

HEALTH BENEFITS AND RISK ASSOCIATED WITH ADOPTING A VEGETARIAN DIET

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ABSTRACT

A vegetarian diet may be adopted for various reasons that can include ecological, economic, religious, ethical and health considerations. In the latter case they arise from the desire to lose weight, in tackling obesity, improving physical fitness and/or in reducing the risk of acquiring certain diseases. It has been shown that properly applied vegetarian diet is the most effective way of reducing body mass (expressed as BMI), improving the plasma lipid profile and in decreasing the incidence of high arterial blood pressure, cardiovascular disease, stroke, metabolic syndrome and arteriosclerosis. In addition, improved insulin sensitivity together with lower rates of diabetes and cancer has been observed.

Some studies have however found that a vegetarian diet may result in changes adversely affecting the body. These could include; hyperhomocysteinaemia, protein deficiency, anaemia, decreased creatinine content in muscles and menstrual disruption in women who undertake increased physical activity. Some of these changes may decrease the ability for performing activities that require physical effort. Nevertheless, on balance it can be reasonably concluded that the beneficial effects of a vegetarian diet significantly, by far, outweigh the adverse ones. It should also be noted that the term 'vegetarian diet' is not always clearly defined in the literature and it may include many dietary variations.

Key words: *vegetarian diet, physical activity, metabolism*

STRESZCZENIE

Dieta wegetariańska może być stosowana z różnych powodów: ekologicznych, ekonomicznych, religijnych, etycznych lub zdrowotnych. Główną przyczyną stosowania diety wegetariańskiej w celu poprawy zdrowia jest zmniejszenie masy ciała i/lub walki z otyłością, oraz poprawy sprawności fizycznej i/lub zwalczania niektórych chorób. Wykazano, że właściwie stosowana dieta wegetariańska w odniesieniu do innych diet, skuteczniej zmniejsza masę ciała (wyrażoną jako BMI), poprawia profil lipidowy osocza krwi, obniża ciśnienie tętnicze krwi, zmniejsza występowanie niebezpiecznych incydentów chorób sercowo-naczyniowych, chorób mózgowo-naczyniowych, zespołu metabolicznego oraz miażdżycy tętnic. Ponadto dieta ta poprawia wrażliwość na insulinę związaną ze zmniejszeniem prawdopodobieństwa rozwoju cukrzycy i zmian rakotwórczych. Według niektórych badań uważa się, że dieta wegetariańska może powodować niekorzystne zmiany w organizmie, do których należą: hiperhomocysteinemia, niedobór białka, niedokrwistość, zmniejszenie zawartości kreatyny w mięśniach oraz zaburzenia cyklu menstruacyjnego w przypadku kobiet o zwiększonej aktywności fizycznej. Niektóre z tych zmian mogą skutecznie zmniejszać zdolność do wykonywania czynności wymagających intensywnego wysiłku fizycznego. Należy jednak podkreślić, że pozytywne skutki diety wegetariańskiej na organizm człowieka przewyższają skutki ujemne. Należy jednak zauważyć, że termin "dieta wegetariańskiej" nie zawsze jest jasno definiowany w literaturze i zawiera wiele dietetycznych opcji.

Słowa kluczowe: *dieta wegetariańska, aktywność fizyczna, metabolizm*

INTRODUCTION

The many types of vegetarian diets devised all share the same characteristic in the elimination of meat, fish and poultry consumption, whilst some also eliminate eggs, milk and dairy products. This diet is based on

foodstuffs of plant origin, such as cereals, legumes, root crops, oilseeds, fruit, vegetables, nuts and mushrooms. Such plant-based foodstuffs are unfortunately now also contaminated with many industrial toxins that include nitrates [19]. It is a however very well recognised that such foodstuffs contain ingredients beneficial to he-

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alth, for instance fibre, phytoestrogens, antioxidants, phytochemicals, n-3 fatty acids and a small amount of cholesterol; the overall effect being reducing the risk of acquiring the following conditions; cardiovascular disease, cancer, diabetes and obesity, along with a plethora of other diseases [9]. Some studies have also indicated the possibility of increasing human life spans [28]. Further studies have stressed that only a properly balanced vegetarian diet is beneficial to health. Whenever a vegetarian diet is ineffective, it is likely that dietary errors may have been made during its adoption [9].

