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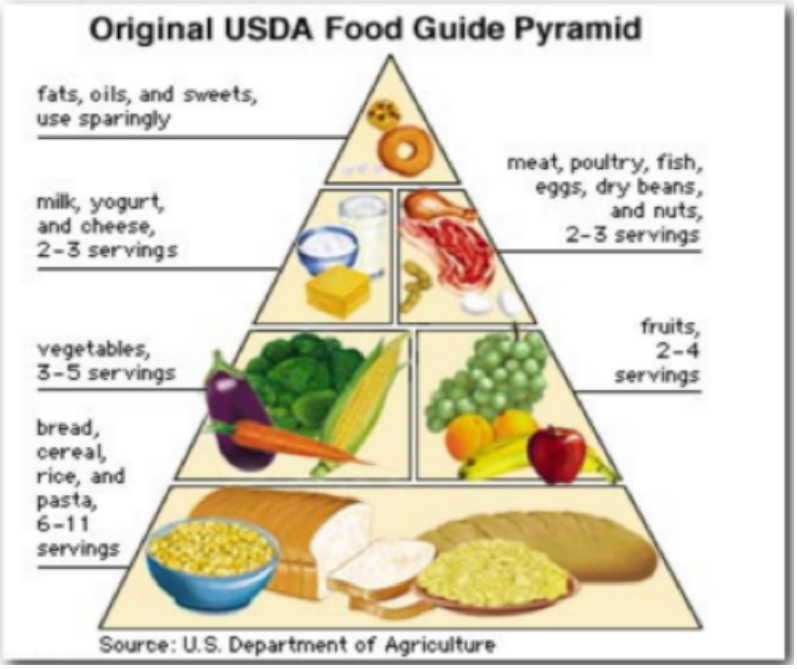
Satija A, Bhupathiraju SN, Spiegelman D, Chiuve SE, Manson JAE, Willett W, et al. Healthful and Unhealthful Plant-Based Diets and the Risk of Coronary Heart Disease in U.S. Adults. Vol. 70, Journal of the American College of Cardiology. 2017. p. 411–22.

What We Know, Think We Know, or Are Starting to Know

We know that plants are good for health. So confident am I in that statement that I feel no obligation to add an appropriate citation of supporting literature.

But **there is also an issue with terminology currently in nutrition, in particular with regard to the term: "plant-based".** The issue is this inherently means nothing. Let' s take the very first set of public health dietary guidelines from 1977, the US Department of Agriculture' s now infamous 'Food Pyramid' :



You can clearly see what the base of the pyramid was formed of in dietary recommendations: plant-based. Based upon plants. Whatever way you want to frame it, the reality is that dietary guidelines have always been for a "plant-based diet". Why the ' Standard Western Diet' has evolved to what it is, with high levels of animal meats - and an industry supporting this insatiable global demand - is more a question of socio-economics and international trade than of nutrition.

Nowadays, the term "plant-based" has become a chameleon of sorts, and could be used to refer to animal-exclusive vegan diets or even the Mediterranean diet. In research, "plant-based" has often described vegetarian diets, which may range from lacto-ovo-vegetarian, pescatarian, lacto-pescatarian, lacto-ovo-pescatarian…you see where this is going, the potential combinations and respective contributions from animal produce are varied.

More to the research point, several recent prospective cohort studies have failed to find that vegetarian diets reduce risk of all-cause mortality or cancer compared to non-vegetarian diets [1,2]. Have vegetarian diets suddenly become unhealthy? No, these studies are highlighting limitations in how we quantify disease risk relative to dietary exposure.

For example, in the Oxford-EPIC study meat eaters had a moderate mean intake – 78g and 69g for men and women, respectively – and had vegetable and fruit intake which, although less than the vegetarian groups, was still higher than average, indicating the false nutritional dichotomy that the healthfulness of a diet is defined merely by the presence or absence of meat [1].

More particularly, there is often a false rebuttable presumption of healthfulness in a "plant-based" diet, however "plant-based" defined by the absence of meat may still encompass conventional unhealthy foods typical in the Western diet [7]. Indeed, it is noted that the mere label of "vegetarian" or "plant-based" defined simply by the absence of meat gives no indication of healthfulness of the diet pattern: refined grains, added sugars, trans fats, french fries, sodas, and sodium are all plant-based, technically [3].

The present study used a diet quality index* to assess the associations between plant-based diet quality and coronary heart disease in three US cohorts.

