

## THE IMPACT OF VEGAN DIET ON B-12 STATUS IN HEALTHY OMNIVORES: FIVE-YEAR PROSPECTIVE STUDY

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### ABSTRACT

**Background.** There are no long-term prospective studies assessing the impact of the vegan diet on vitamin B-12 (B-12) status. Many vegans take B-12 supplements irregularly or refuse to adopt them at all, considering them to be “unnatural” products. The use of B-12 fortified food may be an alternative. Therefore, we aimed to estimate the long-term effect of a vegan diet on serum B-12 concentrations in healthy omnivore adults, comparing the influence of natural products consumption and B-12 fortified food.

**Material and methods.** A five year prospective study was carried out comprising 20 omnivore healthy adult subjects, who moved to strict vegan diet for 5 years. Ten volunteers followed vegan diet based entirely on natural products, while the remaining ten subjects consumed food fortified in B-12. In all subjects serum vitamin B-12 concentration was determined before and 6, 12, 24 and 60 months after the implementation of the diet.

**Results.** A significant decrease ( $p < 0.0002$ ) of serum B-12 concentrations in the whole studied group was noted after 60 months of vegan diet. However, observed changes were in fact limited to the subgroup consuming exclusively natural products ( $p < 0.0001$ ).

**Conclusions.** Transition from omnivore to vegan diet is associated with the risk of vitamin B-12 deficiency. B-12 fortified products might constitute a valuable alternative in vegans refusing to take vitamin supplements.

**Key words:** vegan diet, vitamin B-12, risk of deficiency, vegetarianism

### INTRODUCTION

Western societies are witnessing during last the decades a rising popularity of all types of vegetarian diet. According to the Mintel survey the percentage of vegetarians in Western Europe varies from 2% to 4% of the population, with the United Kingdom being an exception. Vegetarianism seems to be more frequent in British females as 7% of them declare to follow a strict diet (in comparison to 2% of British males) [Mintel... 2006]. Swan documented that 12% of women aged

19-24 years and 11% aged 25-34 years are vegetarians [Swan 2004]. As a comparison, a poll conducted in the United States in 2006 estimated that 6.8% of adults aged 18 years or older never eat meat while 1.4% declare to follow consistently vegan diet [Stahler 2006].

Vegetarians do not eat meat (including fowl) and seafood, or products containing these foods. The vegan eating pattern additionally excludes eggs and dairy. Vegetarians tend to have lower body mass index (BMI) and cholesterol level among other health benefits linked to the diet. They typically enjoy a lower

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risk of cardiovascular disease, obesity, type 2 diabetes, hypertension and some cancers [Key et al. 1999, 2009, Appleby et al. 2002, Vang et al. 2008, American... 2006]. However, it is also well known that eliminating all animal products from the diet increases the risk of certain nutritional deficiencies. Micronutrients of special concern for the vegetarians include vitamin B-12 (B-12) and D, calcium, long-chain n-3 fatty acids and zinc [Sanders 2009, Craig and Mangels 2009, Mądry et al. 2009]. With many fortified products and dietary supplements available today a great improvement of vegetarians key-micronutrients status has been noted as compared to vegetarians 1-2 decades ago [Craig 2009]. Nonetheless B-12 status of some vegetarians is less than adequate due to the lack of its reliable dietary sources and/or of regular supplementation.

Severe clinical symptoms of B-12 deficiency which include ataxia, psychoses, paresthesia, disorientation, dementia, mood or motor disturbances, may appear with or without obviously known hematological symptoms (megaloblastic anemia, macrocytosis) [Reynolds 2006]. There are no long-term prospective studies assessing the impact of the vegan diet on vitamin B-12 status. Many vegans take B-12 supplements irregularly or refuse to adopt them at all, considering to be “unnatural” products. The use of B-12 fortified food may be an alternative. Therefore, we aimed to estimate the long-term effect of a vegan diet on serum B-12 concentrations in healthy omnivore adults, comparing the influence of natural products consumption and B-12 fortified food.