Table 1. Classification of the different types of vegetarian diet

Type of vegetarian diet	Definition
Lacto-ovo-vegetarian	Excludes all types of flesh foodstuffs (meat, poultry, fish), but permits eating all other animal products (e.g. eggs, milk, honey).
Lacto-vegetarian	Excludes flesh foodstuffs and eggs but allows dairy products, honey, etc.
Ovo-vegetarian	Excludes consumption of all animal products with the exception of eggs.
Vegan	Excludes all animal products.
Vitarian	Permits consumption of organic, raw and fresh foods only. Excludes coffee and tea.
Liquidarian	Consumption of vegetarian food in the form of juices.
Fruitarian	Excludes flesh foodstuffs, animal products and vegetables.
Sproutarian	Eating foods in the form of sprouted plant seedlings, such as grains, vegetables, fruits.
Semi-vegetarian	Transitional form between vegetarian and meat based diets; limited amount of meat eaten.

N.B. Some versions of raw food diets emphasize the importance of not slicing foods before being eaten

Moreover, non-dietary factors may also contribute towards the efficacy of a vegetarian diet such as following a healthy lifestyle, which includes physical activity and the avoidance of harmful practices, particularly smoking and alcohol consumption [10]. It has been shown that vegetarians possess good health and suffer fewer from illnesses [12] and have a higher self-respect concerning their proper eating habits [13] than those eating a traditional diet. Many controversies have arisen over the efficacy of adopting a vegetarian diet and thus the aim of this study was to investigate and review the evidence within the literature on the impact that such diets have on the human body; both in a resting state and during physical exercise.

CHANGES IN BODY MASS DUE TO A VEGETARIAN DIET

The obsession of modern society with weight reduction is reflected by the creation of numerous and varied diets. Many indeed demonstrate real effectiveness in tackling obesity and overweight with the proviso that success can only be guaranteed if a given diet is strictly adhered in conjunction with, in parallel, performing addition physical activity [31]. Changes in body mass may cause a number of disorders, amongst which are coronary heart disease, diabetes, hypertension, musculoskeletal disease and various types of cancer [5].

The World Health Organization (WHO) has estimated that at the turn of the twentieth century about 1.2 billion people in the world were overweight [5]. This has been attributed to easy access to and the low cost of subsidised processed foods [31].

Various research studies have now established a relationship between adopting a vegetarian diet with a decrease in the body weight of adults and adolescents. Further studies have also demonstrated lower BMI values in people keeping to this type of diet. In the *Sabate* and *Wien* [26] study, the mean body mass of males and females was respectively 7.6 kg ($p < 0.001$) and 3.3 kg ($p < 0.005$) lower compared to those consuming meat in their diets. A study by *Spencer* et al. [30] showed that meat-eating subjects, aged 20–97 years, had a mean BMI higher by 1.92 kg/m² ($p < 0.05$) in men and 1.54 kg/m² ($p < 0.05$) in women compared to vegans.

A similar study by *Rosell* et al [25] evaluated 45,962 Britons aged over 20 years, of whom 16,083 were vegetarians. This found that the body mass of male vegetarians who had followed a vegetarian diet from childhood (age 1-9 years), and that of male non-vegetarians were respectively on average 3.2 kg ($p < 0.05$) and 3.0 kg ($p < 0.001$) higher than men who started a vegetarian diet after the age of twenty. Corresponding results for the BMI demonstrated higher values in men of the first and second groups (by respectively 1.2 kg/m², $p < 0.01$ and 0.9 kg/m², $p < 0.001$) compared to vegetarians.

The potential effectiveness of vegetarian diets for dealing with obesity was observed in a study by *Tonstad* et al. [34] conducted on a group of 22,434 men and 38,469 women where BMI was measured in six treatment groups (vegetarians, vegans, lacto-ovo-vegetarians, semi-vegetarians, fish eaters, and meat eaters). The mean BMI was found lowest in the vegans (23.06 kg/m²) and gradually increased as follows, lacto-ovo-vegetarians (25.7 kg/m²), fish eaters (26.3 kg/m²), semi-vegetarians (27.3 kg/m²) and meat eaters (28.8 kg/m², $p < 0.001$). A study by *Newby* et al [21] confirmed that the BMI was significantly lower in vegetarians of all types. Here, women subjects were divided into meat eaters

(n=54,257), semi-vegetarians (n=960), lactovegetarians (n=159) and vegans (n=83); results showed significantly higher body mass and BMI values in women consuming meat compared to the other groups ($p<0.005$).

