually impossible. However, we think that MD may be recommended for patients suffering from IBD.

## 2. Vegetarian Diets

A vegetarian diet (VD) relies on the elimination of animal products, primarily meat. A variety of vegetarian diet is a vegan diet in which all animal products—including milk, eggs, honey—are eliminated. These diets have been associated with a higher risk of deficiency of certain nutrients, particularly protein, vitamin B12, iron, vitamin B2, iodine and n-3 fatty acid<sup>[12]</sup>.

Individuals on the low-calorie, lacto-ovo-vegetarian diet consumed a higher amount of vitamin C than subjects following a standard low-calorie diet [13]. Among women on the vegetarian diet, the intake of vitamin C, folate and copper, was higher when compared to a non-vegetarian diet. On the other hand, vegetarians consumed a lower amount of vitamins B2 and B12, niacin, zinc and sodium [14]. Additionally, the serum level of vitamin C increased in individuals on VD [15].

Amarapurkar A. et al. reported that the VD constitutes a risk factor for CD and protects from UC [16]. The study does not show the impact of a vegetarian diet on the course of IBD. However, individuals on the vegetarian diet presented a lower psychological well-being [17]. VD may be favorable for patients suffering from IBD owing to the anti-inflammatory effect and the influence on rebuilding healthy gut microbiota [18]. Additionally, the maintenance of remission occurs more frequently in patients on a VD with a high-fiber content (32.4 g/2000 kcal) when compared with omnivorous individuals [19].

Furthermore, a vegetarian diet was a positive predictor of the total body bone mineral content and the total body areal bone mineral density [20]. Therefore, a decreased BMD of the femoral neck was higher in omnivorous subjects than vegans. However, the incidence of fracture did not differ between the groups [21]. The study showed that a low intake of protein food in terms of vegetarians was associated with a higher risk of wrist fractures [22]. Wang Y. et al. reported the lack of difference in BMD between vegetarians and non-vegetarians. Moreover, the BMD of the femoral neck and lumbar spine was not different in vegans and individuals consuming meat [23]. On the other hand, a long-term study showed that vegan and vegetarian diets constituted risk factors for osteopenia in the femoral neck [24].

### 3. Low-Carbohydrates Diets

A low-carbohydrate diet (LCD) is based on a reduced carbohydrate supply to 50–150 g/day. A very low-carbohydrate diet containing carbohydrate below 20 g/day is called a ketogenic diet [25]. Simultaneously, a low-carbohydrate diet is high in protein and/or -fat.

Individuals following a low-carbohydrates diet (carbohydrates provided less than 45% total energy intake) consumed lower amounts of vitamin C, vegetables and fruits than the subjects in the control group [26]. Additionally, a diet based on guidelines of the Dukan diet (high protein diet, carbohydrates provide 10–25% of total energy intake) results in a lower vitamin C intake (2.5–4.5 mg) [27]. In fact, the ascorbic acid intake was  $94 \pm 59$  mg in the Atkins diet. Nevertheless, it is vital to notice that the authors of the Atkins diet recommend a supplementation of vitamins and minerals [28].

According to Reif et al. high cholesterol and fat intake, especially animal fat, was associated with a higher risk of UC development [18].

The incidence of CD was associated with an intake of fat, animal fat, n-6 fatty acids, animal protein, milk protein, as well as with the ratio of n-6 fatty acids and n-3 fatty acids [29]. Data regarding the association between n-3 fatty acids and CD are contradictory [21][30]. Jantchou et al. reported the association between the total protein intake and animal protein intake, as well as with the risk of IBD [31]. Moreover, there is a risk of CD associated with a meat intake [31].

An animal study has indicated that a 4-week high-fat diet with a standard and a low-protein supply decreased procollagen type 1 N-terminal propeptide (P1NP) when compared with the control group [32]. Kerstetter et al. have reported that a short-term (2 weeks) high-protein diet did not have an influence on bone balance [33]. Additionally, a low-carbohydrate diet may lead to acidosis resulting in an increased excretion of calcium without an increased absorption of calcium, since this element is possibly excreted from bone [34]. According to Draaisma et al. the BMD of children treated with the ketogenic diet and children in the control group was not significantly different [35]. On the other hand, Bergqvist et al. showed that bone mineral content (BMD) has decreased in children on the ketogenic diet [36].

### 4. Low-FODMAP Diet

A low-FODMAP (Fermentable Oligo-, Di- and Mono-saccharides and Polyols) diet assumes reduced the intake of products containing fermentable, poorly digestible oligosaccharide (fructans, galactooligosaccharides, fructooligosaccharides), disaccharides (lactose; only in patients suffering from lactose intolerance), monosaccharides (fructose) and polyols (sorbitol, mannitol, maltitol, xylitol, polydextrose, isomaltose). This further leads to the elimination of certain fruits (e.g., apples, nectarines, peaches, cherries, watermelons) and vegetables (onions, leeks, cauliflowers, asparagus). Low-FODMAP diet is used in the nonpharmacological treatment of irritable bowel syndrome (IBS) [37].

Individuals following a gluten-free and low-FODMAP diet consumed significantly higher amounts of vitamin C when compared with the individuals following a traditional gluten-free diet [38]. Moreover, there was no significant difference in vitamin C intake between patients on a low-FODMAP diet and subjects in the control group [39]. According to Eswaran et

al. patients on low-FODMAP diet consumed higher amounts of vitamin C than patients in the control group, although the difference was not significant [40].

Pedersen et al. reported that symptoms of IBS decreased in patients suffering from IBD adhering to the low-FODMAP diet [41]. A meta-analysis has shown that the adherence to a low-FODMAP diet in patients with IBD decreased symptoms, such as abdominal pains, fatigue and nausea [42]. The low-FODMAP diet may be appropriate for patients suffering from IBD with functional gastrointestinal tract symptoms. However, patients should maintain a regular nutrients intake [43].

The study demonstrated that when compared with patients in the control group the patients on the low-FODMAP diet consumed similar amounts of calcium and vitamin D, which are essential for bone mineralization [44]. Another study showed that patients on the low-FODMAP diet consumed lower amounts of vitamin D and significantly lower amounts of calcium [40].

The comparison of various diets is presented in Table 1.

**Table 1.** Comparison of various diets.

Diet	Vitamin C Content (Compared to Control)	Importance for IBD	Importance for Osteoporosis
Mediterranean diet	Higher	Protects	Prevents
Vegetarian diets	Higher	An increased risk of CD protects from UC	Contradictory data
Low-carbohydrates diets	Lower	Possibly an increased risk of IBD, because of a high intake of animal protein	Possibly an increased risk
Low-FODMAP diet	Higher	Appropriate for IBD patients with symptoms of IBS	Contradictory data

FODMAP—Fermentable Oligo-, Di- and Mono-saccharides and Polyols; CD—Crohn disease; UC—ulcerative colitis; IBS—irritable bowel syndrome.

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