*Geek Box: Diet Quality Index

Diet quality indices provide a means of quantitatively assessing diet, to better characterise healthfulness of an overall dietary pattern, rather than isolated nutrient variables alone. There are a range of indices commonly used in research, including the Diet Quality Index, Healthy Eating Index and Alternate Healthy Eating Index, and the Mediterranean Diet Score - these are the most internationally recognised and validated for assessment of diet quality in various populations. Diet quality indices provide a means to quantitatively assess the healthfulness of dietary pattern, given "quality" is an ambiguous term for research purposes. There are a number of ways an index may assess diet quality: basing the index on food groups and nutrient intakes is the most common, for example and index may have "red meat" as a food group, and then thresholds in grams per day upon which higher or lower scores are assigned. Conversely, polyunsaturated fats may have a threshold in percentages, which higher or lower scores assigned based on PUFA intake as percentage of total energy intake. As an example of a common form of diet quality index, let's consider the Alternate Healthy Eating Index, which consists of 11 dietary components with a maximum of 10-points for each, contributing to a total score of 110. The dietary components are based on an adequacy principle for foods whose consumption is associated with lower risk of disease, including vegetables, wholegrains, whole fruit, nuts and legumes, long-chain omega-3 fatty acids, and polyunsaturated fats: the points score rises with increasing consumption of the dietary component up to a maximum score of 10, which is individualised to the food group: for EPA/DHA a max score is 250mg/d on average or 2 x 114g oily fish servings per week, for wholegrains a max score is 90g/d in men and 75g/d in women. In contrast, dietary components associated with negative health outcomes, including sugar-sweetened beverages and fruit juices, red/processed meats, trans fats, and sodium have a points score inverse to consumption. For example, the max score for sodium is <1,612mg/d, while a score of 0 for sodium >5,271mg/d. Due to positive associations with health outcomes associated with moderate alcohol consumption, a maximum score is available for moderate alcohol intake, while high intake scores a standard value of zero. Diet quality index's may change over time: in the AHEI, for example, a max score is provided if trans fats are <0.5%, but due to changes in the food supply this score is often a default 10 points, not necessarily reflective of diet quality. Thus, diet quality indices can be flexible and evolve to reflect different dietary patterns and factors. However, an index chosen to asses diet quality in a given population should be appropriate to that population.

The Study

The Nurses Health Study I [NHS] and II [NHS2] and Health Professional's Follow-Up Study [HPFS] began in 1976, 1989, and 1986, respectively. The NHS cohorts consisted of female nurses, while the HPFS consisted of male health professionals. A 130 food item semi-quantitative* food-frequency questionnaire was administered at baseline, and then every 2-4 years subsequent.

A plant-based dietary index [PDI] was created for each cycle of the FFQ, with three distinct indices:

- Overall plant-based diet [PDI]
- Healthful plant-based diet [hPDI]
- Unhealthful plant-based diet [uPDI]

18 food groups based on similar nutrient characteristics were created within each of the following categories: healthy plant-based foods, unhealthy plant-based foods, and animal foods.

Food groups were ranked into quintiles [5 ranks] and assigned positive or reverse scores, i.e., participants in the highest quintile of a healthy food group received a score of 5, while the lowest quintile received a score of 1. This was reversed for unhealthy foods: participants in the lowest quintile received a score of 5, while the highest quintile received a score of 1.

A total score for each plant-based index were given by adding up the positive and reverse scores for each food group for healthy plant-based foods, unhealthy plant-based foods, and animal food groups, depending on the diet index:

- PDI: positive scores for plant-based food groups, reverse scores for animal food groups
- hPDI: positive scores for healthy plant-based food groups, reverse scores for unhealthy plant-based food groups and animal food groups
- uPDI: positive scores for unhealthful plant-based food groups, reverse scores for healthy plant-based food groups and animal food groups.

Scores were divided into deciles, i.e., 10 scoring levels ranked from lowest [Decile 1] to highest [Decile 10]. To reflect long-term dietary intake, index scores for each FFQ cycle during the follow-up period were averaged, to predict risk of coronary heart disease [CHD].

The primary outcome was CHD, defined as non-fatal myocardial infarction [MI] and fatal CHD.

