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WHOLE FOOD PLANT BASED DIET: ITS MECHANISMS FOR THE PREVENTION AND TREATMENT OF OBESITY

ALIMENTACIÓN BASADA EN PLANTAS: SUS MECANISMOS EN LA PREVENCIÓN Y TRATAMIENTO DE LA OBESIDAD

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ABSTRACT

Obesity is a metabolic condition with a continuous increasing rate, being considered today a "pandemic". Given that is also associated to a number of other chronic diseases, the need is due for a treatment for this condition that is both effective and healthy in a comprehensive way. In this context, the concepts of lifestyle medicine and plant-based diets have emerged in medicine and in scientific research, and the latter have demonstrated benefits in all these areas and are being part of several cientific association's recommendations today. In this article, a plant-based diet is briefly defined, and the mechanisms by which this type of diet provides benefits for the control of body weight are explored, including the saciety it generates and its characteristic low caloric density, the higher thermic effect of foods, the positive modulation of the gut microbiota, its effects on the insulin sensitivity, the absence of animal protein and how this affects the body weight, and the effects it has on the leptin hormone. This diet has been studied both in observational and interventional sudies, with good results in body weight control. Being a dietary pattern that is safe and heatlhy, it is important to consider it as a good lifestyle for the prevention and treatment of obesity.

Keywords: Obesity, Vegetarians, Diet, Life Style

RESUMEN

La obesidad es una condición metabólica que se encuentra en constante crecimiento, siendo considerada incluso una "pandemia" en la actualidad. Debido a esto y al gran número de enfermedades a las que se asocia, surge la necesidad de un manejo de esta condición que sea efectivo y saludable a nivel integral. En este contexto, entran a la medicina e investigación científica los conceptos de medicina de estilos de vida y de alimentaciones basadas en plantas, habiendo estas últimas demostrado beneficios en todas estas áreas de la salud, y están siendo parte de varias de las recomendaciones de sociedades científicas actuales. En este artículo, se explicará brevemente qué es la alimentación basada en plantas, explorando los distintos estudios observacionales e intervenciones que fundamentan su uso, y se propondrán algunos mecanismos a través de los cuales provee beneficios en el control del peso corporal, entre los cuales destacan: la saciedad que genera y la baja densidad calórica que la caracteriza, el mayor efecto térmico de las comidas, la modulación favorable de la microbiota intestinal, sus efectos sobre la sensibilidad a la insulina, la ausencia de proteína animal y cómo esto afecta el control de peso corporal, y los efectos que produce sobre la hormona leptina. La alimentación basada en plantas se posiciona como una gran alternativa para la prevención y tratamiento de la obesidad, siendo además un patrón alimentario seguro y saludable. Se espera que en el futuro cada vez más profesionales de la salud consideren esta evidencias y lo incorporen como parte de sus herramientas terapéuticas.

Palabras clave: Obesidad, Vegetariano, Dieta, Estilo de vida

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INTRODUCTION

Obesity and overweight are conditions that have increased in the last decades, being considered today as a global pandemic and one of the most prevalent non-transmissible diseases[1]. Latin America is one of the regions with highest obesity rates in the world, half of women are overweight or obese, and in many Latin American countries such as Chile or Mexico, they reach two-thirds and more than half of men[2]. At the same time, obesity is a risk factor in numerous pathologies, among which coronary cardiopathy, cerebrovascular disease, diabetes mellitus type 2 and some types of cancer, in addition to being associated to an increase in mortality by any cause [3].

Although obesity is generated by numerous complex and multifactorial mechanisms, the main cause of its radical development is food[4]. However, there is limited knowledge from health professionals about how to implement good eating habits efficiently, which adds to the limited clinical time spent, impeding an extensive conversation in this matter. This ends with an underuse of this therapeutic resources and the potential benefits that a healthy nutrition has on the health of our patients[5].In this context, we have witnessed the birth of Lifestyle Medicine, defined by the Journal of the American Medical Association as the "evidence-based practice with the goal of helping individuals and their families adopt and maintain behavior that can improve their health and quality of life" [5].

One of the fundamental pillars of Lifestyle Medicine is nutrition, specifically, plant-based nutrition[6]., which has proven to have important benefits over pathologies such as hypertension, diabetes type 2, and dyslipidemia, and leads to a lower cardiovascular mortality, progressively positioning itself as one of the most beneficial eating patterns for the general health of human beings[7,8].

