

Association between Vegetarian Diet and Obesity

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10.13.2015

Abstract

Worldwide obesity has more than doubled since 1980. In 2014, more than 1.9 billion adults were overweight; of these, over 600 million were obese. Obesity is caused by an interaction between the environmental factors, genetic predisposition, and human behavior. The prevalence of obesity proves that none of the strategies on weight management were successful till now. In order to reach ideal weight, healthy weight loss and prevention of weight regain are important. The western dietary pattern characterized by eating red meat, eggs, refined grain is positively associated with obesity whereas observational studies announced that vegetarians have a lower BMI than omnivores, but its role as the best way to control and prevent obesity is still debated. At present, there are limited prospective data on association between vegetarian dietary patterns and healthy body weight change. Electronic literature search was conducted on websites such as PubMed, Science direct and Google scholar and most of searches were focused on 2011-2015. Much of the data on association between vegetarian diets and BMI are from studies whose primary outcome was not obesity although a few well-designed studies have directly examined the relation between vegetarian eating patterns and BMI. According to many scientific literatures, vegetarian diets reduce the risk factors of many chronic diseases such as obesity and having vegetarian diet is inversely related to body mass index (BMI), overweight and obesity.

Keywords: weight gain; vegetarian diets; vegan; obesity; overweight; well-planned vegetarian diet.

Introduction

Overweight and obesity are the fifth leading risk for global death. Almost 2.8 million adults die every year due to overweight or obesity (WHO 2014). Although obesity has been acknowledged as one of the major public health concerns but the prevalence of obesity and overweight is increasing (Vanselow, Pereira & Neumark-Sztainer 2009), and it proves that none of the strategies on weight management were successful till now. Obesity is also a risk factor for the chronic diseases such as CHD, high blood pressure, stroke, some types of cancers, type 2 DM, gall-bladder diseases, lipid problems, inflammation of joints, gout and lung diseases, respiratory distress syndrome during sleep (Rosell et al. 2006; Basu et al. 2014). The World Health Organisation estimates that obesity significantly leads many diseases such as diabetes (44%), ischemic heart disease (23%) and carcinogenesis (7- 41%) (WHO 2009). In a prospective cohort study by Reeves et al. (2007), it was showed that 6000 (5% of all cancers) cancers annually in postmenopausal women in the UK are due to being overweight or obese, of which 4800 are due to obesity.

Obesity has become a serious public health concern in both developed and developing countries (Goyal et al. 2010; Kumar et al. 2014). It is a major problem in the field of public health in Iran, too (Brooks et al. 2006), according to Kelishadi et al. (2014), among 7-11-year-old Iranian children in 2005-2010, 7.78% were obese and 9.71% children had overweight.

In a cross-sectional study of 2195 schoolchildren (1102 girls, 1093 boys) aged 6-12 years in Semnan , Iran, the prevalence of overweight and obesity were 11.5% and 8.2%, respectively and it was mentioned that life style of Iranian children and their dietary habits is one of the causes of obesity (Karimi & Ghorbani 2015).

BMI is a standard tool to estimate weight and is a measure of weight in kilograms (kg) relative to height in meters squared (m^2). According to WHO, a BMI greater than or equal to 25 is overweight and a BMI greater than or equal to 30 is obesity (WHO, 2015).

The main strategies to approach the obesity problem include diet therapy, physical activity, pharmacotherapy, surgery, behavior therapy, and lifestyle modification (National Institutes of Health, 1998). Dietary programs are widespread in the general population, and are widely encouraged in public health policy. People follow different types of diets for preventing and treating overweight and obesity (Yunsheng et al. 2007; Katz & Meller 2014). In other words, 30–50 % of women and 10–30 % of men attempt to lose weight by dieting (Kruger et al. 2004; Koski et al., 2005).

According to choosing a best diet for the purpose of losing weight or preventing overweight/obesity, health aspects of diets must be considered. The health benefits of vegetarian diets were confirmed in many studies (Fraser 1999, 2009; Key et al. 2006; USDA 2010; marsh et al.2011; Tai Le & Sabaté 2014). Individuals can lose weight with many famous diets such as low carbohydrate, low-fat, Mediterranean and high-protein diets but an accurate comparative strategy should be used by researchers to show the health effects and side effects of each diet then individuals can select the best way for losing weight or maintaining weight in a healthy condition.

According to scientific studies vegetarian diets and particularly well-planned vegan diets are associated with the most benefits in compare with the other diets (Craig & Mangels 2009) and these benefits are associated with consumption of more fiber and less animal products and as Tusso et al. (2013) mentioned a healthy, plant-based diet has benefits for everyone and it may be especially beneficial for those with obesity, type 2 diabetes, high blood pressure, lipid disorders or cardiovascular disease.

Based on American Dietetic Association (2009), the role of vegetarian diets is preventing chronic disease and this relation is because of the lower BMI in vegetarians, since it seems that the risk of chronic diseases are decreased in vegetarians (Myers & Champagne 2007).

In a case study it was observed that besides preventing of obesity, treatment of obesity should be based on adopting plant-based diet. Patients can reduce the number of medications to treat a variety of chronic conditions, lower body weight, decreased risk of cancer, and a reduction in their risk of death from ischemic heart disease (Tusso et al. 2013).

The term 'vegetarian diet' is not always clearly defined in the literature and it may include many dietary variations. Although main categories are lacto-ovo-vegetarian and vegan but there are several different types of vegetarian diets. Pilis et al. (2014) proposed this classification. 1. Vegan (Excludes all animal products). 2. Lacto-ovo-vegetarian (Excludes all types of flesh foodstuffs (meat, poultry, fish), but permits eating all other animal products (e.g. eggs, milk, honey). 3. Lacto-vegetarian (Excludes flesh foodstuffs and eggs but allows dairy products, honey, etc). 4. Ovo-vegetarian (Excludes consumption of all animal products with the exception of eggs) .5. Semi-vegetarian (Transitional form between vegetarian and meat based diets; limited amount of meat eaten). 6. Vitarian (Permits consumption of organic, raw and fresh foods only and Excludes coffee and tea). 7. Liquidarian (Consumption of vegetarian food in the form of juices). 8. Fruitarian (Excludes flesh foodstuffs, animal products and vegetables). 9. Sproutarian (Eating foods in the form of sprouted plant seedlings, such as grains, vegetables, fruits).

Many observational studies showed that vegetarian diets have more benefits than the others. The American Dietetic Association mentioned that a well- planned vegetarian diet is not only healthful and nutritionally complete for individuals in all stages of the life cycle, but it also provides health benefits in preventing and treating many diseases (American Dietetic Association 2009).

In a review by Berkow and Barnard (2006), it was mentioned that all essential and nonessential amino acids can be supplied by plant sources and it is necessary for vegetarians to identify nutrients in plant-derived foods and choose their dietary patterns consciously. Although some studies have 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 but according to many studies the beneficial effects of a vegetarian diet is significantly more than the adverse effects of it ((Fraser 1999, 2009; Craig 2009,2010; Pilis et al. 2014; the American Dietetic Association 2009). Briefly, vegetarian diet reduces the risk factor of these diseases: 1-Cardiovascular Disease (CVD) 2- Ischemic Heart Disease 3- Blood Lipid Levels 4- Hypertension 5- Diabetes 6- Cancer 7- Obesity 8- Osteoporosis 9- Renal Disease 10- Dementia 11- Diverticulitis 12- Gallstone 13- Rheumatoid arthritis (Marsh et al. 2011).

In this review the association between overweight/obesity and usual vegetarian diets (vegan, lacto-

ovo-vegetarian, ovo-vegetarian and lacto vegetarian) is going to be assessed and a comparison between different BMI in vegetarians and non-vegetarian and health benefits of these diets are summarized according to many scientific studies.

The reverse association between vegetarian diets and BMI:

The prevalence of overweight/obesity between vegetarian groups:

These studies have shown that, generally, vegetarians and particularly vegans have a lower BMI. In other words, the prevalence of overweight and obesity was highest in the omnivores and lowest in vegans.

In a systematic review the range of prevalence of overweight and obesity in normal adult population of Iran during Jan 2005 through Jan 2014 was assessed that 27.0-38.5 % and 12.6-25.9 % respectively and among children, under-18 years, the range of overweight and obesity prevalence were 5.0-13.5 % and 3.2-11.9% respectively (Jafari-Adli et al. 2014).

In a community-based cross sectional descriptive study, the prevalence of obesity among adults above 25 years old (n=2608) in two villages of South Indian population in 2010-12, was 27.3% (285/1043). The prevalence of obesity was 19.7 in vegetarian (12 / 61) but the prevalence of obesity in non-vegetarian was 27.9 (273 / 980) and it was shown that vegetarian diet is one of the factors which can decrease the prevalence of obesity. Vegetable intake had indirect association with obesity and non-vegetable intake (refers to the intake of fish / chicken / meat / prawn at-least once a week) had direct association with obesity (Shrivastava et al. 2015).

Singh et al. (2014) reviewed the association between overweight/obesity [BMI (in kg/m²>23)] and dietary pattern (in Asian Indians from the Adventist Health Study 2) in figure 1, among non-vegetarian (n = 119), semi-vegetarian (n = 14), lacto-ovo-vegetarian (n = 44), pesco-vegetarian (n = 35) and vegan (n = 9). In this figure, 80% of overweight/ obesity is shown to be in non- and semi vegetarian groups and ~50% in vegans and lacto-ovo-vegetarians. It was mentioned that the consumption of nuts and seeds among vegans and lacto-ovo-vegetarians is higher than 2 pervious groups. This review also showed that the global epidemiology of obesity in India is because of a complex nutrition transition in vegetarians in which whole plant foods (fruit, vegetables, nuts, seeds, unrefined whole grains) are being replaced by refined carbohydrates, fast foods/snack foods/processed foods, and fried foods and the prevalence of obesity among vegetarians even become less than this statistic.