*Geek Box: Semi-Quantitative FFQ

The conceptual basis of food-frequency questionnaires [FFQ], as the primary dietary assessment method in nutritional epidemiology, is dietary intake over a number of years. Assessing frequency of intake over the previous year allows for responses to be independent of seasonal variations in intake, which may occur in individuals. The frequency aspect of an FFQ provides a scale of potential answers which are designed to minimise the variation in actual frequency of intake which could result if a narrower range of options were provided. This allows for more options in the higher frequency categories, to capture foods which make more regular [frequent] contributions to nutritional intake. However, this only reflects data on frequency, with no additional information on portion sizes: this is known as a 'simple FFQ'. A semi-quantitative FFQ, on the other hand, also specifies a portion size with the question on frequency, e.g., instead of "yogurt" it would say "yogurt [1 cup]" (where 'cup' is US measures, i.e., 250ml). Because the specification of portion size is one option, and it is not a measured food diary, it is 'semi-quantitative'. The quantitative aspect of the FFQ is influenced by the food itself, as certain foods have more natural portion sizes that are intuitive, e.g., "slice of bread", "1 egg", or "1 banana". Conversely, other foods do not have natural portion sizes, for example pasta or meat. Typical portion sizes are often used for these foods, but a "bowl of pasta" for me may be substantially different to yours. The challenge for the semi-quantitative aspect of FFQ for foods without natural portion sizes is that research demonstrates humans are quite poor at accurately describing a portion size, even immediately following a meal. To attempt to navigate this issue, average portion sizes are used, e.g., 6-8oz for meats, 2 slices of bacon, or 1 hamburger, or 1/2cup rice or pasta: this is set within the question with more frequency categories. The aim is that the frequency categories provide sufficient options to capture diet, as research shows that portion sizes vary less than frequency of intake, and the variation in intake of any food is more explained by frequency. Thus, research on dietary assessment methods indicates that separate questions on portion sizes are not superior to specifying a portion size - either a natural portion size or typical portion size - as part of the question on frequency of intake of the particular food.

Results: Each PDI ranged from the lowest score median of 42-44 to the highest of 66-68. Participants with higher PDI and hPDI were older, leaner, less likely to smoke, and more active. Participants in the uPDI were younger, more likely to smoke, and less active.

Over 4,833,042 person-years of follow-up, 8,631 participants developed CHD. Comparing the highest to lowest diet quality decile scores yielded the following findings:

- ***PDI***: Non-significant inverse association with CHD [HR 0.92, 95% CI 0.83-1.01]
- ***hPDI:*** Significant 25% reduction in CHD risk [HR 0.75, 95% CI 0.68-0.83]
- ***uPDI:*** Significant 32% increase in CHD risk [HR 1.32, 95% CI 1.20-1.46]

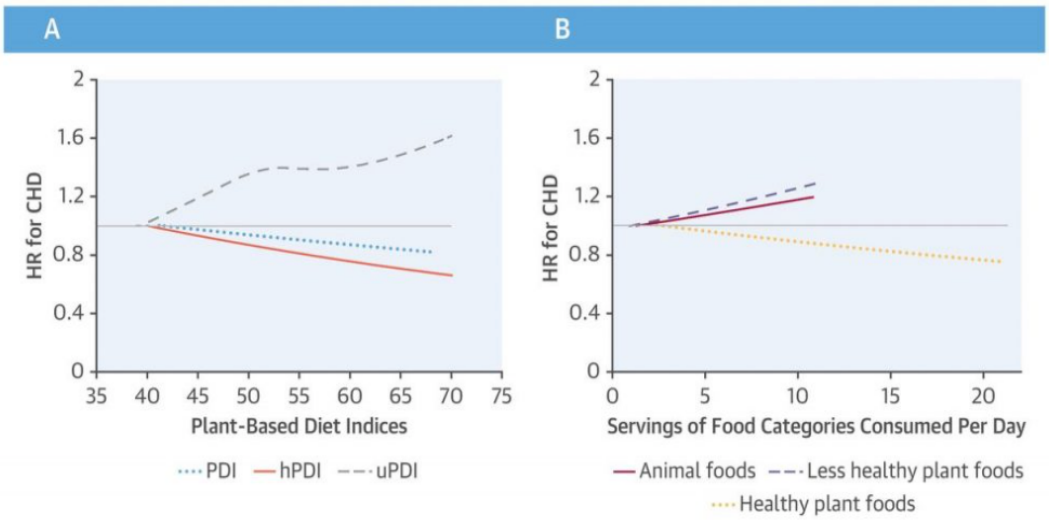
The effects of a 10-point score increase for each diet was also analysed, which indicated the following:

- ***PDI:*** Significant 7% reduction in CHD risk [HR 0.93, 95% CI 0.90-0.97]
- ***hPDI:*** Significant 12% reduction in CHD risk [HR 0.88, 95% CI 0.85-0.91]
- ***uPDI:*** Significant 10% increase in CHD risk [HR 1.10, 95% CI 1.06-1.14]

The Central Illustration from the paper below highlights these results. In Figure A [on the left], you can see how while the dotted blue line for the overall PDI linearly reduces risk with increasing scores, the straight red line for the hPDI in fact has a much stronger association with reduced CHD risk; the dotted grey line for the uPDI has a significant, non-linear increase in CHD risk.