## MATERIAL AND METHODS

The prospective study was carried out comprising 20 healthy adult omnivores (14 females, 6 males,) who intentionally declared to follow strict vegan diet for at least 5 years. The studied group was divided into 2 subgroups. First subgroup (10 subjects; 7 females, 3 males) followed vegan diet based entirely on natural products, while the second (10 subjects; 7 females, 3 males) consumed B-12 fortified food, widely available in health food stands. The participants were randomly assigned to the subgroups and there were no drop-outs during the study. All subjects adhered to the vegan style diet over the five-year period and they did not take B12-containing supplements in the course of

the study. Fasting serum B12 levels were determined in all participants before and 6, 12, 24 and 60 months after the implementation of the diet. B-12 concentrations were assessed with the use of chemiluminescence immunoassay. (Immunolite-Vitamin B-12 test, Diagnostic Products Corporation; IMX Folate Calibration, Abbott). Values lower than 193 pg/ml were considered as abnormal. The differences in B-12 concentrations were analysed with the use of Friedman test and the post-hoc multiple comparison performed using the Dunn test (dependent samples). The level of statistical significance was set at  $p < 0.05$ .

**Ethical considerations.** The protocol of the investigation was approved by the Ethical Committee of the Poznań University of Medical Sciences, Poznań, Poland.

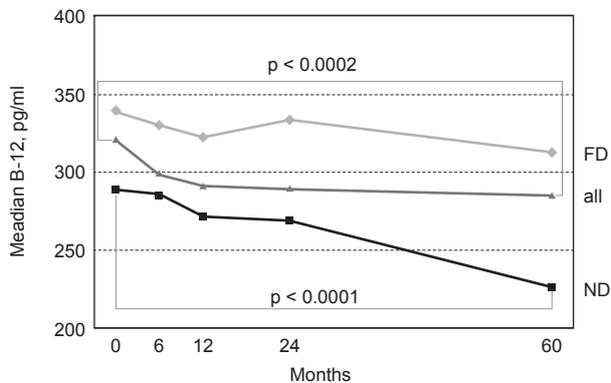
## RESULTS

A significant decrease ( $p < 0.0002$ ) of serum B-12 concentrations in the whole studied group was noted (Fig. 1). However, the observed changes were in fact limited to the subgroup consuming exclusively natural products ( $p < 0.0001$ ). None of the subjects consuming B-12 fortified food demonstrated the decline of B-12 concentration below cut-off level during the whole studied period. Nevertheless, in a subgroup following

**Table 1.** Basic characteristics of the studied subjects

Characteristics	Studied group		
	whole group (N = 20)	FD (N = 10)	ND (N = 10)
Age, years			
Median (mean $\pm$ SEM)	23 (23.0 $\pm$ 0.2)	23 (22.9 $\pm$ 0.2)	23 (23.0 $\pm$ 0.2)
Range	21-25	21-24	22-25
BMI, kg/m <sup>2</sup>			
Median (mean $\pm$ SEM)	21.2 (21.4 $\pm$ 0.4)	21.2 (21.3 $\pm$ 0.3)	21.4 (21.4 $\pm$ 0.4)
Range	18.5-24.7	18.5-24.6	19.0-24.7

ND – vegan diet based upon natural products, FD – vegan diet comprising B-12 fortified products, N – number of participants.



**Fig. 1.** Serum vitamin B-12 concentrations in healthy adult omnivores consuming vegan diet for 60 months. The impact of natural diet and B-12 fortified food: FD – vegan diet comprising B-12 fortified products (N = 10), all – all subjects (N = 20), ND – vegan diet based upon natural products (N = 10)

diet based entirely on natural products, abnormal B-12 level was detected in 2 out of 10 (20%) subjects (166 and 178 pg/ml after 60 months of vegan diet).

## DISCUSSION

Vegans typically have lower plasma B-12 concentrations and higher prevalence of its deficiency than other vegetarians and omnivores [Craig 2009, Elmadfa and Singer 2009]. However, according to PubMed search to date, there are no long-term prospective studies documenting the dynamics of B-12 declining in subjects who moved from omnivore to vegan diet. Despite a number of surveys evaluating the health status of vegetarians, all dietary guidelines are based on cross-sectional studies. This is the first evaluation showing long-term changes in B12 status in vegans, comparing diet based upon natural and B12-fortified products. We documented that 60 months of the vegan diet based exclusively on natural products can lead in healthy adult omnivores to B-12 deficiency. It makes particularly important the recommendation of regular consumption of B-12 fortified food or B-12 supplements, what may attenuate a potential decline in serum B-12 concentrations in individuals adhering to vegantype diets. However, it has been shown by Asok that such recommendations are not easily implemented

[Asok 2003]. The studies on unique groups in the West such as Seventh-Day Adventists showed the extent of poor cobalamin status and highlighted the difficulty of persuading even highly educated subjects that they are at risk of B-12 deficiency and that they should routinely take cobalamin supplements [Hokin and Butler 1999].