In this article, we offer a description of the mechanisms and the relevant scientific evidence that validates the consideration of plant-based foods as an effective intervention in the prevention and treatment of obesity. In this way, our intention is to increase the understanding and dissemination of this nutrition regimen in medical practice.

PLANT-BASED DIET:

Plant based diet is defined as a nutrition pattern that prioritizes in quantity and variety food of vegetable origin as the base of nutrition, and that lack complete or almost completely foods of animal origin (meats of all types, dairy, and eggs), as well as processed foods. "The powerful plate" (Figure 1), created by the organization "Comité de médicos por una medicina responsable", represented this dietary format conceptually [9].

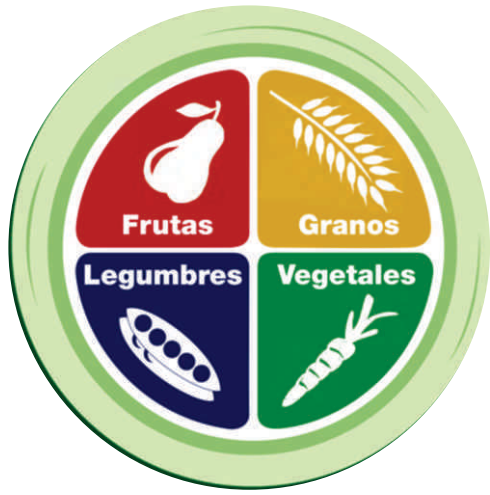

Figure 1. "The powerful plate", Medical commitee for responsible medicine [9].

In comparison to other non-vegetarian diets, a plant-based diet has a favorable nutritional profile because it prioritizes complex carbohydrates, fiber, vitamins and minerals over total and saturated fat. The abundant incorporation of proteins of vegetable origin over animal origin is a primordial difference in this nutrition regimen [10].

METHODS

This non-systematic review was centered on the mechanisms related to different dietary patterns, and the nutrients and foods they contain, and their impact in short and long-term weight control. Research was centered around the question: why is a plant-based diet effective in maintaining and promoting a healthy body weight in humans? For which we proposed the objective to search and analyze the relevant literature in determining these mechanisms, centered on the plant-based diet and using other dietetic patterns for comparison and contrast. The literature search was performed through Pubmed and Scielo data bases.

PLANT-BASED DIET MECHANISMOS IN OBESITY MANAGEMENT.

1. Satiety

In comparison with other animal origin foods,

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vegetables contain more fiber and water, and less fat, resulting in a lower "caloric density", which means, at the same volume it contains les calories. This translates into a greater satiety induction with a lower net caloric intake[11]. In fact, the indication of plant-based diet without a caloric or food-portion restriction has shown to produce a decrease in body weight and good long-term adherence in multiple studies, and the increase in satiety with each meal is key in these results [12,13].

One of the most important examples to support this hypothesis is the "BROAD study" [12], a random controlled sample in which a group of 65 individuals with obesity and overweight and at least an associated disease adopted either a plant-based diet without energy restriction (research group) or with standard medical indications (control group). The participants that adopted the plant-based diet lowered their Body Mass Index (BMI) significantly in comparison to the control group (4.4 vs 0.4 BMI points). In addition to significant decrease in cholesterol and other measured factors such as glycosylated hemoglobin, quality of life and use of medication, among others, which remained including during a follow-up of 12 months.

Low caloric density of vegetable foods is an important factor in the satiety sensation, other mechanisms may be involved in this effect as well. Klementova M. et al.[14] performed a study in which they compared the postprandial concentration of gastrointestinal hormones that promoted satiety, after eating two meals equal in calories and volume. A hamburger of vegetable origin and another of animal origin and cheese. Various postprandial markers relate with satiety sensation increased after the vegetal hamburger in comparison to the animal origin (corroborating it as such), such as the glucagon-like peptide 1 (GLP-1), amylin and peptide YY (PYY) As this, certain bioactive components present in vegetables produce satiety on their own, such as polyphenols or starch-resistant [14].

2. Thermal effect of food

The thermal effect of food, defined as the increase in metabolism after the intake of a meal[15], can be a significant part of the daily energy consumption. A new recent line of research has postulated that a greater presence of complex carbohydrates and lesser presence of fat (such as in the case of plant-based diet), are associated with a postprandial activation of the sympathetic nervous system and with an increase of energy consumption[15,16], which could partially explain the efficacy in the decrease of body weight associated to this dietary pattern.