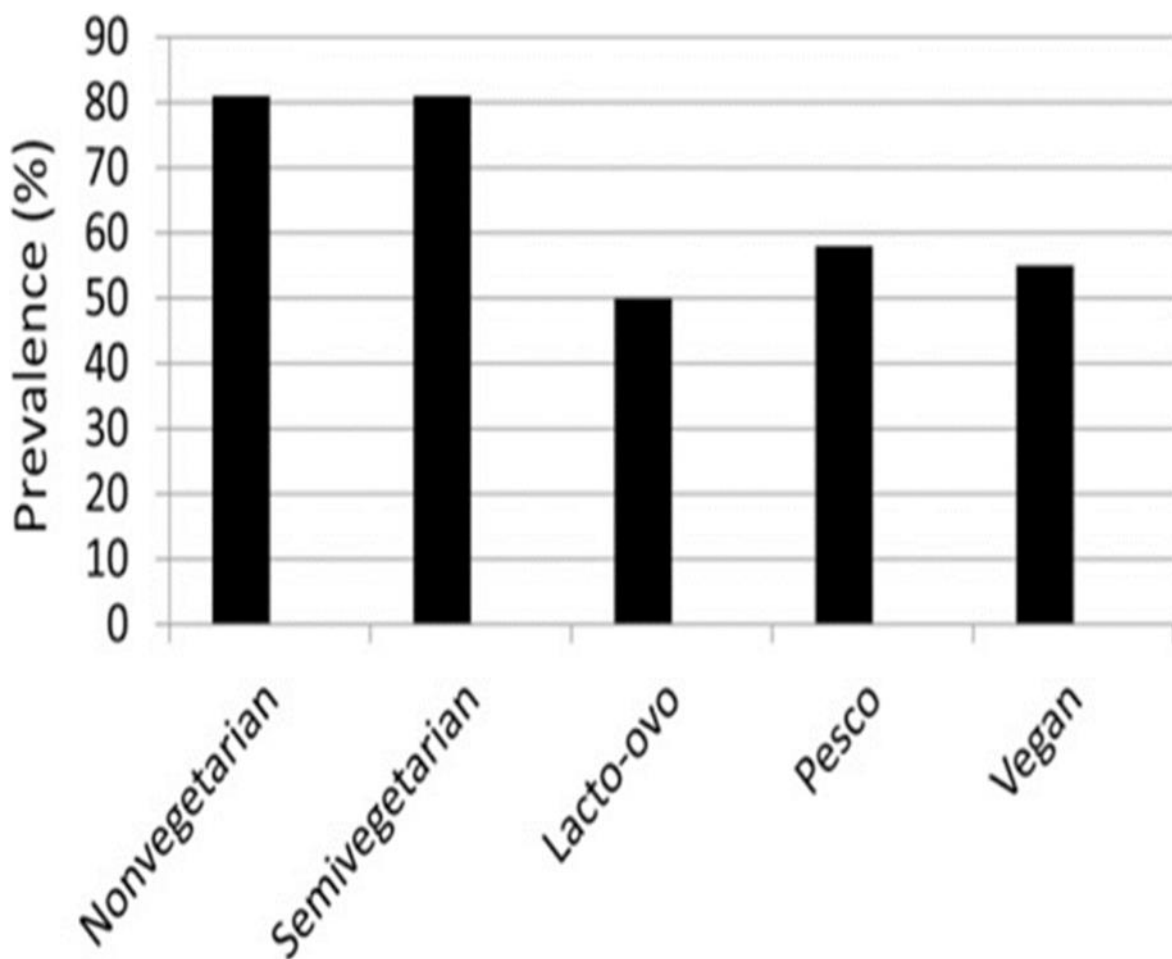


Figure 1: Prevalence of overweight/obesity [BMI (in kg/m²)>23] among Asian Indians from the Adventist Health Study 2d (Singh et al. 2014)

In a cross sectional study (Alrabadi 2012) which compared the effect of lifestyle food on chronic diseases between vegetarians (n=97) and non-vegetarians (n=97), it was concluded that obesity were more prevalence among non-vegetarians (52%) compared to vegetarians (31%).

Berkow and Barnard (2006) reviewed 40 studies (Medline search which is National Library of Medicine, Bethesda, MD) on the weight and BMI of adult male and female vegetarians since 1966 and mostly from the United States, Europe and Australia. They stated that these parameters of both adult male and female vegetarians is approximately 3-20% lower than those of non-vegetarians and the prevalence of obesity is 0 to 6% in vegetarians and 5 to 45% in non-vegetarians.

In a cross-sectional of 55,459 healthy women participating in the Swedish Mammography Cohort, Newby et al. (2005) mentioned that when vegetarians consume some animal products the mean BMI and prevalence of overweight and obesity were highest among omnivores (~24.7) compared with semi-vegetarians (mostly lactovegetarian, sometime consume fish or eggs) (~23.6), lactovegetarians (consume no meat, poultry, fish, or eggs) (~23.4) and vegans (~23.3) and vegans maybe at an even lower risk of overweight or obesity than semi- and lactovegetarians (65% risk reduction compared with 48% and 46%) and the prevalence of overweight or obesity was 40% among omnivores, 29% among both vegans and semi-vegetarians and 25% among lactovegetarians. They found that food and nutrient intakes across the 3 groups of vegetarians showed many significant differences. Notably, all the vegetarian groups had higher intakes of fruit, vegetables, and fiber and lower intakes of fat and protein.

In a cross sectional study of 1475 participants (20-69 years) after analysis of the FFQ (Food Frequency Questionnaire), members were classified as vegans (n = 104), vegetarians (n = 573), semi-vegetarians (n = 498), pesco-vegetarians (n = 145), and omnivores (n = 155). The prevalence of overweight and obesity was highest in the omnivores (20.6% and 8.4%) and lowest in vegans (10.6% and 1.9%) ,The prevalence among vegetarians (14/7% and 3/5%), Semi-vegetarians (17/1% and 2.4%), Pesco-vegetarians 15/9 and 3/4%) were in intermediate level. It was mentioned the vegan diet as the most healthy one (Clarys et al. 2014).

In Belgaum city, Karnataka, a cross-sectional study was conducted in the two Pre-university colleges with a sample of 330 participants. 141 (42.7%) members were vegetarians and 10(7.1) of them were overweight/obese and 189(57.3) members were non-vegetarians and 37(19.6) of them were overweight/obese. It was concluded that one of the factors for reducing the risk of overweight/obesity was the type of diet because the prevalence of overweight and obesity was higher among adolescents who were consuming non-vegetarian diet, although in this study it was not mentioned to the category of vegetarian diet (Banjade et al. 2014).

The influence of plant-based foods on obesity/overweight:

Appleby et al. (1998) examined the associations of diet with body mass index (BMI) in UK, using data from the Oxford Vegetarian Study. Members filled F.F.Q. (food-frequency questionnaire), concerning their diet and lifestyle, 1914 male and 3378 female between ages 20 and 89 years old were classified two groups. First subgroup was meat-eaters (n=2445) and the other subgroup included 2166 vegetarians, 480 fish-eaters and 201 vegans who did not eat any meat, fish, milk, cheese or eggs. However, the numbers of fish eaters and vegans were both small compared with the number of vegetarians and a preliminary analysis of the data showed that there was no significant difference in BMI between these

three groups. Therefore, the fish eaters were grouped with the vegetarians and vegans as non-meat eaters. Mean BMI was lower in non-meat eaters (men=22.05, women=21.32) than in meat eaters (men=23.18, women=22.32). In this analysis it was concluded that there was a significant converse association between dietary fiber intake and BMI but, there was a significant positive association between animal fat intake and BMI. It was mentioned that, this may be partly due to a higher intake of dietary fiber and a lower intake of animal fat.

These findings were supported by Spencer et al. (2003) in a cross-sectional study from the Oxford cohort of the European Prospective Investigation into Cancer and Nutrition (EPIC) which was more accurate than the previous one, because fish-eaters, vegetarians and vegans were classified as three separate groups. Self-reported dietary pattern was used and a total of 37,875 healthy men and women aged 20–97 years old, participated in EPIC-Oxford (the Oxford cohort of the European Prospective Investigation into Cancer and Nutrition is an important study of British vegetarians). Comparing body mass index (BMI) in four diet groups (meat-eaters, fish-eaters, vegetarians and vegans) was shown that , BMI was significantly different between the four diet groups, being highest in the meat-eaters (24.41 kg/m² in men, 23.52 kg/m² in women) and lowest in the vegans (22.49 kg/m² in men, 21.98 kg/m² in women). Fish eaters (23.30 kg/m² in men, 22.66 kg/m² in women) and vegetarians (23.37 kg/m² in men, 22.71 kg/m² in women) had similar, intermediate mean BMI.

After that, Rosell et al. (2006) studied weight gain and body mass index (BMI) over a 5-year period in 21966 participated in the same population (EPIC-Oxford) with aged 20–69 years (meat-eating, fish-eating, vegetarian, and vegan). The lowest weight gain was in people who during the follow-up period had changed to a diet containing fewer animal food. They concluded that people who become more vegetarian reduce or stop gaining weight.

The effects of animal protein on body weight was shown in some researches. Kahn et al. (1997) assessed the changes in BMI in a cohort of 79,236 adults which were monitored over 10 years and concluded that increase in BMI was directly associated with the consumption of meat and inversely associated with the consumption of plant-based foods. In a large prospective study of 103,455 men and 270,348 women, aged 25–70 in normal-weight and overweight subjects showed the positive effect of consumption different types of meat on weight gain after 5 years of follow up (Vergnaud et al. 2010).

The Western dietary pattern characterized by eating red meat, eggs, refined grain is positively associated with obesity and US national cross-sectional data from The NHANES (which include a series of cross-sectional surveys that provided nationally representative information on the nutrition and health status of the US civilian population), showed the direct associations between total meat (including all animal source food) consumption and risk for obesity among 13,602 participates. Those who ate high amount of meat were ~27% more likely to be obese, and 33% more likely to have central obesity compared to those ate low meat (Wang and Beydoun 2009).

Sabate and Wien (2010) reviewed the findings of cross-sectional data from epidemiologic studies and mentioned that “a plant-based diet seems to be a sensible approach for the prevention of obesity in childhood and adolescence, also by the adoption of a vegetarian diet will subsequently decrease a broad range of adverse health effects in adulthood”. In a Guidance School, Tabriz, Iran a total of 257 young females aged 11 – 15 years old were divided into six major dietary patterns; 1- Western Dietary Pattern (WDP) 2- Sweet Junk Foods Dietary Pattern (SJFDP) 3- Lacto Vegetarian Dietary Pattern (LVDP)

explained 4.7% of variances and implied the pattern with high intake of legumes, potato, other vegetables, dough, high-fat dairy products, and margarine 4- Salty Junk Foods Dietary Pattern (SJFDP) 5- Iranian Central Obesity Making Dietary Pattern (ICOMDP) 6- Iranian traditional dietary pattern (ITDP) and among them lacto vegetarian dietary pattern was reversely associated with weight because in this group the conception of plant-based foods were more than the others (Alizadeh, Didarloo & ,Esmailzadeh 2014). According to Orlich et al. (2014) the consumption of dairy products and eggs were reduced even in the lacto-ovo-vegetarians and lacto-ovo-vegetarians compared with non-vegetarians.