The world authorities in the field of nutrition recommended “appropriately planned vegetarian diets as healthful and nutritionally adequate for all stages of the life cycle” [Craig and Mangels 2009]. In the decade of obesity, it is indisputable that vegetarian diets, associated with the low supply of calories per unit volume, may be beneficial for the health, provided however, that we can avoid certain dangers, from which no diet is free. Vegan diet is nowadays growing in popularity among adolescents and young adults, especially females [Intel... 2006, Swan 2004]. Proper monitoring of vegan’s B-12 status appears to be substantial, especially since they do not receive sufficient supervision of medical or nutritional professionals. It may allow for early detection of B-12 declining/deficiency, and possible early introduction of dietary/pharmacological intervention. It should be underlined that in vegans biochemical expression can precede clinical symptoms by many years, and that dietary B-12 deficiency is easily reversible [Carmel 2008].

The obtained data should be interpreted with caution because of the study limitations. The major drawback is the small number of participants, what seems understandable given the restrictiveness of the diet and length of the testing period. What needs to be pointed, is that the dietary B-12 intake was not assessed in the present study. However, the reliability of B12 intake is limited [FAO/WHO... 2005]. The obtained data point to the need of developing an effective attitude to the diet planning in vegans.

In conclusion, transition from omnivore to vegan diet is associated with the risk of vitamin B-12 deficiency. B-12 fortified products might be a valuable alternative in vegans refusing to take vitamin supplements.

Authors’ contribution: Jarosław Walkowiak and Aleksandra Lisowska designed the study. Jarosław Walkowiak, Aleksandra Lisowska and Edyta Mądry collected the data. Edyta Mądry and Jarosław

Walkowiak and Philip Grebowiec wrote the draft of the manuscript. Edyta Mądry prepared table and figure. All undersigned authors are responsible for search of literature, analysis and interpretation of the data, drafting and/or revising of the manuscript.

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## WPŁYW DIETY WEGAŃSKIEJ NA STĘŻENIE WITAMINY B-12 U ZDROWYCH DOROSŁYCH: PIĘCIOLETNIE BADANIE PROSPEKTYWNE

### STRESZCZENIE

**Wstęp.** Nie ma długofalowych badań prospektywnych oceniających wpływ diety wegańskiej na zawartość witaminy B-12 (B-12) w surowicy. Wielu wegan sięga po suplementy B-12 nieregularnie lub odmawia ich przyjmowania, uznając je za produkty „nienaturalne”. Spożywanie żywności wzbogaconej B-12 można traktować jako alternatywę suplementacji. Celem przeprowadzonego badania była ocena długofalowego stosowania diety wegańskiej na stężenie B-12 w surowicy u zdrowych dorosłych osób będących dotychczas na diecie zwykłej oraz porównanie wpływu diety wegańskiej opartej wyłącznie na produktach naturalnych z dietą zawierającą żywność wzbogaconą.

**Materiał i metody.** Prospektywne badanie 5-letnie zostało przeprowadzone na 20 zdrowych dorosłych ochotnikach, którzy zdecydowali się przejść na ścisłą dietę wegańską. W grupie 10 osób stosowało dietę wyłącznie opartą na produktach naturalnych, natomiast pozostałe 10 – spożywało żywność wzbogaconą w B-12. U wszystkich badanych oceniano stężenie B-12 w surowicy przed dietą oraz 6, 12, 24 i 60 miesięcy po wprowadzeniu diety wegańskiej.

**Wyniki.** W całej badanej grupie zaobserwowano statystycznie znaczne ( $p < 0,0002$ ) zmniejszenie stężenia B-12 w surowicy po 60 miesiącach stosowania diety wegańskiej. Jednakże obserwowane zmiany były de facto ograniczone do podgrupy spożywającej wyłącznie produkty naturalne ( $p < 0,0001$ ).

**Wnioski.** Przejście na dietę wegańską wiąże się z ryzykiem wystąpienia niedoboru witaminy B-12. Żywność wzbogacona w B-12 może być cenną alternatywą dla wegan odmawiających przyjmowania suplementów witaminowych.

**Słowa kluczowe:** dieta wegańska, witamina B-12, ryzyko niedoboru, wegetarianizm

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