An improper vegetarian diet can however lead to protein deficiency, which in a study by *Nazarewicz* [20] did not cause any deficit in the body's energy or changes in the BMI. Studies by *Haddad et al.* [16], *Taiwo* and *Thomas* [32] did however observe a protein-energy deficiency in vegetarians. The data thus suggest that adopting a vegetarian diet can be an effective means for reducing body mass.

CARDIOVASCULAR DISORDERS ARISING FROM A VEGETARIAN DIET

The aforementioned study by *Haddad et al* [16] demonstrated that compared to meat eaters, vegans had lower blood levels of saturated and monounsaturated fats ($p<0.01$), cholesterol ($p<0.001$), and higher levels of fibre ($p<0.001$), ascorbic acid ($p<0.05$), folic acid (women $p<0.01$, men $p<0.001$), copper (women $p<0.05$, men $p<0.001$), and manganese (women $p<0.05$, men $p<0.01$). Vegans also showed significant differences to meat eaters (i.e. controls) by having lower blood levels of leukocytes ($p<0.05$), neutrocytes (statistically insignificant), platelets ($p<0.05$) and urea ($p<0.05$) but a higher concentration of albumin ($p<0.05$). These values may indicate a lower content of protein in the vegetarian diet. In addition, vegetarians run the risk of having a deficiency of iron, calcium, zinc, vitamin D, and B12, as well as of amino acids. Unfortunately, there was no information provided in this study about the quality of vegetables and fruits consumed by subjects and it is well known that nutritional content may differ, up to several times, between foods grown on artificial fertilisers with organic foods grown on natural fertilisers. The problem of vitamin B₁₂ deficiency in vegetarians was confirmed by *Herrmann et al.* [17], who also showed that plasma vitamin B₁₂ levels fall with increasing concentrations of homocysteine ($r = -0,299$, $p<0.05$); an effect which is recognised to be an independent factor for the emergence of cardio-vascular diseases [15].

Eating large amounts of vegetables and fruits, which form a major part of all vegetarian diet types, also has a beneficial effect on the cardiovascular system. Plant based foodstuffs (e.g. apples, onions, broccoli, berries, olives, lettuce, tomato, red pepper, grapefruit etc.) provide the body with multiple antioxidants. The most active of these include the antioxidant vitamins (α -tocopherol, ascorbic acid), flavonoids and carotenoids (lycopene, lutein, β -carotene, cryptoxanthin, zeaxanthin). Their biological activity are based on inhibiting the oxidation of LDL cholesterol, increasing HDL cholesterol and re-

ducing total cholesterol concentrations in the circulation [14]. This results in a lower risk of developing arteriosclerosis [27]. A study by *Somannavar* and *Kodliwadmth* [29] confirms that vegetarians have significantly higher antioxidant levels compared to those eating a mixed diet ($p<0.001$). Another health benefit for adopting a vegetarian diet is that blood levels of total cholesterol (T-C) and LDL cholesterol (LDL-C) are maintained correctly. The plasma lipid profiles of vegetarians and those eating a traditional diet was studied by *Dourado et al* [11] which demonstrated that the latter group had significantly higher average T-C (207.11 mg/dl) and LDL-C (143.79 mg/dl) blood concentrations compared to the former at respectively T-C; 160.06 mg/dl, LDL-C; 87.40 mg/dl ($p<0.001$). Both of the last aforementioned studies also show that meat eaters have a significantly higher systolic blood pressure (123.76 mmHg) compared to vegetarians (114.86 mmHg) ($p<0.05$).

In conclusion, it is clear that in spite of there being some disadvantages in a vegetarian diet, which are largely due to it being misapplied, it can effectively protect against high blood pressure and reduce the risk of heart disease, stroke and arteriosclerosis.

EFFECT OF A VEGETARIAN DIET ON METABOLISM AND ENDOCRINE FUNCTION

The authors take the view that the high amounts of carbohydrates and low amounts of fat as seen in vegetarian diets increases cellular insulin sensitivity thereby affording some protection against diabetes. This hypothesis was checked in a study by *Tonstad et al* [34] conducted on a group of 38,469 women and 22,434 men. It was found that the incidence of type 2 diabetes occurred in the following groups in descending order of magnitude; meat eaters (7.6%), semi-vegetarians (6.1%), fish eaters (4.8%), lacto-ovo-vegetarians (3.2%) and vegans (2.9%), ($p<0.05$). A related study by *Wolfram* and *Ismail-Beigi* [35] suggested a correlation between increased cellular insulin sensitivity (that provided glucose homeostasis) with the consumption of vegetables and whole grains. Indeed, the lower risk of metabolic syndrome in vegetarians as compared to semi-vegetarians and meat eaters ($p<0.001$) has been documented by *Rizzo et al* [24] whose data showed that it is reasonable to hypothesise that a vegetarian diet can also be used in tackling metabolic syndrome.