Tonstad et al. (2009) studied data from Seventh-Day Adventist church members across North America and categorized the type of vegetarian diet based on a food-frequency questionnaire and declared that among 22,434 men and 38,469 women(≥ 30 years), all vegetarian groups which contained vegan (23.6 kg/m^2), lacto-ovo (25.7 kg/m^2), pesco- vegetarian (26.3 kg/m^2) and semi-vegetarian (27.3 kg/m^2) were associated with lower BMI than non-vegetarian group (28.8 kg/m^2) and even vegan diets shows 5-unit BMI less than non-vegetarian ones and mentioned the role of vegetarianism to protect against obesity. Grantham et al. (2014) showed these results in figure2.

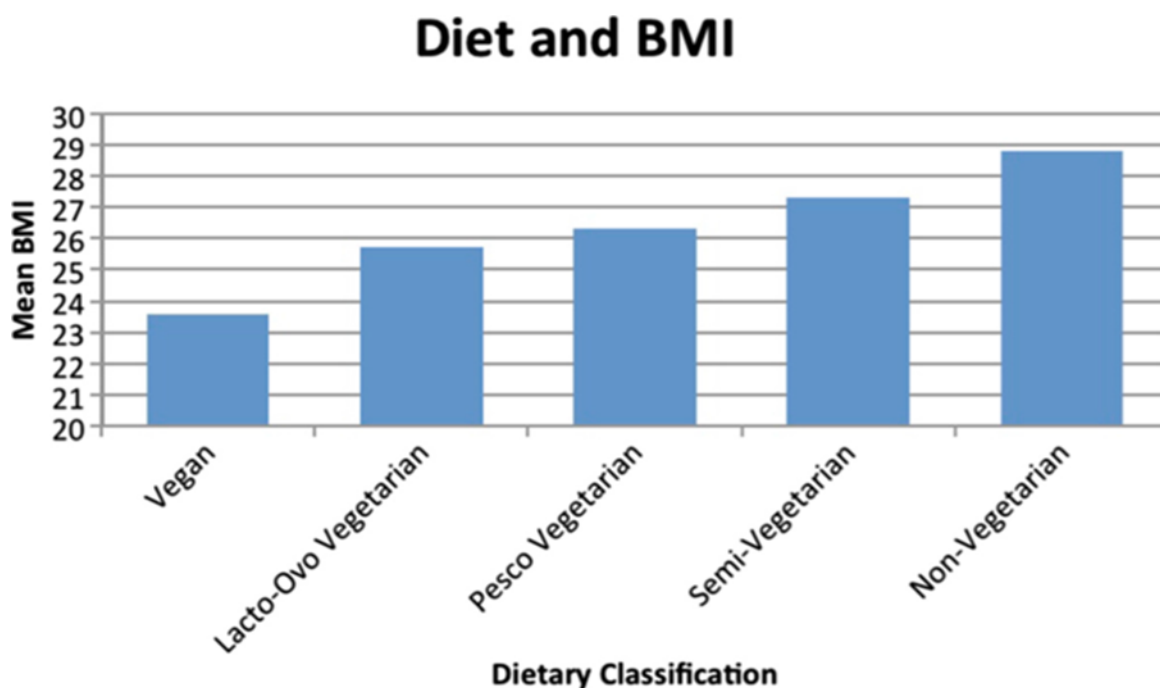


Figure2: Average BMI across diets. A survey of ~100,000 members of the Seventh Day Adventist Church in North America. Source: (Tonstad et al. 2009) cited in (Grantham et al. 2014)

In a cohort research, Gilsing et al. (2013) compared the five diet groups based on the FFQ. Mean BMI was lowest among vegetarians (men 23.4 and women 23.1) and pesce-vegetarians (men 23.4, women 22.7) and increased with increasing meat intake. 1 day/week meat consumers (men 24.2, women 23.9), a random sample of 2–5 days/week (men 24.8, women 24.9) and 6–7 days/week meat consumers (men 25.1, women 25.2).

Rizzo et al. (2013) analyzed nutrient profiles of vegetarian dietary patterns in a cross-sectional study of 71,751 subjects (~59 years) from the Adventist Health Study 2 (The AHS-2 cohort comprises more than 96 000 Seventh-day Adventist men and women recruited from the USA and Canada between 2002 and 2007). In this cross sectional study 5 diet groups were defined, 1- non-vegetarians (Mean BMI = 28.7) consuming total meat and fish more than one time per week meat (red meat, poultry, at least once per month). 2-Semi-vegetarians (Mean BMI = 27.3): consuming dairy products and/or eggs, eat some meat (red meat and poultry, fish) one or more times per month but less than once a week. 3-Pesco vegetarians (Mean BMI = 26.2) consuming dairy or egg without restrictions, fish one or more times per month but consumed red meat and poultry less than one time per month. 4-Lacto-ovo vegetarians (Mean BMI = 25.9) were those consuming the total of meat, poultry, or fish less than once a month, also with no restrictions on eggs and/or dairy products. 5- Strict vegetarians (Mean BMI = 24.0) consuming each of the following not at all or less than one time per month: meat (red meat, poultry), fish, eggs, milk, and dairy products. Mean BMI among was highest in non-vegetarians (28.7) and lowest in strict vegetarians (24.0) and concluded that there was a clear association between higher intakes of meat and dairy products and obesity.

After that, Orlich et al. (2014) compared the food consumption patterns of several vegetarian and non-vegetarian diets among 89000 members (≥ 25 years) in a cross sectional analyses in this population (the AHS-2 cohort) and assessed dietary intake by using an FFQ (vegans consumed eggs/dairy products, fish and all other meats < 1 time/month; lacto-ovo-vegetarians consumed eggs/dairy products ≥ 1 time/month but fish and all other meats < 1 time/month; pesco-vegetarians consumed fish ≥ 1 time/month but all other meats < 1 time/month; semi-vegetarians consumed non-fish meats ≥ 1 time/month and all meats combined (fish included) ≥ 1 time/month but ≤ 1 time/week; and lastly, non-vegetarians consumed non-fish meats ≥ 1 time/month and all meats combined (fish included) > 1 time/week) and mentioned that, the differences in food consumption patterns is important in helping to explain the association of vegetarian diets with several important health outcomes and declared that a health motivation for choosing a vegetarian diet causes that vegetarian dietary patterns had health benefits such as protection against obesity.

Farmer (2014) declared that vegetarian eating patterns should be recommended without energy restriction for safe and nutritious weight loss and weight management, also in some studies it was concluded that vegetarian diets lead to lose weight even without caloric restriction.

In a study, the weight loss with vegan diet (vegan participants were instructed to exclude all animal products (meat, fish, poultry, eggs, or dairy from their diet and high-GI foods to limit) or a low-calorie diet (included 1200 kcal/d for participants weighing 90 kg or less and 1500 kcal/d for participants weighing more than 90 kg among overweight (body mass index, 39.9 ± 6.1 kg/m². 18 women (27.8 ± 4.5 years) with Polycystic ovary syndrome (PCOS) (which is associated with obesity) were compared among

overweight women (age 18–65 years old) with polycystic ovary syndrome and body weight and dietary intake were assessed at 0, 3, and 6 months. Vegan participants lost significantly more weight at 3 months (−1.8%) 0.0 [−1.2%, 0.3%] low-cal; $P = .04$) and vegan participants had a greater decrease in energy (−265 [−439, 0] kcal/d) and fat intake (−7.4% [−9.2%, 0] energy) and greater improvements in dietary intake at 6 months as compared with a standard low-cal dietary approach.at 6 months compared with low-cal participants (0 [0, 112] kcal/d, $P = .02$; 0 [0, 3.0%] energy, $P = .02$). These results suggest that adoption of a vegan diet may be effective for promoting short-term weight loss among women with PCOS (Gabrielle et al. 2014).

Vegetarian diets lead to lose weight even without caloric restriction besides other advantages of vegan diets leads to concern to vegan diet as an acceptable diet for space program because vegans consume fewer calories and have a reduced body weight. In an interesting 30-day research, a group of 16 omnivores (9 females, 7 males) between 30 and 50 years of age was selected to examine for the effects of eating a total vegan diet during and post consumption of the diet. The 10-day diet was repeated three times within the 30 day study and there was no caloric restriction. A mean weight loss of 1.7 kg was seen and it was concluded that making a shift to a vegan diet is potentially feasible (Olabi et al. 2014).

Results from a systematic review and meta-analysis (Barnard et al. 2014) of adults with vegetarian diets of >4 weeks duration without energy intake limitations showed that vegetarian diets lead to reduces in mean body weight to − 4.6 kg, also in a multicenter randomized controlled trial (Mishra et al.2013), employees from 10 sites of a major US company participated (in Tucson, Arizona; San Diego, California; Lakeland, Florida; Macon, Georgia; Chevy Chase, Maryland; Buffalo, New York; Woodbury, New York; Dallas, Texas; Fredericksburg, Virginia and Virginia Beach, Virginia). 94 members at intervention diet and 117 members at control group, participants were above 18 years with BMI>25 kg/m² and/or previous diagnosis of type 2 diabetes, were randomized to either follow a low-fat vegan diet (consisting of whole grains, vegetables, legumes, and fruits, with no restriction on energy intake and avoid animal products contain meat, poultry, fish, dairy products and eggs and to minimize added oils, with a target of <3 g of fat per serving) or make no diet changes for 18 weeks(control group). Vegetarian or vegan diets lead to weight reduction of 4.6 kg and it is showed mean changes in body weight were 4.3 kg but 0.08 kg in control group ,it was concluded that a plant-based diet causes weight loss even in the absence of caloric restriction and exercise.

Although in these researches, different types of diet were studied but an important common result among them was the direct association between consuming plant-based foods and reducing in BMI and as the consuming of animal-sources become increased, the BMI was increased too, in other words, BMI in vegans was lowest in compare to other groups.

Mechanism of the reverse association between vegetarian diets and BMI:

Plant proteins reduce risk of obesity by promoting increased glucagon activity:

In a review study, McCarty MF (1999, 2000) mentioned the cellular mechanism in which vegan diet effects on weight management. The key of this association was in vegan proteins such as soy protein which are higher in non-essential amino acids than most animal-derived food proteins and as a result stimulates glucagon production and amplify the cAMP dependent mechanism that down-regulate lipogenic enzymes and cholesterol synthesis, while up-regulating hepatic LDL receptors and production of the IGF-I antagonist IGFBP-1, in other words the relatively low essential amino acid content of some vegan diets may decrease hepatic IGF-I synthesis. Since, vegan diets are high in fiber and low in saturated fat can down-regulate insulin secretion. Briefly, these mechanisms promote weight loss by lower elevated serum lipid levels. Besides fat restriction, hepatic fatty acid oxidation in vegans also play role in the body weight reduction because hepatic fatty acid oxidation promotes appetite control. A relative disinhibition of hepatic fatty acid oxidation in vegans may play a role in the body weight reduction, also increased thermogenic activity may be involved (glucagon has thermogenic effects).

