Nutrition Briefs

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Dietary Patterns

The Role of Diet in the Prevention of Hypertension and Management of Blood Pressure: An Umbrella Review of Meta-Analyses of Interventional and Observational Studies

Significance: An umbrella review supports the recommendations of the DASH and the Mediterranean-type diet patterns for prevention and management of hypertension. Future studies need to collect data on intakes of dietary fiber, fish, eggs and meats.

High blood pressure (BP) is a major pathological risk factor for the development of several cardiovascular diseases. Diet is a key modifier of BP, but the underlying relationships are not clearly demonstrated. This is an umbrella review of published meta-analyses to critically evaluate the wide range of dietary evidence from bioactive compounds to dietary patterns on BP and risk of hypertension. PubMed, Embase, Web of Science, and Cochrane Central Register of Controlled Trials were searched from inception until October 31, 2021, for relevant meta-analyses of randomized controlled trials or meta-analyses of observational studies. A total of 175 publications reporting 341 meta-analyses of randomized controlled trials (145 publications) and 70 meta-analyses of observational studies (30 publications) were included in the review. The methodological quality of the included publications was assessed using Assessment of Multiple Systematic Reviews 2 and the evidence quality of each selected meta-analysis was assessed using NutriGrade. This umbrella review supports recommended public health guidelines for prevention and control of hypertension. Dietary patterns including the Dietary Approaches to Stop Hypertension and the Mediterranean-type diets that further restrict sodium, and moderate alcohol intake are advised. To produce high-quality evidence and substantiate strong recommendations, future research should address areas where the low quality of evidence was observed (for example, intake of dietary fiber, fish, egg, meat, dairy products, fruit juice, and nuts) and emphasize focus on dietary factors not yet conclusively investigated.

Carbohydrates

Micronutrient Intake from Three Popular Diet Patterns in the United States: Modeled Replacement of Foods Highest in Added Sugar and Sodium Using the National Health and Nutrition Examination Survey, 2005–2018

Significance: Modeled replacement of foods highest in added sugar led to more favorable changes in mean micronutrient intake compared to modeled replacement of foods high in sodium.

This work was supported by IAFNS' Carbohydrate Committee

Introduction: Fifty-two percent of adults in the United States reported following a popular diet pattern in 2022, yet there is limited information on daily micronutrient intakes associated with these diet patterns. The objective of the present study was to model the impact on micronutrient intake when foods highest in added sugar and sodium were replaced with healthier alternatives to align with the Dietary Guidelines for Americans recommendations. **Methods:** Dietary data were acquired from 34,411 adults ≥ 20 y in the National Health and Nutrition Examination Survey, 2005–2018. The National Cancer Institute methodology was used to estimate usual dietary intake at baseline of 17 micronutrients using information from up to two dietary recalls per person. A food substitution model was used to evaluate the impact on micronutrient intake when three servings of foods highest in added sugar and sodium were substituted with healthier alternatives. **Results:** Dietary modeling to replace foods highest in added sugar with healthier alternatives increased the mean intake of fat-soluble vitamins (0.15% for vitamin A to 4.28% for vitamin K), most water-soluble vitamins (0.01% for vitamin B1 to 12.09% for vitamin C), and most minerals (0.01% for sodium to 4.44% for potassium) across all diet patterns. Replacing foods highest in sodium had mixed effects on the mean intake of micronutrients. The intake of most fat-soluble vitamins increased by 1.37–6.53% (particularly vitamin A and D), yet while the intake of some water-soluble vitamins and minerals increased by 0.18–2.64% (particularly vitamin B2, calcium, and iron) others decreased by 0.56–10.38% (notably vitamin B3 and B6, magnesium, sodium, and potassium). **Discussion:** Modeled replacement of foods highest in added sugar led to more favorable changes in mean micronutrient intake compared to modeled replacement of foods highest in sodium. Due to the composite nature of mixed dishes that include multiple ingredients, food substitutions may result in both favorable and unfavorable changes in micronutrient intake. These findings highlight the challenges of making single item food substitutions to increase micronutrient intake and call for further research to evaluate optimal combinations of replacement foods to maximize the intake of all micronutrients simultaneously.

