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HEALTH CONSIDERATIONS OF VEGANISM

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VEGANISM; HEALTHY LIFESTYLE CHANGE OR DISAVANTAGOUS TO LONG TERM HEALTH?

The vegan diet has gained momentum in recent years, with more people transitioning to the diet, whether for health or ethnically based reasons. With over 350,000 people expected to sign up for Veganuary 2020. The main reasons for pledging to follow Veganuary is 46% health, 34% animal welfare, 12% environment and 8% other (Veganuary 2020).

As health is the primary reason to adopt a vegan diet the following paper investigates the health benefits and shortcomings of adopting a vegan diet.

The vegan diet is often characterised as being very restrictive and is associated with both health benefits and health concerns. Controversy regarding the diet exists from those fully opposing the diet to those actively supporting and advocating it. With such increased uptake accompanies the questions raised on how veganism or plant-based diets can maintain optimal health when essential nutrients cannot be found naturally from a vegan diet without the intake of supplements.

Whether you are vegan or not, the choice of plant-based alternative products directed at vegans and the whole foods market has exploded with a projected market worth of $24.3bn by 2026; an increase of 9.1% over the CAGR estimated in 2019 (Markets Watch 2020).

In the last few decades, the 'ideal' diet has switched significantly, from one at low risk of nutritional deficiencies, to those that reduce energy intake to protect from diseases induced by overeating. The underpinning health associations from Mediterranean, vegan and vegetarian diets has gained growing interest, mainly because they have gained research into the protection from cardiovascular diseases, metabolic syndrome, and some cancers by their increased fresh produce and fibre intake.

PRAL score

Acidogenic diets, commonly measured by the potential renal acid load (PRAL), have been linked with many common and increasingly seen metabolic diseases including insulin resistance, hepatic dysfunction, and cardiometabolic risk; the main of which are avoidable with good nutrition and an active lifestyle (Lanier, et al 2016). Vegan diets are linked to low acid loads, as the consumption of vegetable and fruits decreased the acidity level of the body and increases the pH to a desired level (Cosgroveet al 2017). A study in 2017 revealed that by reducing the intake of meat and animal products for 2-6 day per week a reduction of urine acid levels was observed and an improved PRAL score. Therefore, since low dietary PRAL scores have been related to improve metabolic parameters, adoption of a vegan diets for several days per week could be used as a diet strategy to lower disease risk of non-communicable disease (Iwase at al 2015).

Nutrient intake

Long-term consumption of a vegan diet has been associated with some favourable laboratory measures, but it has also been linked with lowered intakes of key nutrients, compared to the recommended daily nutrient reference values. "The Finnish Study" highlighted the need for nutritional guidance to vegans (Elorinne et al 2016). Overall, vegans presented with low B12 intakes, low PUFA n-3 intakes, decreased vitamin D, iodine and selenium intakes. This is of concern as all the nutrients listed are essential for achieving and maintaining health. Furthermore, iodine and selenium levels are generally deficient in UK populations even prior to adopting a dietary model that restricts the intake of nutrients or eliminates food groups (Thomson 2014). It is therefore paramount that the nutritional intake is carefully considered or consulted with a dietitian before adopting a plant-based or vegan diet.

A Swedish study from 2002 investigated vegan dietary intakes and concluded that vegans had higher intakes of vegetables, legumes, and dietary supplements than than omnivores (Larsson and Johansson 2002). Whilst it may seem obvious that plant-based diets contain an increased vegetable intake the recent serge of vegan snacks, ready meals and meat alternatives is presenting a potential increase in the consumption of salt, saturated fats and artificial sweeteners, that could present long term health risks similar to any diet that has a high reliance of 'processed food' (Chat 2018).

A UK study showed vegans commonly have dietary intakes lower than the average requirements of riboflavin, vitamin B12, vitamin D, calcium, iodine and selenium. Intakes of calcium and selenium remained low even with the inclusion of dietary supplements. But reviews also demonstrate that dietary habits of vegans vary considerably but generally do not meet the average recommended nutrient requirements of some essential nutrients (Lightowler and Davies 2015).

In general, the findings from scientific literature suggest that the vegan diet can contribute to a health promoting lifestyle providing that diets are well-planned, balanced, and include a variety of foods, in particular fortified and enriched products. The vegan society insist that the use of dietary supplements is paramount to maintain health and ensure all nutrient are consumed (Kolasa 2017). While specific vitamin and mineral intakes may be of concern for vegans, there is mixed evidence suggesting that vegans are at an increased risk of nutritional deficiencies, this is due to a lack of long-term studies on vegan nutritional intake. However, long-term analysis of vegetarian diets has presented an increased risk of deficiencies if a dietary strategy isn't planned effectively or with care. Yet long-term nutritional studies have concluded that an increase in certain vitamins can augment the absorption of other vitamins and minerals; increasing their bio availability. Specifically, vitamin C that enhances the absorption of nonheme iron, this demonstrates the need for more understanding of nutrient interaction. Potential food combinations or specific supplementation combinations could be beneficial to vegan health (Cockell 2007).