Increasing insulin sensitivity in vegetarian diets due to weight loss:

It was mentioned that reductions in iron stores increase insulin sensitivity and a vegan diet provides iron in its non-heme form, which is somewhat less absorbable than heme-iron. In a study of two groups of (30 ovo-lactovegetarians and 30 meat eaters) healthy participates with BMIs <23 kg/m², it was showed that vegetarians had adequate, but lower, body iron stores, compared with meat eaters. The vegetarians also demonstrated less insulin resistance (steady-state plasma glucose) (Hua, Stoohs & Facchini 2001).

In a case-control study among 21 vegans and 25 omnivores, it was shown that the vegan diet leads to improved insulin sensitivity and lower intramyocellular lipid (IMCL) storage. the reduction of mitochondrial activity is a genetic reason for insulin resistance and leads to lipid accumulation within muscle cells (intramyocellular lipid) and high-fat diets appear to down regulate the genes required for mitochondrial oxidative phosphorylation in skeletal muscle (Goff et al. 2005).

In a randomized, controlled trial the short-term effect of a low-fat, vegan diet on body weight, body composition, metabolism, and insulin sensitivity was tested on 64 overweight, post-menopausal women, whom were randomly assigned to a low-fat, vegan diet (10% of energy from fat, 15% protein, 75% carbohydrate) consisted of vegetables, fruits, grains, and legumes. Control diet was based on National Cholesterol Education Program guidelines (total fat =< 30%, saturated fat =<7%, protein approximately 15%, carbohydrate >55% of energy; cholesterol<200 mg/day), without energy intake limits, for 14 weeks. Mean body weight decreased by 5.8 +/- 3.2 kg in the intervention group, significantly more than the 3.8 +/- 2.8 kg weight change in the control group and fasting glucose, mean glucose during oral glucose tolerance testing, and fasting insulin decreased significantly in the intervention group, whereas oral glucose tolerance and insulin sensitivity significantly improved in this group. They explained that the change in thermic effect of food happened by changing in weight because of increasing insulin sensitivity in vegetarian diets (Barnard et al. 2005).

Dietary Guidelines for Americans (2010) mentioned that vegan diets may cause more calories to be burned because food is not being stored as fat and in a multicenter randomized controlled trial Wolfram and Ismail-Beigi (2011) emphasized to a correlation between the consumption of vegetables and whole grains and increased cellular insulin sensitivity (that provided glucose homeostasis) and the greatest improvement in blood lipids, body weight, and hemoglobin level occurred in participants following low-fat, plant-based diets. Mishra et al. (2013) showed that in vegetarian diets reductions in total fat intake and replacing saturated to unsaturated fat, increase insulin sensitivity in cells and allows cells to metabolize glucose more quickly rather than storing it as body fat.

Tucker, Chaminant and Bailey (2015) focused on the association between meat intake and insulin Resistance in 292 women (35–49 years) without Type 2 Diabetes and concluded that moderate and high meat intakes are associated with increased insulin resistance because high levels of amino acids interfere with normal metabolism of glucose and can promote insulin resistance.

The role of consuming whole nuts in weight management:

The reverse association between the frequency of nut consumption and BMI was mentioned in 2 review by Mattes. Contrast to theoretical thinking about positive role of nut in weighting gain, however, epidemiological studies have consistently showed reverse association between the frequency of nut consumption and BMI. It was demonstrated 3 mechanisms for this relation: 1- nuts have high satiety properties. The low glycemic index of nuts has been proposed as a reason by which they modulate appetite, 2- Microstructural analyses of fecal samples was shown that the efficiency of absorption of energy from nuts is limited because the resistance of the parenchymal cell walls of nuts to microbial and enzymatic degradation. Thus, cells that are not ruptured during mastication may pass through the gastrointestinal tract without releasing the oil (consuming whole nuts has this mechanism and not their butter form). In that review it was mentioned to a trial in which peanuts provided 95% of the energy from fat to 10 participants, who adhered to a vegetarian diet for 6 days .With whole nuts, 17.8% of the lipid load was lost in the stool, whereas values were 7.0% and 4.5% for peanut butter and peanut oil loads. 3- Chronic consumption of nuts may increase energy expenditure and it has been associated with elevated resting energy expenditure (REE) but the reason was not clear. High unsaturated fatty acid composition and protein concentration may be involved because unsaturated fats are oxidized more readily than saturated fats (Mattes, Kris-Etherton & Foster 2007; Mattes 2008).

This inverse association between nut consumption and risk of overweight in adults has been found among children and adolescents living in Southern California. In Matthews et al. (2011) study, 1764 children and adolescents, 6-19 years old, attended in 16 Seventh-day Adventist schools and 13 public schools in Southern California filled FFQ. Foods were classified into seven food groups by a Registered Dietitian as follows: grains (e.g. cereals, crackers, bread, biscuit, muffin, pancakes, French toast, waffles, macaroni, noodles, spaghetti, meat substitute products, granola bar, pop tart), nuts (nuts and peanut butter), fruits (e.g. apple, citrus, banana, other fruits, canned fruits, raisins, dried fruits, orange juice, other fruit juice), vegetables (e.g. vegetable salad, carrot sticks, celery sticks, potatoes, green beans, refried beans, other beans, cooked vegetable), dairy (e.g. whole milk, chocolate milk, cottage cheese, cheeses, yogurt, pudding, ice cream, frozen yogurt, milk shake), meats (e.g. eggs, real wieners, hamburger patty, steak, roast beef, fried chicken, chicken, bacon, sausage links, bologna, ham, pork

chops, fish) and low nutrient-dense foods (LNDNF) (e.g. punch, donuts, sweet roll, chips, French fries, other fried potatoes, candy bars, other candy bar, cookies, cake, pie, twinkie, popsicle). Combination of meat and grain foods (e.g. burrito, taco, pizza, tostada, hamburger on bun) were counted as half serving of meat and half serving of grain. Combination of meat and vegetable foods (e.g. soup, stew and chili) were counted as half serving of meat and half serving of vegetable. Combination of LNDNF and dairy foods (e.g. ice cream bar) were counted as half serving of LNDNF and half serving of dairy. Combination of LNDNF and grain foods (e.g. ice cream cone, frozen yogurt cone) were counted as half serving of LNDNF and half serving of grain. It was shown that beside the protective role of plant-based foods against overweight, the regular and frequency of consumption of grains, nuts, and vegetables were inversely related to the risk of being overweight.

A similar finding was also observed in a study of 215 adolescents (14-15yrs) from 5 Adventist secondary school, 53 participants in the vegetarian category and 160 (154 with complete records) participants classified as non-vegetarian. Vegetarians consumed red meat, chicken and fish less than once a week. Mean BMI was 21.9 in non-vegetarian and 20.5 in vegetarians, in the results besides less BMI in vegetarian, the negative association between BMI and nut usage was assessed (Grant et al. 2008).

Gut microbiota in vegans has a role in preventing obesity due to high intake of fiber:

In a review by Glick-Bauer and Yeh (2014), it was mentioned to the studies which compare differences between gut microbiota in vegans and omnivores and it was concluded that a vegan health advantage such as prevention of obesity is associated with a unique gut microbiota profile that includes reduced abundance of pathobionts and greater abundance of protective species. Obesity has been linked to a decreased prevalence of Bacteroidetes (which includes both Prevotella and Bacteroides), and an increase in Firmicutes and Actinobacteria. *F. prausnitzii* which is a member of the Firmicutes, is one of the species that more prevalent in vegans and appears to play a protective role in obesity. *F. prausnitzii* and butyrate (butyrate is produced by intestinal microbiota produce, through metabolism of dietary fiber) production in the gastrointestinal tract are associated with each other.

The health benefits of this diet is not only because of avoiding meat and other animal products but also increased consumption of whole plant foods (fruits, vegetables, whole grains, seeds, nuts, beans) and associated beneficial nutrients such as fiber, antioxidants, vitamins, minerals, and phytochemicals (USDA 2010; Key et al. 2006).

Well-planned vegetarian diets:

Nutritional concerns about plant-based diets:

A well-planned vegetarian diet is a diet which ensures adequate intake of all nutrients and a variety of plant-based sources and has a balanced vegetarian diet rich in fiber and complex carbohydrates, has less fat, cholesterol, and saturated fat. (Lizia 2015) and is monitored by a health care professional or registered dietitian (Sabate & Wien 2010).

In a research from a national cross-sectional survey (conducted every five years by the Italian Institute of Statistics) was mentioned strongly that “As for all types of diets, vegetarian diets should also

be controlled and it would be important to follow nutritional guidelines to avoid the risk of developing deficiencies due to the lack of some nutrients” (Ponzio et al. 2015). So in order to have a well-planned vegetarian diet, American Dietetic Association (2009) provided a list of web resources on vegetarian diets and mentioned that food and nutrition professionals can assist vegetarians with current, accurate information about vegetarian nutrition, foods, and resources.

This well-planned vegetarian diet is a useful strategy to treat or prevent obesity (Tonstad et al. 2009), because in compare to meat eaters, properly balanced vegetarian diet leads to a lower BMI and it is an healthful and nutritionally adequate way (Pilis et al. 2014; Craig 2010), so as Katz & Meller (2014) mentioned, eating only plant foods does not guarantee a healthful, balanced diet and it not only can't treat obesity but also has an adverse effect by causing nutrient deficiencies, also Duo Li (2013) declared that without a well-designed vegetarian diet, it will cause non-communicable diseases such as increased plasma homocysteine, low mean platelet volume and platelet aggregatability which are associated with low intake of vitamin B12 and n-3 PUFA)

According to Key et al. (2006), vegetarian diets are relatively low in protein, saturated fat, long-chain n-3 fatty acids (eicosapentaenoic acid or EPA and docosahexaenoic acid or DHA), retinol (vitamin A), vitamin B12 and Zn; vegans may have particularly low intakes of vitamin B12 and low intakes of Ca.

Protein

A well-balanced, plant-based diet will provide adequate amounts of essential amino acids and prevent protein deficiency. For instance essential amino acids can be obtained by eating certain combinations of plant-based foods. Examples include brown rice with beans, and hummus with whole wheat pita. (Young & Pellett 1994). In a review by Williamson et al. (2005), it was mentioned that eating different plant foods, in combination, can provide the right balance of essential amino acids. Berkow and Barnard (2006), also declared that all essential and nonessential amino acids can be supplied by plant sources and it is necessary for vegetarians to identify nutrients in plant-derived foods and choose their dietary patterns consciously. According to Marsh et al. (2011), plant sources of protein include legumes, nuts, and soy products, including soy milk, soy yoghurt, tofu, and tempeh. Grains and vegetables also contain protein but in small amounts.