3. Intestinal microbiome modulation

The microbiome is a group of over 48 billion microorganisms that live in the gastrointestinal tract, mainly in the colon. Obesity has been one of the most studied conditions since its relationship with the microbiome. In one of the pioneer works in this area, it was shown that the microbiome of obese humans are different from their control groups without obesity[17]. Interestingly, rats without microbiome that received an "obese microbiome" transplant showed a significant increase in body fat compared to those that were colonized with "non-obese microbiome".

The main mechanism by which the microbiome is related to obesity is through the regulation of food intake: the microbiome regulates direct gastrointestinal-neural pathways mediated by the vagus nerve, through the release of anorexigenic/orexigenic signals. In addition, the microbiome regulates energy metabolism through the modulation of insulin sensitivity, regulation of lipolysis and thermogenesis processes[18].

Through fiber fermentation present in fruits, vegetables, legumes, and whole grains, they are released as a subproduct of short-chain fatty acids (SCFAs)[19]. As part of their function, these metabolites can be an energy substrate for colonocytes, a substrate and inducers of local and hepatic gluconeogenesis (protecting against obesity induced by diet and intolerance to the associated glucose), and regulate lipolysis and thermogenesis from adipose tissue, among others[18]. Interestingly, it has been described that a much greater fiber intake brings an increase in SCFA levels, which in itself induce an increase in anorexigenic hypothalamic signals, favoring states of satiety[18, 20]. Additionally, the microbiome participates in the regulation of other molecules that are relevant in food intake and energy metabolism, such as bile acids[20]. These are particularly relevant since diets high in fats and meat products favor the development of secondary bile acids through the microbiome action, promoting deregulations of the energy metabolism [19].

Lastly, another relevant factor in understand the relationship between the microbiome and obesity is the stabilization of the intestinal barrier, whose integrity is fundamental for the maintenance and

regulation of inflammatory processes in the body[21]. Diets high in processed, hydrogenated oils and animal products (western diet), diets low in carbohydrates (ketogenic diet) or diets high in glucose, may induce intestinal permeability, endotoxemia, insulin resistance, low release of SCFA and a generalized inflammatory state[21]. On the contrary, diets based on fruits, vegetables and whole grains, rich in fiber and polyphenols (Mediterranean diet or plant-based diets) favor the intestinal barrier integrity, protecting the system of before-mentioned pathologies[21].

Together, the available evidence suggests that plant-based diets, rich in whole grains and fiber induce a protective effect for obesity in a microbiome-dependent form.

4. Insulin

Obesity is strongly associated with the development of insulin resistance[22], a requirement for the development of Diabetes Mellitus type 2 (DM2). Among the foods responsible for this association, the refined carbohydrates, and sugars (known for their high glycemic index) hold first place. On the contrary, the consumption of whole grains, rich in carbohydrates of low glycemic index and fiber, increase insulin sensitivity, lowering DM2 risk, which has been shown in prospective studies with mainly plant-based diets[23].

Fats are another important micronutrient in the risk of developing DM2. Saturated fatty acids reduce insulin sensitivity by accumulating free fatty acid intermediaries in muscular cells[24], altering their response to this hormone. This way, an increase in free fatty acid levels, secondary to a diet rich in saturated fats, tends to be associated with developing obesity, insulin resistance and DM2 [8].

The adequate function of insulin is important for carbohydrate metabolism, improving energy use in general, which would be beneficial in body weight management[15]. This way, a dietary pattern that limits not only simple carbohydrates but also saturated fats, and that prioritize fiber intake, is associated with a state of greater insulin sensitivity, with lesser risk of obesity and DM2 [25].

5. Animal protein versus vegetable protein

The composition and origin of diet protein have effects differentiated over metabolism. A relevant example is the modulation of glucagon and insulin secretion in response to the intake of certain amino acids [26,27].

Vegetable protein has a lower proportion of essential amino acids and greater of non-essential amino acids., in comparison to proteins of animal origin[26, 28], which was considered a disadvantage before. However, we now know that proteins from vegetable sources favor a greater net glucagon activity and a negative regulation of insulin secretion, which results, among other things, in a decrease of de novo lipogenesis and a decrease in fat storage[26]. On the contrary, essential amino acids that are abundant in animal origin foods, induce adipogenesis with an increase of total body fat[28]. This hypothesis has been tested using diets with a specific restriction to Methionine, an essential amino acid, as a therapeutic alternative to improve metabolic health. These diets have been capable of reversing obesity in animals, through mechanisms such as the promotion of fat oxidation, glycolysis and the metabolism of tricarboxylic acid cycle[29].