A low-fat vegetarian diet has been proven effective in decreasing both blood oestrogen levels and menstrual cycle disruption [22]. A six-week study by *Pirke et al.* [23] however reported the disappearance of menstruation in a higher number of vegetarians than non-vegetarians. In addition, women eating a vegetarian diet had in their lu-

teal phases lower concentrations of luteinizing hormone, oestradiol and progesterone; these low concentrations of sex hormones being probably due to a small amount of animal fat nevertheless present in a vegetarian diet [4].

Women that are particularly vulnerable to disruption of their menstrual cycle are those that undertake recreational or professional sports. Lower calorie consumption and a smaller supply of fat in a vegetarian diet can lead to hyperprolactinaemia. This disorder is manifested by the low blood levels of oestradiol and progesterone [22]. The relationship between low energy consumption and menstrual disorders were presented by the *Tomten* and *Hostmark* study [33]. This found that female runners who consumed low amounts of energy (9.7 ± 0.5 MJ) experienced irregular menstrual cycles, whilst women that consumed significantly more energy (12.3 ± 0.7 MJ) ($p < 0.01$) had regular menstrual cycles. A vegetarian diet lowers cholesterol, LDL, HDL lipoproteins in the blood [2], which leads to changes in the length and regularity of the menstrual cycle as well as the age in which the menopause occurs [6].

A VEGETARIAN DIET AND PHYSICAL ACTIVITY

It is assumed that a properly designed vegetarian diet can improve the performance of athletes by means of the dietary content of macro- and micro-nutrients. The significant and basic elements constituting a sports diet are a combination of protein and carbohydrate [4]. According to *Lemon* [18], the amount of protein required depends on the type of sport in question. The daily intake of protein for endurance training should be 1.2 to 1.6 g per kg of body weight, whilst for stamina building this should be 1.6 to 1.7 g/kg. The controversy surrounding vegetarian diets is linked with the fewer proteins being in foods on the menu. A study by *Barr* et al [3] however demonstrates that a vegetarian diet can provide large amounts of proteins if dairy products and eggs are included. Vegetarians can additionally supplement their diet with proteins derived from legumes, nuts, seeds and whole grains [22]. Thus a correctly designed vegetarian diet should provide an average of 12.5% energy derived from protein. As reported by *Borrine* et al [7], the body's need for protein is associated with being provided with adequate amounts of carbohydrates. The body consumes up to twice as much protein during intense exertion when insufficiently supplied with carbohydrates. A high carbohydrate intake beneficially affects muscles and regulates the level of glycogen. The overall share of energy from sugars ranges from 60 to 65% [7]. A study by *Deriemaeker* et al. [10] showed a greater intake of mono- and di-saccharides in males on a vegetarian diet (283 ± 60 g/day) and for females

(268 ± 45 g/day), compared to a traditional meat eating diet; males (120 ± 65 g/day) and females (185 ± 38 g/day) ($p < 0.001$). *Barr* et al. [3] confirmed that the high proportion of carbohydrates in the diet is associated with obtaining better results for endurance sports.

Another controversial aspect of athletes adopting a vegetarian diet (especially women) is the issue of possible anaemia due to iron deficiency and as a result, a reduction in exercise capacity [3]. Based on research conducted by the American Dietetic Association and Dieticians of Canada [1], iron intake successively increases for each of the following groups; vegans, lacto-ovo-vegetarians and meat eaters. It has also been found that increasing fibre intake and phytic acid reduces blood levels of certain trace elements such as iron and zinc. A loss of iron in athletes is demonstrated by gastrointestinal bleeding, increased sweating, haemolysis and menstrual disorders in women. In most cases, vegetarian athletes can adjust the level of iron by eating foods rich in vitamin C, citric acid, malic acid, tartaric acid, fructose and sorbitol [7].

When considering the practical effects of a vegetarian diet on physical activity, the concentration of creatinine in the muscles should be checked. It is believed that the lower creatinine levels found in vegetarian athletes should be increased for improving the muscle's ability to exercise [3]. *Burke* et al. [8] have stated that the administering creatinine as a dietary supplement can significantly ($p < 0.05$) increase the physical performance and muscle strength of athletes that follow a vegetarian diet.