Iron

Hunt (2003) mentioned, iron deficiency is not more common in vegetarians, although iron stores are often lower. Plant-based foods that are rich in iron include kidney beans, black beans, soybeans, spinach, raisins, cashews, oatmeal, cabbage, and tomato juice (Waldmann et al. 2004) but Iron intake from plant sources should be combined with other foods that aid iron absorption, for example with a meal containing Vitamin C and other organic acids found in fruits and vegetables enhance nonheme iron absorption (Lizia 2015; Craig 2009, 2010).

Calcium

Calcium is available for vegans by consuming calcium-fortified soy milk, fruit juices, soy and rice

milk, tofu, soy yogurt, cereals, sesame seeds, almonds, and dried beans and low oxalate green vegetables such as broccoli, bokchoy and kale, (Lizia 2015; Weaver et al. 1999 cited in Craig, 2010).

n-3 Polyunsaturated fat

Omega-3 fatty acids play an important role in cardiovascular health, infant visual function, and neurodevelopment (Yashodhara et al. 2009 cited in Marsh, 2011). Vegetarians obtain omega-3 fats predominantly from the omega-3 fatty acid α -linolenic acid (ALA). DHA is absent from vegan diets and present in limited amounts in vegetarian diets but the significance of this difference on health outcomes remains unclear but ALA are associated with a reduced risk of CVD (Davis & Kris-Etherton, 2003 cited in Marsh 2011).

For the vegan, certain microalgae are a good source of DHA (longer-chain docosahexaenoic acid), and the oil from brown algae (kelp) is a source of EPA (eicosapentaenoic acid). Rich sources of α -linolenic acid (ALA), the precursor of EPA and DHA, include flaxseed, walnuts, canola oil, chia seed, and soy are good sources for long-chain n-3 fatty acids (Craig, 2009; Williams CM & Burdge G, 2006 cited in Craig, 2010).

Zinc

Zinc is found in whole grains, legumes, and soy products. In a research which is carried out by Gibson (1994 cited in Craig 2009), it was mentioned that although zinc absorption in vegetarians are less than non-vegetarians but it appears that there may be facilitators of zinc absorption and compensatory mechanisms to help vegetarians adapt to a lower intake of zinc and according to Hunt (2003) zinc deficiency is no greater in vegetarians than in non-vegetarians. Marsh et al. (2011) emphasized that commonly eaten plant foods, such as nuts, seeds, and whole grains, are high in zinc and may be the reason for the apparent satisfactory status in vegetarians.

Vitamin D

Vitamin D deficiency is a public health problem not just for vegetarians (Raiten & Picciano 2004), because it is found naturally in only a few foods such as oily fish (cod liver oil), wild mushrooms, and eggs. According to Koyyalamudi et al. (2009), button mushrooms exposed to ultraviolet irradiation produced vitamin D, which could potentially provide a food source for vegans.

Vitamin B12

Koebnick et al. (2004) compared vitamin B₁₂ status in healthy pregnant women adhering to one of the following diets (ovo-lacto vegetarians for at least 3 years (OLVs; n = 27), low-meat eaters (LME, n = 43), and women eating an average western diet. It was showed that vitamin B₁₂ deficiency is frequent in pregnant women consuming ovo-lacto vegetarian diets and suggested that an optimal dietary intake of vitamin B₁₂ during pregnancy should be at least above 3 microg vitamin B₁₂/d.

Recent researches (Watanabe et al. 2014) showed that although in the United States, ready-to-eat cereals is fortified with vitamin B₁₂ and have a high proportion of vitamin B₁₂ but because processed

foods are strongly avoided by most vegetarians in addition to animal products, intake dried purple laver (nori) is the most suitable natural plant vitamin B₁₂ source and it also contains high levels of other nutrients that are lacking in vegetarian diets, such as iron and n-3 polyunsaturated fatty acids.

Vitamin B₁₂ is also found in various types of tea leaves. Vitamin B₁₂ contents of soybeans are low or undetectable, however, a fermented soybean-based food called tempe contains a considerable amount of Vitamin B₁₂. Only trace amounts of Vitamin B₁₂ were found in broccoli, asparagus, Japanese butterbur, mung bean sprouts, tassa jute, and water shield. Some edible Mushrooms such as black trumpet (*Craterellus cornucopioides*) and golden chanterelle (*Cantharellus cibarius*) and dried shiitake mushroom fruiting bodies (*Lentinula edodes*) contained Vitamin B₁₂. Proper Vitamin B₁₂-enriched vegetables by treating them with a solution that contains high levels of Vitamin B₁₂ is also beneficial to vegetarians. In that review it was mentioned that adding an organic fertilizer such as cow manure increased the Vitamin B₁₂ content of spinach leaves although it is insufficient, in another research, Kumudha and Sarada (2015) compared effect of different extraction methods on Vitamin B₁₂ from Blue Green Algae, *Spirulina Platensis*.

Health Benefits of a Vegetarian Diet:

Results associating diet with chronic disease in a cohort of 34192 California Seventh-day Adventists are summarized by Fraser (1999) and it was found that vegetarians had lower risks of obesity, hypertension, diabetes, arthritis, colon cancer, prostate cancer, fatal IHD in males, and death from all causes. Obesity increased as meat consumption increased (In men BMI was ~ 24.263 in vegetarians, ~25.18 in semi-vegetarians and ~26.24 in non-vegetarians, the BMI in vegetarians women was ~23.73, in semi-vegetarians was ~ 24.83 and ~ 25.88 in non-vegetarian). In this analyses 2–3% of Seventh-day Adventists are vegans and 29.5% were vegetarian (ate no fish, poultry, or meat 21.2% were semi-vegetarian (ate fish and poultry, but < 1 time/week and 49.2% were non-vegetarian (ate meat as frequently as did other Californians). As Fraser mentioned, California Seventh-day Adventists groups were contained the wide variety of dietary habits, so it was an important case to study relations between diet and chronic disease for over 40 years.

In 2009, Fraser review the results from Adventists and look critically at the evidence on the health effects of vegetarian diets and emphasized that diets based on plant foods, such as a vegetarian diet, seem to be associated with a health benefit and a lower risk of several chronic diseases (Fraser 2009). This study is in line with Craig and Mangels (2009) study, which was mentioned that vegetarian diets were associated with a number of health benefits such as lower risk of death from heart disease, lower low density lipo-protein (LDL) cholesterol levels, lower blood pressure, lower rates of type 2 diabetes, lower body mass index (BMI) and lower rates of cancers.

Also in a study of 15,474 Austrian adults (aged 15 years and older) by Burkert et al. (2013), it was mentioned that among four groups of the analyzes (1-All vegetarians were analyzed as one group 2- omnivorous diet rich in fruits and vegetables 3- diet less rich in meat.4- Omnivorous diet rich in meat), consuming a diet rich in fruits and vegetables is associated with better health and mean BMI in vegetarian was 22.9, in omnivorous diet rich in fruits and vegetables was 24.9, in omnivorous diet less rich in meat was 25.2 and in omnivorous diet rich in meat was 25.9.

The health benefits of the properly-designed vegetarian diets is not only because of avoiding meat and other animal products but also increased consumption of whole plant foods (fruits, vegetables, whole grains, seeds, nuts, beans) and associated beneficial nutrients such as fiber, antioxidants, vitamins, minerals and phytochemicals, because vegetarian diets are usually rich in carbohydrates, n-6 fatty acids, dietary fiber, carotenoids, folic acid, vitamin C, vitamin E and Mg (Key et al. 2006; USDA 2010).

As it was shown in Grant et al. (2007) study consistent with the observed health benefits in adults, adolescents who had a vegetarian diet showed significantly better scores for risk factors for CVD such as BMI, waist circumference and cholesterol, compared to their non-vegetarian classmates. A cohort of 207 adolescents (53 participants placed in the vegetarian category and 154 participants classified as non-vegetarian) with 14-15 years old and generally in good health from 5 Adventist secondary schools in the Sydney and Hunter regions of New South Wales, Australia, the relation between vegetable-rich diet and markers of health were assessed. Participants were classified as vegetarian (i.e. having a vegetable-rich diet, if they consumed red meat, chicken and fish less than once a week). Adolescents consuming predominantly vegetarian foods showed significantly better scores on markers of cardiovascular health, including, body mass index (BMI), waist circumference, Cholesterol /High density lipoprotein ratio and low density lipoprotein. Mean BMI (kg/m²) was 21.9 (21.3 – 22.6) in non-vegetarian and 20.5 (19.6 – 21.3) in lacto-ovo vegetarian.

A study which compared the nutritional status of 106 vegetarians with 106 non-vegetarian subjects indicated that a vegetarian diet can be adequate to sustain the nutritional demands to at least the same degree as that of omnivores. (Deriemaeker et al. 2010).

In a review by Tai Le and Sabaté (2014), three cohorts of Adventists in North America: Adventist Mortality Study (22,940 members, 35-90 years), Adventist Health Study (34,198 members, 25–90 years) and Adventist Health Study-2 (96,194 members, 30–112 years) were compared by health outcomes of non-vegetarian diets and vegetarian dietary patterns (vegan and lacto-ovo-vegetarian), they concluded that vegetarian diets confer protection against cardiovascular diseases, cardiometabolic risk factors, some cancers and total mortality. BMI in vegetarians were approximately 2–4 points lower than non-vegetarians. Vegetarians had 55% lower odds of developing hypertension. The odds of developing type-2 diabetes was 25% to 49% lower for vegetarians compared to non-vegetarians. The odds of developing metabolic syndrome (MetS) for vegetarians were about half compared to non-vegetarians. Vegetarians experienced a modest, 8% risk reduction for overall-cancer and had approximately half the risk of developing colon cancer. Also, vegetarians had 23% risk reduction for cancer of the gastrointestinal tract and 35% risk reduction for prostate cancer. vegetarians had a 10% to 20% decreased in all-cause mortality, 26% to 68% lower risks of mortality from ischemic heart disease, cardiovascular disease, and cerebrovascular disease, 48% risk reduction in mortality from breast cancer, and modest risks reduction from other-cause total mortality. The risk of these factors was even lower in vegans in compare with lacto-ovo-vegetarian.

In a cross sectional study Alrabadi (2012) compared the effect of lifestyle food on chronic diseases between 97 vegetarians (as subjects who reported consuming meat and poultry <1 time/month) and 97 non-vegetarians (who consuming red meat or poultry ≥1 time/month). It was concluded that diabetes was significantly more prevalence among non-vegetarians (44%) compared to vegetarian (38%). 63% of the non-vegetarians had Hypertension while 51% of vegetarians had the same disease.

Effects of vegetarian diets on diabetes:

Tonstad et al. (2009) collected self-reported demographic, anthropometric, medical history, and lifestyle data from Seventh-day Adventist church members across North America. The type of vegetarian diet was categorized based on a food-frequency questionnaire and it was found that among 22,434 men and 38,469 women, 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%). In this study there appeared to be an incremental protection as dietary pattern moved from non-vegetarian to semi-vegetarian to pesco vegetarian to lacto ovo vegetarian to vegan.