In conclusion, there are diverse metabolic pathways through which a greater intake of essential amino acids (that are found in abundance in animal proteins) produce obesogenic effects, which would explain the protective effects of vegetable protein in obesity treatment.

6. Leptin

Leptin is a hormone that has received great attention in the last decade due to its role in obesity and metabolic syndrome. Synthesized mainly in white adipose tissue, this hormone acts as a regulator of energy homeostasis, decrease in food intake, and is involved in lipid and carbohydrate metabolism, increasing insulin sensitivity in peripheral tissues[30]. Leptin levels tend to be associated to the quantity of body fat, with greater obesity, greater concentration of blood leptin[30]. However, some individuals develop leptin resistance, a condition that results in the production of antagonistic effects in weight control, contributing to obesity[31]. Leptin resistance is secondary to very high levels of same as a consequence of the increase of body fat tissue and the excessive intake of saturated fats and sugars[32]. As this, plant-based diets, being a dietary pattern that promotes weight loss and minimizes saturated fat and simple sugar intake, may result in an increase of leptin sensitivity, which at the same time, leads to an increase of insulin sensitivity, in addition to favoring lipid metabolism[32].

EFFICACY

The vegetarian population has a significantly lower weight and BMI than populations that consume diets

rich in meat[33]. In fact, prospective studies have observed the negative effects in weight associated with the intake of different quantities of meat, showing a direct relation and dose-dependance between the intake of animal protein (in the form of any meat) and weight gain[34].

Comparing different diets for the treatment of obesity through interventions, we have noticed that one can obtain good results with different types of foods[35,36], with vegetarian diets we lose the same or more weight than with non-vegetarian diets, obtaining even better results with diets completely plant-based in comparison to ovo-lacto-vegetarian diets[37]. Furthermore, weight loss and adherence to the type of food persists throughout time[12].

SAFETY

In the last decade, we have seen a growth in the incorporation of plant-based diets in multiple scientific society recommendations and expert opinions, due to its various benefits and excellent safety profile (38-40). Currently, this diet has been established in international reference guides as safe and healthy for all stages in life, including pregnancy, nursing, infancy, childhood, and adolescence (41). However, it is fundamental to be responsible facing certain nutrients that may be critical or require supplements in plant-based diets. These nutrients, their requirements and how to obtain them are described below:

1. Vitamin B12

Vitamin B12 is not a component of vegetable foods, which is why it is recommended that vegetarians, vegans and all those who follow plant-based diets, consume a safe and reliable source of this vitamin, through supplements, to prevent its deficit[42]. We must emphasize that a significant prevalence of this vitamin's deficit has been studied in omnivorous populations (over 20% in adults)[43], which is why we recommend that its measure and supplementation be evaluated and considered in individuals that follow any dietetic pattern, especially populations at greater deficit risk, such as the elderly, patients with pernicious anemia, gastrointestinal disorders, chronic metformin users, chronic users of antiacid medications and bariatric surgery[44].

Vitamin B12 supplementation may be done orally or intramuscularly, although some authors recommend initiating treatment intramuscularly in case of deficit. In case of not having any deficit, the maintenance dose for oral supplementation, according to age, is described in Table 1[45].

Tabla 2: Vitamin B12 dose for maintenance, orally, with Cyanocobalamin[45].

	Multiple daily dose	Daily dose	Bi-weekly dose	Weekly dose
Pregnancy and nursing	2 ug every 8 hrs	50 ug	1000 ug / dose	2000-2500 ug
6 months – 3 years	1 ug every 12 hrs	5 ug	-	
4 - 10 years	2 ug every 12 hrs	25 ug	500-1000 ug / dose	1000-2500 ug
≥ 11 years	2 ug every 8 hrs	50 ug	1000 ug / dose	2000-2500 ug

2. Essential fatty acids Omega–3

The omega-3 fatty acids are essential, and they need to be obtained in the diet. In human diet, they are mainly in the form of Alpha linolenic acid (ALA), Eicosapentaenoic Acid (EPA) and Docosahexaenoic acid (DHA). These last two are almost exclusively in food of animal origin (fish, fat, eggs and seafood), while ALA is found in abundance in food of vegetable origin. Humans are capable of metabolizing the latter to form EPA and DHA, which is why a plant-based diet with adequate intake of ALA (1,6 g in men and 1,1 g in women), would be enough to obtain the DHA requirements[45,46]

The hepatic adaptability during low levels of EPA and DHA would be a mechanism by which vegetarian populations could reach adequate levels of these fatty acids[47, 48] On the other hand, there are factors that can affect the conversion rate, such as a high intake of linolenic acid (ALA), better known as omega-6, which is why a diet proportion of LA:ALA between 4:1 and 2:1 is recommended, avoiding food rich in omega-6, trans

fats and saturated fats (such as margarine and coconut and palm tropical oils, in addition to food of animal origin)[45].