In Figure B [on the right], you can see the associations for servings of foods based on the food groupings: animal foods and unhealthy plant-based foods increasing risk, which is stronger for unhealthy plant-based foods; conversely, healthy plant-based foods linearly decrease CHD risk with increasing servings per day.

CENTRAL ILLUSTRATION: Dose-Response Relationship of Plant-Based Diet Indices and Animal, Healthy Plant, and Less Healthy Plant Foods With CHD Incidence



Satija, A. et al. J Am Coll Cardiol. 2017;70(4):411-22.

The Critical Breakdown

Pros: The validation process for the FFQ in the NHS and HPFS is one of the most robust dietary assessments for reproducibility [i.e., the consistency of the FFQ across repeated measures in the same individual] and validity [i.e., the accuracy with which the FFQ measures diet]. The total follow-up in the cohorts is the longest active prospective study in nutrition research, and the large number of incident CHD cases increase the confidence in the findings.

Cons: The cohorts were 96% White/Caucasian, and not representative of the wider demographics of the population. The diet quality indices were relatively crude and while a 'healthy omnivorous diet' score was created but does not appear to have been included in the analysis. For the animal food groups which were all reverse scores, foods like low-fat dairy, eggs, and fish, were included, which may lack nuance. Inclusion of a fully scored healthy omnivore diet index would have been more informative.

Key Characteristic

Conducting a distinct analysis of healthy vs. unhealthy plant-based foods was an important addition to much of the vegetarian epidemiology, given that standard practice to date has been to define dietary patterns dichotomously simply as the presence or absence of meat alone. The creation of the diet quality scoring indices allowed for a quantitative assessment of the relationship between dietary patterns, which may carry the label "plant-based" or "plant-foods", but are distinct in their food sources, and consequently, health effects.

Participants in the uPDI consumed more saturated fat [~13%], less fibre [~13g], more trans-fats [~2.2%], and low intakes of healthy plant foods [6 servings per day vs. 14 in the healthy plant-based group]. While the overall PDI yielded a modest trend toward reduced CHD risk, this was not significant; however, the distinction based on plant-based food groups provided additional nuance to the health effects of dietary patterns defined as "plant-based", which have been previously been defined dichotomously in epidemiology. The stronger association for unhealthy plant-based foods vs. animal foods should also be considered in the context of the changing food supply [more under Relevance, below].

Interesting Finding

Recall the issue with dichotomous definitions: in this study "plant-based" did not mean exclusive of animal produce. It is interesting then that the difference between servings of animal foods between the highest PDI score group and lowest was 3 servings in the highest score vs. 5-6 servings in the lowest score.

However, separating out the healthy vs. unhealthy plant-based dietary indices, in the the highest decile of the hPDI animal food intake average 3.7 servings per day; in the highest decile of the uPDI animal intake was 3.5 servings. Thus, while there was a difference between number of servings in the overall PDI, in fact it appears that the differences in outcomes between the hPDI and uPDI were not strongly mediated by animal produce alone. The wider characteristics of the unhealthy plant-based dietary pattern, as detailed above under ***Key Characteristic***, were likely more an explanation of the association with CHD.

Relevance

With the advent of popularity in diets which reduce or exclude animal produce, the food industry is responding with an increasing array of 'meat substitutes' or alternatives to foods of animal origin. These changes in the food supply are recent, and many such alternative or substitutes are not necessarily nutritionally comparable [in the case of 'milk alternatives', which are devoid of protein and additional micronutrients], or better [many products on shelves have high levels of saturated fat, sodium, and sugars].

This isn't the first time the industry has filled a gap.

For example, Data from the National Health and Nutrition Examination Survey [NHANES] in the United States indicates that from 1977 to 1996, the typical diet increased significantly in overall dietary energy, with the food groups contributing most to increased energy density including salty snacks, soft drinks, pizza, with significant contributions from candy, fruit drinks, french fries, and cheeseburgers [(4)]. Many of these foods may be considered "plant-based", and indeed formed a significant proportion of food intake in the present study. The healthfulness of a dietary pattern is not dichotomous, and merely reducing or excluding animal produce is not a guarantee of health improvement. Thus, we come back to one of the fundamental questions in nutrition: what is effect of replacement/substitution?

Application to Practice

One encouraging finding in the present study is that modest reductions in overall animal food group servings [5-6 to 3] in favour for healthful plant food groups may have a significant influence on CHD risk. Practitioners should also consider becoming more familiar with the many substitute and/or alternative products carrying the label of "plant-based" "vegan" or otherwise on supermarket shelves, to help individuals better navigate the current nutrition transition and avoid adopting a plant-based version of the 'Standard Western Diet'.

References

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