In 2013, Tonstad et al. declared that the vegan diet appeared to afford the greatest protection against the development of diabetes. The incidence of diabetes in relation to diet using data from the Adventist Health Study-2 (AHS-2) was showed that among 15200 men and 26187 women (30 years and older and free of diabetes) which were grouped as vegan, lacto ovo vegetarian, pesco vegetarian, semi-vegetarian or non-vegetarian with a follow-up questionnaire after two years mentioned that the cases of diabetes developed in 0.54% of vegans, 1.08% of lacto ovo vegetarians, 1.29% of pesco vegetarians, 0.92% of semi-vegetarians and 2.12% of non-vegetarians. The greatest protection against the development of diabetes is shown in vegan diet and part of the protection is due to the lower BMI of vegetarians compared to non-vegetarians. BMI in vegans were 23.8 kg/m², in lacto-ovo vegetarians was 25.6kg/m², in pesco-vegetarians was 25.9kg/m², in semi-vegetarians was 26.8kg/m² and in non-vegetarians was 28.2kg/m², so vegan and lacto-ovo vegetarian diets were associated with a decreased risk of diabetes. A vegetarian diet that included fish was not associated with a significant risk reduction of diabetes.

In a randomized control trial individuals (mean age was 57 years old) with type2 diabetes were randomly assigned to a low-fat vegan diet (n = 49) or a diet following 2003 American Diabetes Association guidelines (conventional, n =50) for 74 wk. and both diets were associated with significant sustained weight reduction (24.4 kg in the vegan group and 23.0 kg in the conventional diet group), during the 74-wk study period, but the vegan diet appeared to be more effective for control of glycemia and plasma lipid concentrations. 71% (35 of 49) of participants in the vegan group and 58% (29 of 50) of participants in the conventional diet group altered their diabetes medications (Barnard et al. 2009).

In a Randomized controlled trials which conducted in individuals with diabetes for ≥ 3 weeks and it was mentioned to the effect of diets emphasizing tree nuts which are a healthy source of vegetable protein, unsaturated fatty acids, fibre, antioxidants, vitamins (i.e. folic acid, vitamin B6, niacin, tocopherols), minerals (i.e. magnesium, potassium, calcium), and phytochemicals, for improve glycemic control in individuals with type 2 diabetes (Viguiliouk et al. 2014).

Effects of vegetarian diets on cancer:

The other effect of vegan diet is the role of plant based diet on decreasing risk of cancer. According to McCarty (1999, 2000), animal proteins are rich in essential amino acids and up-regulate Insulin-like growth factors (IGF-I) activity and thereby act as a cancer promoter but low-quality vegan proteins down-regulate IGF-I activity and also increased phytochemical intake is likely to contribute to the reduction of cancer risk in vegans.

Also in a systematic review of case-control studies (included 3609 cases and 7137 controls), the association between concentrations of IGF-I and IGFBP-3 and prostate, colorectal, premenopausal and postmenopausal breast, and lung cancer were assessed by Renehan et al. (2004) and it was showed that high concentrations of IGF-I were associated with an increased risk of prostate cancer and premenopausal breast cancer and high concentrations of IGFBP-3 were associated with increased risk of premenopausal breast cancer, because IGF-1 regulate cell proliferation, differentiation, and apoptosis.

Allen et al. (2002) have shown that vegans have lower plasma levels of IGF-I than either meat-eaters or lacto-vegetarians. high levels of IGF-I may increase breast cancer risk and vegans have lower plasma levels of insulin-like growth factor-I than either meat-eaters or lacto-vegetarians, too (Allen et al. 2004).

It was confirmed that vegetarians have significantly higher antioxidant levels compared to those eating a mixed diet which effectively prevent free radicals generation. In a cross-sectional study by Somannavar and Kodliwadmth (2011), 100 healthy individuals (50 vegetarians and 50 non-vegetarians) and 40-60 years of both sexes in Belgaum urban area were participated .Volunteers were divided into 3 groups: 1. Lacto-vegetarians (n=25), 2. Lacto-ovo-vegetarians (n=25) and 3. Non-vegetarians (n=50) who consumed animal products such as meat, poultry, fish and other sea foods at least twice a week. It was showed that the level of enzymatic antioxidant glutathione peroxidase and non-enzymatic antioxidants Vitamin A (this fat soluble vitamin scavenges $O_2\bullet$ – and reacts directly with peroxy radical) and Vitamin E (this fat soluble vitamin converts, $O_2\bullet$ –, $\bullet OH$ and lipid peroxyl radicals to less reactive forms and acts as a chain breaking antioxidant) were lower in non-vegetarians compared to lacto-vegetarians and lacto-ovo-vegetarians. The blood level of Malondialdehyde (MDA) (lipid peroxidation product) was significantly increased in non-vegetarians. It was mentioned that because the diets of non-vegetarians are good source of iron and copper, so intakes of these transition metals in the diet have important role in the initiation and progression of lipid peroxidation.

Previously, Fraser (1999) mentioned that the incidence of colorectal cancer is also lower in vegetarians than in non-vegetarians.

Effects of vegetarian diets on coronary heart disease (CHD) and IHD (ischemic heart disease):

A meta-analysis of seven prospective cohort studies with a total of 124706 participants showed that vegetarians had a 29% lower risk of mortality from IHD, 16% lower mortality from circulatory diseases and a 12% lower mortality from cerebrovascular disease compared with omnivores (Huang et al. 2012).

In a review which used original data from 5 prospective studies, 76172 men and women (16-89 years) were participated and compared ischemic heart disease death rate ratios of vegetarians and non-vegetarians. Vegetarians were those who did not eat any meat or fish (n = 27,808). The vegetarians had a 24% reduction in ischemic heart disease death rates compared with non-vegetarians and the ischemic heart disease death rate ratios compared to regular meat eaters were 0.78 (95% CI 0.68-0.89) in semi-vegetarians(who ate fish only or ate meat less than once a week) and 0.66 (95% CI 0.53-0.83) in vegetarians (key et al. 1998). Appleby et al. (1995) mentioned that the exclusion of meat from the diet might result in a 15–25% reduction in CHD risk.

In a cohort of British vegetarians and non-vegetarians with 44561 participants (non-vegetarian = 29441, vegetarian = 15120), who lived in England and Scotland and attended in the European Prospective Investigation into Cancer and Nutrition (EPIC)–Oxford, after an average follow-up of 11.6 years, it was showed that besides lower BMI in vegetarians, they have a 32% lower risk of developing IHD (ischemic heart disease) than do people who consume meat and/or fish and lower IHD was probably mediated by non-HDL-cholesterol concentration [20.45 (95% CI: 20.60, 20.30) mmol/L], and systolic blood pressure [23.3 (95% CI: 25.9, 20.7) mm Hg] (Crowe et al. 2013).

Jenkins et al (2014) determined the 6-month effect of a diet that was both low-carbohydrate and plant-based on weight loss and low-density lipoprotein cholesterol (LDL-C), 23 participants overweight (50% test, 68% control) were divided into two groups 1- a low-carbohydrate vegan diet (26% of calories from carbohydrate, 31% of calories from vegetable proteins and 43% from fat) 2-high-carbohydrate lacto-ovo vegetarian diet (58% carbohydrate, 16% protein and 25% fat) and concluded that consumption of low carbohydrate vegan diet was associated with significantly reduced of LDL-C and weight loss(−6.9 kg) but body weight reduction in high carbohydrate diet was −5.8 kg, (7% vs 6% reductions, respectively). A weight loss diet which reduced carbohydrate in exchange for increased intakes of vegetable sources of protein, such as gluten, soy and nuts, together with vegetable oils offers an opportunity to improve both LDL-C and body weight, both being risk factors for CHD.

Effect of vegetarian diets on blood levels of total cholesterol and low-density lipoprotein (LDL):

Another health benefit for adopting a vegetarian diet is that blood levels of total cholesterol (T-C) and LDL cholesterol (LDL-C) are lower in compare with non-vegetarian. In a cross-sectional study among 29 lacto-ovo vegetarians and 58 non-vegetarians adult Brazilian, it was demonstrated that mean total cholesterol (207.11 mg/dl) and LDL (143.79 mg/dl) were higher among non-vegetarians, this levels in lacto-ovo vegetarians were 160.06 mg/dl for total cholesterol and 87.40 mg/dl for LDL cholesterol, also meat eaters have a significantly higher systolic blood pressure (123.76 mmHg) compared to vegetarians (114.86 mmHg) (Dourado et al. 2011).

According to Zhang et al. (2012) vegetarians not only had lower BMI, but also had lower levels of TC, LDL, and triglycerides and despite a lower mean HDL, vegetarians had a significantly lower TC/HDL ratio and also had a significantly lower 10-year predicted probability of CHD than did omnivores.

Individuals with type 2 diabetes (n= 99) were randomly assigned to a low-fat vegan diet (n =49) or a diet following the American Diabetes Association (ADA) guidelines (n= 50). Participants were evaluated at baseline and 22 weeks. A low-fat vegan diet was ~10% of energy from fat, 15% protein, and 75% carbohydrate and The ADA diet was 15–20% protein, ~7% saturated fat, 60–70% carbohydrate and monounsaturated fats, and cholesterol < = 200 mg/day. Besides body weight decreased 6.5 kg in the vegan group but 3.1 kg in the ADA group, LDL cholesterol fell 21.2% in the vegan group but 10.7% in the ADA group. So although both a low-fat vegan diet and a diet based on ADA guidelines improved glycemic and lipid control in type 2 diabetic patients but these improvements were greater with a low-fat vegan diet (Barnard et al. 2006), also in a multicenter randomized controlled trial, participate with body mass index >25 kg/m² and/or previous diagnosis of type 2 diabetes were randomized follow a low-fat plant-based diet (n=94) or no diet changes (n=117) after an 18-week, it was shown that total and LDL

cholesterol fell 13.7 and 13.0 mg/dl in the intervention group but 1.3 and 1.7 mg/dl in the control group (Mishra et al. 2013).

In a randomized controlled trial which, 23 overweight participants (50% test, 68% control), comparative between a low-carbohydrate vegan diet (26% of calories from carbohydrate, 31% of calories from vegetable proteins and 43% from fat) and high-carbohydrate lacto-ovo vegetarian diet (58% carbohydrate, 16% protein and 25% fat) over a 6-month was shown that consumption of the low carbohydrate vegan diet was associated with significantly reduced of LDL-C besides an additional 2% advantage in body weight reduction compared with the high-carbohydrate diet and a 13% drop in LDL-C (Jenkins et al. 2014).