Women are at greater risk of anaemia regardless of the dietary model adhered to, therefore those who eat a diet low in haem iron (haem iron has the highest bio-availability in the human body) maybe at risk of increased deficiency. The use of biotechnology in the creation of synthetic versions of haem-iron for example could be an area of great development for protecting female and vegan health.

Hypothesis that long-term vegan dieters develop adaptations to low nutrient bioavailability has been documented in anecdotal articles, but it is without substantiated evidence and a thought process that could be dangerous to long- and short-term health without further investigation**.**

Short-term clinical studies have shown that the avoidance of deficiency is attributed to vegans' who have gain a greater understanding of nutrient sources and have therefore calculated a well-balanced diet. It is reported that those individuals that are hyper-aware of potential health concerns make provisions to ensure adequate supplement and fortified foods are consumed. But as deficiencies can take years to present themselves, it is not credible to assume a 2-8-week study is sufficient to assure a lack of deficiency.

Table 1; Nutrients at highest risk of deficiency in Vegan and plant-based diets.

	RISK OF DEFICIENCY
IRON	Iron deficiency is not common in males and therefore generally not a concern in healthy male adults. Females are at great risk of iron deficiencies. Iron deficiency results from an inadequate supply of iron to cells following depletion of the body's reserves. Microcytic anaemia occurs when body iron stores are so low that haemoglobin synthesis and red blood cell formation are severely impaired. Iron deficiency is the most common nutritional deficiency worldwide, affecting primarily children, women of childbearing age, pregnant women, frequent blood donors, and individuals with certain medical conditions. Haem iron comes from haemoglobin and myoglobin in animal food sources and represents 10%-15% of total dietary iron intake of meat eaters. Yet, because it is much better absorbed than nonheme iron found in both plant and animal food sources, haem iron contributes up to 40% of total absorbed iron. Iron supplementation may cause gastrointestinal irritation, nausea, vomiting, diarrhoea, or constipation, and interfere with the absorption and efficacy of certain medications, including antibiotics and drugs used to treat osteoporosis, hypothyroidism and Parkinson's disease symptoms.
VITAMIN D	Vitamin D can be synthesised in the skin upon exposure to sunlight and is then metabolised in the liver and kidney to the metabolically active form called 1α,25-dihydroxyvitamin D. Vitamin D is essential for maintenance of bone mineralisation through the regulation of calcium and phosphorus homeostasis. Vitamin D also exhibits many non-skeletal effects, particularly on the immune, endocrine, and cardiovascular systems. Vitamin D intakes that are insufficient in pregnancy may be associated with several adverse effects for the mother and new-born. Safety and benefits of vitamin D supplementation during pregnancy both need to be evaluated in clinical trials.
B12	Vitamin B12 or cobalamin plays essential roles in folate metabolism and in the synthesis of the citric acid cycle intermediate, succinyl-CoA. Vitamin B12 deficiency is commonly associated with chronic stomach inflammation, which may contribute to an autoimmune vitamin B12 malabsorption syndrome called pernicious anemia and to a food-bound vitamin B12 malabsorption syndrome.