Despite the aforementioned studies, the viewpoints expressed concerning the benefits of a vegetarian diet and its effect on exercise capacity are not sufficiently documented in power sports, endurance sports or even in everyday life to permit anything more than a tentative conclusion to be drawn at the moment. Further research is thus essential.

CONCLUSIONS

1. Properly balanced vegetarian diet leads to a lower body mass and lower BMI, compared to meat eaters. There have been attempts to use a vegetarian diet for treating obesity and overweight.
2. A higher intake of carbohydrates achieved through a vegetarian diet may be beneficial for the body by decreasing amounts of saturated fatty acids; this also results in the maintenance of lipid metabolism and lower blood pressure and reduces the incidence of arteriosclerosis, coronary heart disease, type 2 diabetes and metabolic syndrome.
3. Improperly applied vegetarian diets can lead to lowered levels of vitamin B₁₂, producing an increase

in blood levels of homocysteine, which is associated with increased risk of cardiovascular morbidity, a reduction in the blood levels of sex hormones and disruption of the menstrual cycle.

4. Controversies however remain concerning the safety of a vegetarian diet when adopted by athletes. The concerns relate to a sufficient supply of proteins, iron and creatinine together with the occurrence of irregular menstrual cycles, especially in hard-training women. However, some research has demonstrated that a properly balanced vegetarian diet can reduce the adverse symptoms and that such a diet can be successfully used by top level world-class athletes.