Effects of vegetarian diets on metabolic syndrome:

a cross-sectional analysis of 773 subjects (mean age 60 years) from the Adventist Health Study 2, which compared dietary patterns in their relationship with metabolic syndrome (MetS) was shown the lower risk of metabolic syndrome in vegetarians as compared to semi-vegetarians and meat eaters. In this study vegetarians as subjects who reported consuming meat, poultry, or fish <1 time/month. Semi-vegetarians were defined as consuming fish at any frequency but consuming other meats <1time/month or total meat (with red meat and poultry ≥ 1 time/month and, 1time/week). Non-vegetarians were defined as consuming red meat or poultry ≥ 1 time/month. Besides mean BMI was lowest in vegetarians(25.7 kg/m²), intermediate in semi-vegetarians (27.6 kg/m²), and highest in non-vegetarians (29.9 kg/m²), it was showed the lower risk of metabolic syndrome in vegetarians as compared to semi-vegetarians and meat eaters (Rizoo et al. 2011)

Effects of vegetarian diets on hypertension:

In a systematic review, Myers and Champagne (2007) mentioned that the prevalence of hypertension ranges was from 2 to 40% among vegetarians and 8 to 60% among non-vegetarians.

In a review of vegetarian, Berkow and Barnard (2005) reported that SBP (systolic blood pressure) of vegetarians was 3–14mmHg lower and DBP (diastolic blood pressure) was 5–6mmHg lower than non-vegetarians in observational studies and mentioned that vegetarian diet may help in both the prevention and management of hypertension.

According to Fraser (2009), in the Adventist Health Study-2, in compared with non-vegetarians, vegans were 75% less likely to be treated for hypertension, lacto-ovo vegetarians 65% less likely, pesco-vegetarians 38% less likely, and semi-vegetarians 23% less likely.

Comparison of famous diets:

Patients can lose weight with most dietary plans but health effects of various diets are different.

Low carbohydrate diets:

According to Katz and Meller (2014), a truly low-carbohydrate diet (including high protein, of either animal or plant origin) would be low in all sources of carbohydrate, including vegetables, fruits, whole grains, and, to a lesser extent, beans and legumes but this diet is at least as effective as any other approach nevertheless, studies relevant to health outcomes across the life span are lacking. Carbohydrate-restricted diets are calorie restricted as well and in the absence of calorie restriction, high-protein, low-carbohydrate diets can contribute to weight gain and adverse metabolic effects.

In a randomized trial (Gardner et al. 2007) which was compared 4 weight-loss diets, participants (women aged 20 to 50 years) were randomly assigned to follow the Atkins (very low in carbohydrate, n=77), Zone (low in carbohydrate, n=79), LEARN (Lifestyle, Exercise, Attitudes, Relationships, and Nutrition; low in fat, high in carbohydrate, based on national guidelines, n=79) or Ornish (very high in carbohydrate, n=76) and received weekly instruction for 2 months, then an additional 10-month follow-up was programmed. It was showed that weight loss was greater for women in the Atkins diet group compared with the other diet groups. Atkins, -4.7 kg (-6.3 to -3.1 kg), Zone, -1.6 kg (-2.8 to -0.4 kg), LEARN, -2.6 kg (-3.8 to -1.3 kg), and Ornish, -2.2 kg (-3.6 to -0.8 kg).

High protein diet:

In some studies it was mentioned that high protein diet was good for controlling appetite during weight loss in overweight and obese persons.

Leidy et al. (2011) examined the impact of consuming frequent, HP (high protein) meals on appetite and satiety during weight loss. 27 overweight/ obese men (age 47 ± 3 years; BMI 31.5 ± 0.7 kg/m²) were randomized to groups that consumed an energy-restriction diet as either higher protein (HP, 25% of energy as protein, n = 14) or normal protein (NP, 14% of energy as protein, n = 13) for 12 weeks support the consumption of HP intake, for improved appetite control and satiety in overweight/obese men during energy restriction diet. In a review by Westerterp-Plantenga et al. (2009) this role of HP diet on appetite and satiety was mentioned too.

Low-fat diet:

In a meta-analysis of five trials including a total of 447 individuals (16 years and older with BMI = 25 or more), the effects of a low-carbohydrate diet as a diet allowing a maximum intake of 60 g of carbohydrates per day without energy intake restriction and a low-fat diet as a diet allowing a maximum of 30% of the daily energy intake from fat with energy intake restriction were compared for up to 1 year. It was mentioned that although low-carbohydrate diets were more effective in weight loss but this effect was no longer obvious after 12 months of follow-up and also there was no clear benefit of either diet when their effects on cardiovascular risk factors were examined. Low-carbohydrate diets were associated

with favorable changes in triglyceride and probably HDL-C values but total and LDL-C levels decreased more in individuals randomized to low-fat diets (Nordmann et al 2006).

In some studies it was mentioned that low-fat and vegetarian diet together is emphasized on minimally processed, plant-derived foods. Vegetarian diets are mostly plant based but typically include dairy and eggs and may selectively include other animal products, such as fish and other seafood. Low-fat has overall some health benefits such as weight loss to improvements in various biomarkers to reductions in cardiac events and mortality. Low-fat, plant-based eating has been associated with reducing in cancer and cardio metabolic disease (Katz & Meller 2014).

Mediterranean:

Mediterranean diets often emphasis on olive oil, vegetables, fruits, nuts and seeds, beans and legumes , dairy intake and whole grains. Fish and other seafood are used but in this diet consumption of meat is quite limited. Moderate wine intake is often explicitly included as well. It was declared that Mediterranean diet is better than a low-fat diet at improving a wide array of cardiac risk factors. The Mediterranean diet showed favorable effects on lipoprotein levels, endothelium vasodilatation, insulin resistance, metabolic syndrome, antioxidant capacity, myocardial and cardiovascular mortality and cancer incidence in obese patients (Katz & Meller 2014).

But in a systematic review of meta-analyses that compared the Mediterranean diet with a control diet (lower fat diet) on the treatment of type 2 diabetes among adults with or at risk for type 2 diabetes, it was showed that although the Mediterranean diet was associated with better glycaemic control and cardiovascular risk factors than control diets, but there was some doubts about the influence of Mediterranean diet (MedDiet) on obesity because of its high fat content (mainly monounsaturated) that it can result increasing in the BMI. (Ferro-Luzzi , James & Kafatos 2002).

In a two-year trial (Shai et al 2008) which were assigned 322 moderately obese subjects (mean age, 52 years; mean BMI (31); male sex (86%), participates accept one of three diets:1- low-fat, restricted-calorie; based on American Heart Association guidelines.in this group an energy intake was 1500 kcal per day for women and 1800 kcal per day for men, with30% of calories from fat, 10% of calories from saturated fat, and an intake of 300 mg of cholesterol per day.2-Mediterranean, restricted-calorie The moderate-fat, restricted-calorie. This diet was rich in vegetables and low in red meat, with poultry and fish replacing beef and lamb and energy intake to 1500 kcal per day for women and 1800 kcal per day for men, with a goal of no more than 35% of calories from fat; 3-low-carbohydrate, non–restricted-calorie, this diet was based on the Atkins diet and the intakes of total calories, protein, and fat were not limited. However, the participants were counseled to choose vegetarian sources of fat and protein and to avoid trans-fat. They concluded that the Mediterranean and low-carbohydrate diets are more effective to the low-fat diet for weight loss (The mean weight loss was 2.9 kg for the low-fat group, 4.4 kg for the Mediterranean-diet group, and 4.7 kg for the low-carbohydrate group) and to be just as safe as the low-fat diet. In addition to producing weight loss these two diets had some beneficial metabolic effects (The reduction in the ratio of total cholesterol to high-density lipoprotein cholesterol was 20% in the low-carbohydrate group and 12% in the low-fat group) and among the 36 subjects with diabetes, changes in fasting plasma glucose and insulin levels were more favorable among those assigned to the Mediterranean diet than among those assigned to the low-fat diet.

MA et al. (2007) who analyzed eight popular weight-loss plans and measured dietary quality by the (AHEI) Alternate Healthy Eating Index (The AHEI is a valuable tool in selecting a weight-loss plan that maximizes both weight loss and CVD prevention) mentioned that none of the popular weight-loss plans achieved a perfect AHEI score but the Ornish plan, which is almost a completely vegetarian plan, scored high largely due to the amount of vegetables, fruit, cereal fiber intake, and low trans-fat. The Weight Watchers higher carbohydrate and the New Glucose Revolution plans also did well due to the emphasis on fruits and vegetables, higher whole-grain composition, and low trans-fats. The Atkins/45-g carbohydrate plan had the lowest AHEI, because it was the lowest in fruit and fiber and the highest in red meat and Trans fats.

Discussion

Some obstacles have arisen over the efficiency of adopting a vegetarian diet. The term 'vegetarian diet' is not always clearly defined in the literature and is often used to describe a whole range of diets with varying degrees of restriction. Although each vegetarian subgroup has a definition but in different studies there are various diets in each subgroups, for instance in some studies vegans (exclude all animal products), occasionally consume meat, also dietary habits between countries and dietary assessment methods are different. So it is a challenge to meaningfully compare the health benefits of various vegetarian diets and comparison for accurate effect of vegetarian diets on an item like obesity is difficult. Also this diet has been studied less extensively than other famous diets and direct comparison of diets in regard to health outcomes over time is lacking, too.

Bedford and Barr (2005) mentioned there is a negative point in self-report analysis about the association between obesity/overweight and vegetarian diets. For instance, some self-identified vegetarians who have strict diet without consuming any meat, occasionally use seafood, poultry, or meat. So a strict definition of vegetarianism must be used by all researches then real association between obesity/overweight with vegetarian diets can be clearer and as a result, the prevalence of obesity among vegetarians will be less than these results.

In India a cross sectional research of 156,317 adults (99,574 women and 56,742 men, aged 20–49 years) showed some different results from other western studies. BMI in vegetarians did not differ significantly from their non-vegetarian counterparts. Mean BMI in pesco-vegetarians (20.3 kg/m^2), vegans (20.5 kg/m^2), semi-vegetarians (20.6 kg/m^2), non-vegetarians (20.7 kg/m^2), lacto-ovo vegetarian (21.0 kg/m^2) and lactovegetarian (21.2 kg/m^2), in this analysis, contrary to other western studies did not show an expected association between vegans (who eat no animal products) and significant reduction of obesity. It was mentioned that, self-reported vegans in India have some differences in their diets which isn't so restricted. This suggests that self-identification is not a good measure for estimating the prevalence of vegetarianism (Agrawal et al. 2014).