In order to satisfy and even exceed the ALA requirements (2 g per day, according to the recommendations of some authors for vegan individuals)[42], the daily intake of vegetables rich in these nutrients, such as ground chia seeds (713 mg of ALA per teaspoon), ground flaxseed (570 mg of ALA per teaspoon), flaxseed oil (608 mg of ALA in ¼ teaspoon) and nuts (515 mg of ALA in 3 halves of a unit) are recommended[49].

In case the appropriate levels are not reached through food, you can recur to algae-based supplements, which are a viable vegetarian alternative for supplying Omega-3[50].

3. Calcium and Bone Health

The recommendations for daily intake of calcium vary depending on country and organization but tend to be between 600 and 1000 mg per day for adults[51,53].

A deficit in the intake of this nutrient has been found in practically any type of diet pattern, which is why it is a nutrient that should be considered when planning any type of diet[43]. Vegetable foods rich in in this mineral are arugula, turnip leaves, watercress, almonds, ground sesame seeds and calcium-fortified vegetable drinks, among others[54], which is why it is recommended to incorporate daily, especially if a plant-based diet is followed.

Calcium supplementation is not recommended for the general public without a clear indication, due to possible adverse effects observed due to calcium supplement intake[55]. Supplementation through a balanced diet is exempt of these risks and seems to be the safest and most effective way to avoid the deficit of this mineral.

4. Proteins

The recommended daily intake of protein is 0,83 g/kg per day[56]. Since the digestibility of vegetable protein is less than that of animal protein, some authors recommend that the daily intake for vegetarians and vegans be 1.3 times greater (0,9-1 gr/kg)[57]. These values are greatly exceeded in individuals that follow omnivorous diets[58]. Although individuals that follow vegetarian and vegan diets tend to consume less amount of proteins, they habitually exceed these minimum requirements without additional interventions[58,59]. This is because many vegetable foods contain significant amounts of diverse proteins (legumes, whole grains, dried fruits, seeds, etc.)[60], some even exceed the protein content of animal products.

Due to all this, it is considered that when the caloric requirements of a vegetarian and vegan diet are met, sufficient protein and essential amino acids are obtained, no matter the stage of life the person finds themselves in[42]. This way, including vegetable foods of all groups throughout the day, we can obtain essential amino acids in adequate amounts.

5. Iron

Dietary iron is presented in two forms, heme (only in food of animal origin) and nonheme (in food of animal and vegetable origin). Heme iron has greater bioavailability [61]. since its absorption is not affected by interactions with other foods or by the organism's state of iron. However, nonheme iron absorption varies depending on the individual's physiological needs (partially from the iron reserve), and the food composition that contains it (presence of phytates, polyphenols, vitamin C, etc.) varying its absorption between 1% and 23% [62].

The recommended daily intake of iron is 8 mg per day in adult men and 18 mg in adult women[63]. Iron deficiency (anemia) is the most prevalent worldwide nutritional shortage, independently of the dietary regimen[64], with similar prevalence among vegetarian, vegan and omnivorous subjects[54]. In contrast, the excess of heme iron in the organism has turned into a growing research area, having observed a correlation with illnesses such as cirrhosis, cardiovascular disease, diabetes mellitus type 2, and cancer [65].

In order to satisfy the iron requirements in plant-based diets, it is recommended to include food rich in the same daily (such as legumes and green-leaf vegetables), at the same time as food that helps absorb nonheme iron (such as peppers, citric fruits and

others)[42,66].

Likewise, phytates from foods are an element that can inhibit absorption of nonheme iron, which is why it is also recommended to regularly apply culinary methods such as soaking, grinding and germination, to minimize the content of these in foods[54].

CONCLUSIONS

The efficacy of a plant-based diet in the management of obesity and maintenance of a health body weight has been demonstrated while observing population that follow these dietary patterns as well as putting it to the test in prospective studies. There are diverse mechanisms involved in the capacity to promote a health weight in addition to providing multiple benefits to metabolic and cardiovascular health. For these reasons, plant-based diets should be considered as an excellent tool, a healthy habit, for the prevention and treatment of overweight and obesity.

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