REFERENCES

1. American Dietetic Association; Dietitians of Canada.: Position of the American Dietetic Association and Dietitians of Canada: Vegetarian diets. *J Acad Nutr Diet* 2003;103(6):748 – 765.
2. *Barnard N.D., Scalili A.R., Berton P., Hurlock D., Edmonds K., Talev L.*: Effectiveness of a low vegetarian diet in altering serum lipids in healthy premenstrual women. *Am J Cardiol* 2000;85(8):969-972.
3. *Barr S. I., Rideout C. A.*: Nutritional considerations for vegetarian athletes. *Nutrition* 2004;20:696 – 703.
4. *Bennett F. C., Ingram D. M.*: Diet and female sex hormone concentrations: an intervention study for the type of fat consumed. *Am J Clin Nutr* 1990;52:808 – 812.
5. *Berkow S. E., Barnard N.*: Vegetarian diets and weight status. *Nutr Rev* 2006;64:175 – 188.
6. *Biela U.*: Determinants of the age at natural menopause. *Przegl Lek* 2002;59(3):165-169 (in Polish).
7. *Borrione P., Loredana G., Quaranta F., Parisi A.*: Vegetarian diet and athletes. *Sport Präventivmed* 2009;20 – 24.
8. *Burke D.G., Chilibeck P.D., Parise G.*: Effect of creatine and weight training on muscle creatine and performance in vegetarians. *Med Sci Sports Exerc* 2003;35:1946.
9. *Campbell T.C., Campbell T.M.*: Startling implications for diets, weight loss and long-term health: the China study. Ben Bella Books, Dallas, 2006.
10. *Deriemaeker P., Alewaeters K., Hebbelinck M., Lefevre J., Philippaerts R., Clarys P.*: Nutritional status of Flemish vegetarians compared with non-vegetarians: a matched samples study. *Nutrients* 2010;2:770 – 780.
11. *Dourado K. F., Arruda Câmara e Siqueira Campos F., Sakugava Shinohara N. K.*: Relation between dietary and circulating lipids in lacto-ovo-vegetarians. *Nutr Hosp* 2011;26(5):959 – 964.
12. *Gacek M.*: Selected lifestyle and health condition indices of adults with varied models of eating. *Rocz Panstw Zakl Hig* 2010;65(1):65-69 (in Polish).
13. *Gacek M.*: Selected nutritional behaviours in adults of differentiated nourishment pattern. *Rocz Panstw Zakl Hig* 2008;59(1):59-66 (in Polish).
14. *Grajek W.*: The role of antioxidants in reducing the risk of cancer and cardiovascular disease. *Zywn Nauk Techn Ja* 2004;1(38):3 – 11 (in Polish).
15. *Grieb P., Kłapcińska B., Smol E., Pilis T., Pilis W., Sadowska-Krępa E., Sobczak A., Bartoszewicz Z., Nauman J., Stańczak K., Langfort J.*: Long-term consumption of a carbohydrate-restricted diet does not induce deleterious metabolic effects. *Nutr Res* 2008;28:825-833.
16. *Haddad E. H., Berk L.S., Kettering J.D., Hubbard R.W., Peters W.R.*: Dietary intake and biochemical, hematologic, and immune status of vegans compared with non-vegetarians. *Am J Clin Nutr* 1999;70(3):586 – 593.
17. *Herrmann W., Schorr H., Purschwitz K., Rassoul F., Richter V.*: Total homocysteine, vitamin B₁₂, and total antioxidant status in vegetarians. *Clin Chem* 2001;47(6):1094 – 1101.
18. *Lemon P. W.*: Effects of exercise on dietary protein requirements. *Int J Sport Nutr* 1998;8(4):426 – 427.
19. *Mitek M., Anyżewska A., Wawrzyniak A.*: Estimated dietary intakes of nitrates in vegetarians compared to a traditional diet in Poland and acceptable daily intakes: is there a risk? *Rocz Panstw Zakl Hig* 2013;64(2):105-109 (in Polish).
20. *Nazarewicz R.*: The effect of vegetarian diet on selected biochemical and blood morphology parameters. *Rocz Panstw Zakl Hig* 2007;58(1):23-27 (in Polish).
21. *Newby P.K., Tucker K.L., Wolk A.*: Risk of overweight and obesity among semi-vegetarian, lacto-vegetarian, and vegan women. *Am J Clin Nutr* 2005;81(6):1267 – 1274.
22. *Nieman D. C.*: Physical fitness and vegetarian diets: is there a relation? *Am J Clin Nutr* 1999;70:570 – 575.
23. *Pirke K.M., Schweiger U., Laessle R., Dickhaut B., Schweiger M., Waechtler M.*: Dieting influences the menstrual cycle: vegetarian versus non-vegetarian diet. *Fertil Steril* 1986;46(6):1083 – 1088.
24. *Rizzo N. S., Sabaté J., Jaceldo-Siegl K., Fraser G. E.*: Vegetarian dietary patterns are associated with a lower risk of metabolic syndrome. *Diab Care* 2011;34:1225 – 1227.
25. *Rosell M., Appleby P., Spencer E., Key T.*: Weight gain over 5 years in 21,966 meat-eating, fish-eating, vegetarian, and vegan men and women in EPIC-Oxford. *Int J Obes* 2006;30:1389 – 1396.
26. *Sabaté J., Wien M.*: Vegetarian diets and childhood obesity prevention. *Am J Clin Nutr* 2010;91(5):1 – 5.
27. *Segasothy M., Phillips P. A.*: Vegetarian diet: panacea for modern life-style diseases? *Q J Med* 1999;92:531 – 544.
28. *Singh N. P., Sabaté J., Fraser E.G.*: Does low meat consumption increase life expectancy in humans? *Am J Clin Nutr* 2003; 78: 526 – 532.
29. *Somannavar M.S., Kodliwadmam M.V.*: Correlation between oxidative stress and antioxidant defense in south Indian urban vegetarians and non-vegetarians. *Eur Rev Med Pharmacol Sci* 2011;16:351 – 354.
30. *Spencer E.A., Appleby P. N., Davey G. K., Key T.J.*: Diet and body mass index in 38,000 EPIC-Oxford meat eaters, fish eaters, vegetarians and vegans. *Int J Obes* 2003;27:728 – 734.
31. *Sullivan D.*: Association between vegan, vegetarian, and omnivorous diets and overweight and obesity. Hartford, University of Connecticut 2011; 44 – 47.

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32. *Taiwo O. O., Thomas K. D.*: Plasma biochemical parameters in Nigerian children with protein energy malnutrition. *East Afr Med J* 1992;69:428-432.
33. *Tomten S.E., Hostmark A.T.*: Energy balance in weight stable athletes with and without menstrual disorders. *Scand J Med Sci Sports* 2006;16:127 – 133.
34. *Tonstad S., Butler T., Ru Y., Fraser G. E.*: Type of vegetarian diet, body weight, and prevalence of type 2 diabetes. *Diabet Care* 2009;32:791 – 796.
35. *Wolfram T., Ismail-Beigi F.*: Efficacy of high-fiber diets in the management of type 2 diabetes mellitus. *Endocr Pract* 2011;17(1):132 – 142.

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