Gilasing et al. (2013) who compared self-reported vegetarians with vegetarians whose status has been confirmed by their response on the food frequency questionnaire (FFQ) declared that nearly half of those who called themselves as vegetarian reported to consume fish, meat or poultry on the FFQ, but significant differences between both groups in terms of diet and lifestyle characteristics was small. It was mentioned to the level of health consciousness which is more extent among the vegetarians in compare with non-vegetarians.

In a population-based study vegetarians appeared more 'health conscious' than non-vegetarians (Bedford & Barr 2005) and in a review, Marsh et. al (2011) declared that "improved health is one of the many reasons people choose to adopt a vegetarian diet", so most of the vegetarians and particularly vegans try to have a well-planned diet. It means that the motivation of choosing such diets is important matter which leads to some differences in the results of studies and on the health effects of vegetarian diets. Most of the vegetarians and particularly vegans are concerned about health and the health motivation for the diet can lead to a well-planned and adequate vegetarian diet which has some health benefits like preventing and treating overweight/ obesity.

According to Dyett et al. (2013), many factors influence diet choice but health is the most reported reason for diet choice (47%) among vegans and the degree of health motivation in such diets has direct association with the prevalence of various chronic diseases such as obesity. Other factors are considering animal welfare, and religion.

Orlich et al. (2014) studied vegetarian dietary patterns in AHS-2 population (it was showed that a major motivation of Adventist vegetarians was health) and mentioned that motivation for choosing vegetarian diet is very important and if the primary motivation is not health and for instance the avoidance of animal suffering causes to fallow vegetarian diets, it causes some heterogeneous results among studies on the health effects of vegetarian diets.

Nevertheless, Zhang et al. (2013) showed that even in the absence of health consciousness, vegetarian diets were more effective than non-vegetarian diets. They assessed the association between BMI and obesity among vegetarians and non-vegetarians in Southern China and compared the influence of such diets on overweight/ obesity in western populations. A total of 296 men (170 vegetarians and 126 omnivores) with aged 21 years or older participated and dietary assessment was conducted using a food frequency questionnaire (F.F.Q.). In China, vegetarianism originates from the Buddhism. Buddhist vegetarians consume, grains (primary rice), vegetables, fruits, and significant amount of soybeans and soybean products. No meat, fish, or poultry was consumed, but occasionally small amount of eggs or dairy products could be consumed. The non-vegetarians were not on special diet (they were not random samples of the general population and they were selected from a government administrative office and they were more educated and could have been more health conscious than vegetarian groups), but it was showed that although the total fat intake in Buddhist vegetarians was similar to that in omnivores (because in China, eating raw vegetables is uncommon and the most common method of cooking vegetables is to stir fry them). Results showed that Chinese Buddhist vegetarians had a significantly lower cardiovascular risk factors, including BMI, blood pressure, plasma glucose, and lipid/lipoprotein profile. BMI was 23.6 (kg/m²) in vegetarians and 24.4(kg/m²) in non-vegetarians. The average weight was 5.3 kg lower and BMI was 0.8 kg/m² (3.3%) lower in Buddhist vegetarians than non-vegetarians but as compared these result with Berkow & Barnard (2006) review, these differences were smaller to those observed in western populations , which was mentioned that the BMI of both adult male and female vegetarians is 3-20% lower than those of non-vegetarian.

Some studies (Weserterp-Plantenga et al. 2009; Leidy et al. 2011) showed that high protein diets were effective strategy for losing weight, but the majority of epidemiological studies showed that the lowest weight gain had happened in the group with the highest intake of carbohydrates and lowest intake of protein. In the cohort study of Rosell et al. (2006), which assessed weight gain over 5 years in 21,966 meat-eating, fish-eating, vegetarian, and vegan men and women in EPIC-Oxford, it was showed that the largest weight gain was seen in the meat-eaters, whereas the smallest weight gain was seen in the vegans and also among people who had changed their diet (during follow-up) into containing fewer animal food.

In a meta-analysis, Schwingshackl and Hoffmann (2013) examined the influence of low-fat (30% of intake as fat) diets containing either higher protein (.25% of intake as protein) or lower protein (20% of intake as protein) on long-term (included ≥ 12 month of follow-up) management of overweight/obesity. No differences in weight loss, fat mass loss, or reductions in waist circumference were observed between diets. No differences in total, LDL, or HDL cholesterol or triglycerides were detected. They declared that high-protein diets is not supported by evidence and more researches are needed to manifest the exact effect of a high-protein diet for treating obesity. In another meta-analysis, Bueno et al. (2013) compared very-low-carbohydrate (a diet with no more than 50 g carbohydrates/d) with low fat diet (a restricted-energy diet with less than 30% of energy from fat) in the long-term(>12 month) management of obesity. It was showed that high-fat, low-carbohydrate diets contain higher protein content and may not be appropriate for all ages, populations, and disease states.

Yet still there are challenges about effects of getting low-carbohydrate diets or high-carbohydrate diets on controlling weight. Some vegetarians have overweight because they consume more carbohydrate.

Although many popular weight loss diets such as Atkins emphasis carbohydrate restriction but because these diets contains high protein, animal products, rich in saturated fat and cholesterol, may make low-carbohydrate diets less appropriate. Even during active weight loss, these high-saturated fat diets do not lower serum low-density lipoprotein cholesterol (LDL-C) below baseline and there is concern that if such diets continue to be eaten when weight loss has ceased a more atherogenic blood lipid profile may result. Findings from controlled trials do not support that the Atkins diet is effective beyond 6 months; there is no clear evidence that Atkins style diets are better than other types of diet for helping people to lose weight; and their long-term effects on health and disease prevention are unknown (Astrup, Meinert & Harper 2004) (Dansinger ML et al. 2005).

Previously in a study by Kennedy et al. (2001), the dietary quality among 10014 adults (age 19 years and older) from 'The Continuing Survey of Food Intake by Individuals'(CSFII) was measured by the Alternate Healthy Eating Index (AHEI) and vegetarians (which ate no meat, poultry or fish were only 6%) were compared with non-vegetarian which was subdivided into low carbohydrate (less than 30% of energy from carbohydrate),medium (30% to 55%) and high (greater than 55%) and within the high carbohydrate group, members were classified as having Pyramid (30% or less energy from fat and at least one serving from USDA Food Guide Pyramid) and non-Pyramid group which subdivided into low fat (less than 15% of energy from fat) and moderate fat(15% to 30% energy from fat). It was mentioned that vegetarian consume more carbohydrate and BMI was lower in vegetarians (25.2) and the high carbohydrate Pyramid group(25.2), also the diet quality as measured by AHEI was lowest for the low carbohydrate group.

In 2006, Nordmann et al mentioned that although low-carbohydrate diets were associated with favorable changes in triglyceride and probably HDL-C values but because it made unfavorable changes in total cholesterol and LDL-C levels, so such diets currently cannot be recommended for prevention of cardio-vascular disease.

Newby et al. (2005) suggested that “a high-carbohydrate diet may be protective against obesity if the carbohydrates come from fiber-rich foods such as fruit, vegetables, and whole grains” and mentioned that current low carbohydrate diets must attention to the fact that different carbohydrate foods have different effects on appetite and energy intake.

Also, in 2009, Merchant et al. assessed the dietary habits of 4,451 healthy Canadian adults from ‘The Canadian Community Health Survey’. It was declared that the risk of obesity was inversely associated with the intake of carbohydrates and intake of carbohydrates below 47% of the total energy intake was associated with a greater risk of suffering from overweight or obesity, and a lower risk for intakes between 47-64%.

In 2010, ‘the European Food Safety Authority’ assessed several studies of long-term intervention, that dietary changes which promote a higher intake of carbohydrates (> 50% of energy) have been associated with a lower risk of weight gain in several population groups, including subjects with normal weight, overweight and obesity (European Food Safety Authority 2010).

Pilis et al. (2014), mentioned that 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. Drewnowski et al. (2004), also mentioned that carbohydrates contained in diets (with the exception of total sugars) tend to have a modest inverse association with energy density but the fat content is generally directly associated with high energy density.

Some studies have found greater weight loss among women following a low-fat vegan diet as compared with a standard low-fat diet. In a two-year randomized weight loss trial which compared a vegan diet to a more moderate low-fat diet indicates the therapeutic use of a vegetarian diet is more effective for treating overweight and obesity in both the short term (<1 year) and longer term (>1 year) than alternative non-vegetarian diets for the same purpose. They stated that the vegan group were able to eat a greater volume of food than the other group, without taking in extra calories due to its low fat content and high fiber content. Individuals in the vegan group lost more weight than those in the other group at 1 year [-4.9kg vs. -1.8] and at 2 years [-3.1 kg vs. -0.8 kg] (Turner-McGrievy et al. 2007).

Mediterranean diet presents many similarities to some types of vegetarian diet (Esposito et al. 2015), since they are mostly plant-based and include a high consumption of whole-grain foods, fruit and vegetables and in studies, it was mentioned that there was an inverse association between adherence to the Med-Diet and both the BMI and obesity and they concluded that rich in foods of vegetable origin and unsaturated fatty acids, was appears to be mainly responsible for the beneficial effects of Mediterranean diet (Tyrovolas et al. 2009; Romaguera et al. 2009). So vegetarian diets and particularly vegan diets which are completely plant-based may have extra effects on preventing and managing overweight/obesity,

but more researches must be designed to compare benefits and exact differences between these two diets and also among diets which are rich in plant-sources.

The common aspect of many studies in this review showed that increasing consumption of plant-sources foods has direct association with factors of health. According to the conclusion of the study, health benefits of these diets were related to plant-sources foods, so as the consumption of plant foods was increased the health benefits became increased, too. Many studies showed that consumption of plant foods in vegetarian diets and particularly vegan diets were more than the others but additional research studies are needed to identify the best means of introducing plant-based diets and a strict definition of vegetarianism must be used by all researches then real association between obesity/ overweight with vegetarian diets can be clearer and then as a result the prevalence of obesity will be even less than these results. This study demonstrates an inverse association between vegetarian dietary patterns and BMI compared with the non-vegetarian dietary pattern.

CONCLUSIONS

According to consistent evidences from scientific literatures, this study suggests that vegetarian diets and particularly vegan diet leads to reduction of mean body weight and there is an inverse association between overweight/obesity and vegetarian diet and appropriately planned vegetarian diets are healthful and nutritionally adequate. In this review, it is showed that vegetarian diets are beneficial in the prevention and treatment of overweight-obesity and compared with other vegetarian diets, overweight/obesity are less in vegans. In many studies when vegans were compared to not only omnivores but to other vegetarian subgroups as well, a pattern of protective health benefits emerged. Although preliminary data are valuable, more scientific studies on vegetarian are needed to get clearer picture of their health status and clinicians seeking to help individuals lose weight may wish to take advantage of this effect because prevention of obesity can happen by planned vegetarian diets and also patients can reduce the number of medications to treat a variety of chronic conditions.

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