	Impairment of vitamin B12 absorption can cause megaloblastic anaemia and neurologic disorders in deficient individuals. Normal function of the digestive system required for food-bound vitamin B12 absorption is commonly impaired in individuals over 60 years of age, placing them at risk for vitamin B12 deficiency. Vitamin B12 and folate are important for homocysteine metabolism. Elevated homocysteine levels in blood are a risk factor for cardiovascular disease (CVD). Low maternal vitamin B12 status has been associated with an increased risk of neural tube defects (NTD), but it is not known whether vitamin B12 supplementation could help reduce the risk of NTD. Vitamin B12 is essential for the preservation of the myelin sheath around neurons and for the synthesis of neurotransmitters. Both depression and osteoporosis have been linked to low vitamin B12 status and high homocysteine levels.
IODINE	Iodine is a key component of thyroid hormones, which are required throughout life for normal growth, neurological development, and metabolism. Insufficient iodine intake impairs the production of thyroid hormones, leading to a condition called hypothyroidism. Iodine deficiency results in a range of adverse health disorders with varying degrees of severity, from thyroid gland enlargement (goitres) to severe physical and mental illness. Iodine deficiency-induced hypothyroidism has adverse effects in all stages of development but is most damaging to the developing brain. Maternal iodine deficiency during pregnancy can result in maternal and foetal hypothyroidism, as well as miscarriage, preterm birth, and neurological impairments in infants. Pregnant women, lactating mothers, and young infants are among the most vulnerable to iodine deficiency due to their special requirements during these life stages. Seafood is an excellent source of dietary iodine. Dairy products, grains, eggs, and poultry contribute substantially to dietary iodine intakes in the UK
SELENIUM	Selenium exerts various biological functions mainly as part of the amino acid, selenocysteine. The levels and chemical forms of selenium in plant-based food vary according to the composition and selenium content of the soil in which the plants are grown. Selenium-rich food sources include Brazil nuts, grains, seafood, organ meats, poultry, and dairy products. Impaired antioxidant protection in selenium-deficient individuals may affect physiological responses to stress and neurological developments in infants.
CALCIUM	Calcium is a major constituent of bones and teeth and plays an essential role as second messenger in cell-signalling pathways. Circulating calcium concentrations are tightly controlled by the parathyroid hormone (PTH) and vitamin D at the expense of the skeleton when dietary calcium intakes are inadequate. The skeleton is a reserve of calcium drawn upon to maintain normal serum calcium in case of inadequate dietary calcium. Data from observational studies and randomised controlled trials support calcium supplementation in reducing the risk of high blood pressure and preeclampsia in pregnant women. Current available data suggest that adequate calcium intakes may play a role in body weight regulation and have therapeutic benefits in the management of moderate-to-severe premenstrual symptoms. Adequate calcium intake is critical for maintaining a healthy skeleton and the growing skeleton of the unborn baby in pregnancy. Calcium is found in a variety of foods, including dairy products, beans, and vegetables of the kale family. Yet, the content and bioavailability varies among foods, and certain drugs are known to adversely affect calcium absorption.
ZINC	Zinc is a nutritionally essential mineral needed for catalytic, structural, and regulatory functions in the body. Dietary zinc deficiency is quite common in the developing world, affecting an estimated 2 billion people. Consumption of diets high in phytate and lacking foods from animal origin drive zinc deficiency in these populations. Dietary zinc deficiency has been associated with impaired growth and development in children, pregnancy complications, and immune dysfunction with increased susceptibility to infections.

	Zinc bioavailability is relatively high in meat, eggs, and seafood; zinc is less bioavailable from whole grains and legumes due to their high content in phytate that inhibits zinc absorption.
POLYUNSATURATED FATTY ACIDS	Linoleic acid (LA), an omega-6 fatty acid, and α-linolenic acid (ALA), an omega-3 fatty acid, are considered essential fatty acids because they cannot be synthesised by the human body. The long-chain omega-3 fatty acids, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), can be synthesised from ALA, but due to low conversion efficiency, it is recommended to consume foods rich in EPA and DHA. Both omega-6 and omega-3 fatty acids are important structural components of cell membranes, serve as precursors to bioactive lipid mediators, and provide a source of energy. Long-chain omega-3 polyunsaturated fatty acids exert anti-inflammatory effects; it is recommended to increase their presence in the diet. DHA supplementation during pregnancy may reduce the risks of early premature birth and very low birth weight. DHA is important for visual and neurological development. However, supplementation with long-chain during pregnancy or early infancy appears to have no significant effect on children's eye health, neurological development or physical growth.

Adapted from Institute of Medicine (US) Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, 1998 & Trumbo et al 2009.

Vegans are viewed to ingest much higher intakes of carbohydrates, fibre and polyphenols such as genistein and daidzein. This is associated with reduced inflammation, increased gut microbiota diversity and increase antioxidant levels. However, a clinical study review revealed that antioxidant levels were higher in those following ovo-vegetarian and pescatarian diets (Ver Schage 2016).

Protein intake is generally sufficient in vegans especially with the increase of commercially available plant proteins, yet careful consideration should be observed to ensure all essential amino acids are supplied, special considerations need to be made to lysine and methionine that are generally low in plant-based protein sources (Trumbo 2009)

The UK National Diet and Nutritional Survey conducted in 2014 evaluated the past 6 years of data. The data found that there were high 'at risk' groups of nutrient deficiency due to following 'trendy' or 'new' diets that had not been planned or carefully evaluated. The survey collected data from 3,238 adults aged 20-59. The results presented that the age group at highest deficiency risk were males and females aged 20-29. (UK National Diet and Nutrition Survey 2016).