Protein

Microbial Phytases: Properties and Applications in the Food Industry

Significance: This paper provides a comprehensive review of properties, functionalities, nutritional importance and industrial applications of different microbial phytases from fungi and bacteria.

Microbial phytases are enzymes that break down phytic acid, an anti-nutritional compound found in plant-based foods. These enzymes which are derived from bacteria and fungi have diverse properties and can function under different pH and temperature conditions. Their ability to convert phytic acid into inositol and inorganic phosphate makes them valuable in food processing. The application of microbial phytases in the food industry has several advantages. Firstly, adding them to animal feedstuff improves phosphorus availability, leading to improved nutrient utilization and growth in animals. This also reduces environmental pollution by phosphorus from animal waste. Secondly, microbial phytases enhance mineral bioavailability and nutrient assimilation in plant-based food products, counteracting the negative effects of phytic acid on human health. They can also improve the taste and functional properties of food and release bioactive compounds that have beneficial health effects. To effectively use microbial phytases in the food industry, factors like enzyme production, purification, and immobilization techniques are important. Genetic engineering and protein engineering have enabled the development of phytases with improved properties such as enhanced stability, substrate specificity, and resistance to degradation. This review provides an overview of the properties and function of phytases, the microbial strains that produce them, and their industrial applications, focusing on new approaches.

Research Advances in Plant Protein-Based Products: Protein Sources, Processing Technology and Food Applications

Significance: A comprehensive report on the diverse sources of traditional and emerging plant proteins, including classifications, processing technologies, applications, limitations/barriers in product applications and strategies to overcome these shortcomings.

Plant proteins are high-quality dietary components of food products. With the growing interest in sustainable and healthy food alternatives, plant proteins have gained significant attention as viable substitutes for animal-based proteins. Understanding the diversity of protein sources derived from plants, novel processing technology, and multiple applications is crucial for developing nutritious and sustainable plant protein-based products. This Review summarizes the natural sources of traditional and emerging plant proteins. The classifications, processing technologies, and applications of plant protein-based products in the food industry are explicitly elucidated. Moreover, the advantages and disadvantages of plant protein-based food products are revealed. Strategies such as protein fortification and complementation to overcome these shortcomings are critically discussed. We also demonstrate several issues that need to be addressed in future development.

Low- and No-Calorie Sweeteners

Sugar and Low/No-Calorie-Sweetened Beverage Consumption and Associations with Body Weight and Waist Circumference Changes in Five European Cohort Studies: The SWEET Project

Significance: An analysis of five European studies found adverse associations between sugar-sweetened beverages and weight and waist circumference. Low- and no-calorie sweetener use was only associated with weight gain.

Purpose: Results of prospective studies investigating associations between low/no-calorie sweeteners (LNCS) and body weight-related outcomes are inconclusive. We conducted dose-response and theoretical replacement individual patient data meta-analyses using harmonized prospective data to evaluate associations between sugar-sweetened beverage (SSB) consumption, low/no-calorie sweetened beverage (LNCB) consumption, and changes in body weight and waist circumference. **Methods:** Individual participant data were obtained from five European studies, i.e., Lifelines Cohort Study, NQplus study, Alpha Omega Cohort, Predimed-Plus study, and Feel4diabetes study, including 82,719 adults aged 18-89 with follow-up between 1 and 9 years. Consumption of SSB and LNCB was assessed using food-frequency questionnaires. Multiple regression analyses adjusting for major confounders and including substitution models were conducted to quantify associations in individual cohorts; random-effects meta-analyses were performed to pool individual estimates. **Results:** Overall, pooled results showed weak adverse associations between SSB consumption and changes in body weight (+ 0.02 kg/y, 95%CI 0.00; 0.04) and waist circumference (+ 0.03 cm/y, 95%CI 0.01; 0.05). LNCB consumption was associated with higher weight gain (+ 0.06 kg/y, 95%CI 0.04; 0.08) but not with waist circumference. No clear associations were observed for any theoretical replacements, i.e., LNCB or water for SSB or water for LNCB. **Conclusion:** In conclusion, this analysis of five European studies found a weak positive association between SSB consumption and weight and waist change, whilst LNCB consumption was associated with weight change only. Theoretical substitutions did not show any clear association. Thus, the benefit of LNCBs as an alternative to SSBs remains unclear.