- Females presented higher risk of mineral deficiencies in potassium (24.7%), zinc (8.6%), selenium (50%), iodine (18%) and calcium (9,4%).
- Males were at risk of mineral and vitamin deficiencies in selenium (26%), magnesium (14%), iodine (17%) and vitamin A (11%) deficiency.
- Males and females aged 40 to 49 were the most likely to be deficient in selenium (41.0%).
- Across all age groups and both genders, fewer than 5% of people were at risk of vitamin C, vitamin B12 and folate deficiency.
- More than 10% of men were at risk of vitamin A deficiency.
- More than 10% of women were at risk of riboflavin deficiency.

A study by Shen et al 2019, elevated the omega-3 fatty acid status of a cross sectional group of healthy adults aged 20-65yrs of age who were following 'self-prescribed' diets.

- Both genders, of all age groups showed increased risk of being deficient in omega-3 fatty acids. 32-89% presented as deficient.

Whilst both the National Nutritional and Diet Survey and the survey by Shen et al were not vegan specific data it does highlight the incidence of deficiency within in groups where dietary restriction is made. Furthermore, the participants all presented as healthy and without risk of disease.

Body Mass Index

Studies conclude that the body mass of vegans is on average lower than that of others who eat animal products (Nadimi,et al 2013). However, when composition was analysed by DEXA scanning on average the lean body mass of vegans was much lower than that compared to ovo-lacto-vegetarians and meat eaters. This is reflected in the lower mean resting metabolic rate (RMR) that is believed to be a reflection of a lower protein intake and therefore a lower dietary induced thermogenic effect.

The body fat mass varies significantly in studies; previously the vegan diet has been associated with reduced fat mass as plant-based foods are naturally higher in fibre and lower in fat content. But as new products have emerged in the market that have higher fat content from sources such as vegetable fats, nut butters, palm, rapeseed oils and coconut oils and the all year-round availability of foods such as avocado and nuts, dietary fat intake has increase. Therefore, a once 13% lower mean kcal intake in vegans was seen compared to meat eaters, is now not observed (Spencer 2003).

Cholesterol

Yoko et al 2017 compiled a plant-based diet review where results showed that vegan and plant-based diets were associated with decreased total cholesterol, low-density lipoprotein cholesterol, and high-density lipoprotein (HDL) cholesterol, but not with decreased overall serum triglycerides. Ovo-lacto-vegetarian diets presented the best augmentation to cholesterol levels as HDL lipids only reduced slightly and LDL and VLDL reduced significantly improving the cholesterol and health status of the individuals (Hardinge 2012).

Gut health

The relatively recent inclusion of vegan diets in studies of gut microbiota and health allows the opportunity to assess whether the vegan gut microbiota is distinct. A beneficial characteristic of a vegan diet may be partially explained by the associated microbiota profile. The relationship between diet and the intestinal microbial profile appears, with vegans displaying a gut microbiota more diverse than that from of meat eaters, but not always significantly different from that of vegetarians. Reduced levels of inflammation may be the key feature linking the vegan gut microbiota with protective health effects. However, it is still unclear whether a therapeutic vegan diet can be prescribed to alter the gut microflora for long-term health benefits (Wu et al 2016).

Socio-economic status

Vegan–vegetarian diets have different connotations in richer and poorer countries, being associated with a higher educational level and income in developed countries, and with poverty in developing countries. Therefore, the overall health state of veganism is very different depending on socio-economic status. For those who can plan, buy supplements and seek regular health intervention a vegan diet can be attributed to a health sustaining manner, however it is acknowledge that the need for quality bio-available supplementation is required to protect long term health (Schmutz and Foresi 2016).

Overall

The error of not planning an adequate diet is the main limiting factor of a plant-based, vegan diet. It is widely acknowledged that there are nutrient limitations that can be detrimental to health, when an individual is solely reliant on nutrients from plant-based sources. It is essential that those adopting a vegan or plant-based diet consider the literature on nutrient deficiency and ensure optimal intake of nutrients is maintained.

The increased plant matter has shown to positively enhance the gut microflora and PRAL score, that can contribute to health. However, the increased consumption of plant-matter can be adapted without eliminating animal products and therefore limiting the risk of nutrient deficiency.

A complete spectrum of the vegan food options needs to be assessed as vegan products continue to become more widely available and highly palatable. At present a vegan diet has been associated with being beneficial to health, however with increased ‘on the go’ options the risk of over consumption and over reliance on heavily processed foods is of great concern. Bringing with it, its own risks of increased energy intake, increased sugar consumption and increased fat intake that can negatively affect health parameters in the short and long term.

A plant-based or plant- enriched diet, that contains milk and eggs is deemed as the ideal diet for optimal health based on scientific literature, as it balances the reduced need for supplementation and increases dietary plant matter essential for health and ensures all essential nutrients are consumed.

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