Cognitive Health

The Effects of Olive Oil Consumption on Cognitive Performance: A Systematic Review

Significance: Olive oil intake was found to enhance cognitive functioning and reduce cognitive impairment in a systematic review study of older adults.

Introduction: The Mediterranean diet is marked by the regular intake of olive oil, which may play a role in preventing and protecting against cognitive deterioration and dementia. The strength of these effects have been examined by several recent randomized controlled trials (RCTs), but their findings have not been consistent. In light of this inconsistency, the present study performed a systematic review to examine the relationship between the consumption of olive oil and cognition. **Methods:** The Web of Science, Scopus, PubMed, and Google Scholar were systematically searched up to August 11, 2023. The review included RCTs, cross-sectional studies, cohort studies and case-control studies that explored the impact of olive oil consumption on cognitive performance among those older than 55 years old. Studies were excluded if they employed a design other than those mentioned above, involved participants under 55 years old, or did not specifically examine the cognitive effects of olive oil consumption. The quality of the included studies were measured using the Cochrane risk-of-bias tool and the Newcastle Ottawa Scale checklists. **Results:** Eleven studies were identified, which were comprised of four cross-sectional studies, four prospective cohort studies and three RCTs. The cohort studies and RCTs consistently found that olive oil consumption had a favorable effect on cognitive performance across a number of cognitive domains over time. Similarly, all of the cross-sectional studies reported that the consumption of olive oil was positively associated with cognitive health. **Conclusion:** The consumption of olive oil was found to enhance cognitive functioning and to reduce cognitive decline. Further large-scale investigations are required to strengthen this conclusion.

Dietary Pattern, Food and Nutritional Supplement Effects on Cognitive Outcomes in Mild Cognitive Impairment: A Systematic Review of Previous Reviews

Significance: A systematic review found few nutritional intervention studies were conclusive in outcomes related to cognitive improvement in mildly cognitively-impaired subjects. High-quality intervention research is needed to further investigate nutrition's impacts in this area.

Context: Nutritional interventions may benefit cognition in people with mild cognitive impairment (MCI). However, evidence is yet to be synthesized in a way that can inform recommendations for clinical and public health settings. Objective: To systematically review evidence on the effect of dietary patterns, foods, and nutritional supplements on cognitive decline in individuals with MCI . **Data Sources:** Guided by the Preferred Reporting items for Systematic Review and Meta-Analysis Protocols 2015 statement, the Medline, EMBASE, and CINAHL databases, the JBI Database of Systematic Reviews and Implementation Reports, Cochrane Database of Systematic Reviews, and Database of Abstracts of Reviews of Effects were searched (publication years 2005 to 2020). Included studies were English-language systematic reviews and meta-analyses of randomized controlled trials and cohort studies reporting on the effectiveness of nutritional interventions on cognition of individuals with MCI. Data Extraction: Two reviewers independently selected studies and extracted data on cognitive outcomes and adverse events. Review quality was assessed using AMSTAR 2 (A Measurement Tool to Assess Systematic Reviews-2). Primary study overlap was managed following Cochrane Handbook guidelines. Data Analysis: Of the 6677 records retrieved, 20 reviews were included, which, in turn, reported on 43 randomized controlled trials and 1 cohort study that, together, addressed 18 nutritional interventions. Most reviews were limited by quality and the small number of primary studies with small sample sizes. Reviews were mostly positive for B vitamins, omega-3 fatty acids, and probiotics (including 12, 11 and 4 primary studies, respectively). Souvenaid and the Mediterranean diet reduced cognitive decline or Alzheimer's

disease progression in single trials with <500 participants. Findings from studies with a small number of participants suggest vitamin D, a low-carbohydrate diet, medium-chain triglycerides, blueberries, grape juice, cocoa flavanols, and Brazil nuts may improve individual cognitive subdomains, but more studies are needed. **Conclusions:** Few nutritional interventions were found to convincingly improve cognition of individuals with MCI. More high-quality research in MCI populations is required to determine if nutritional treatments improve cognition and/or reduce progression to dementia.

Lipids

Association of Dietary Fatty Acids with the Risk of Atherosclerotic Cardiovascular Disease in a Prospective Cohort of United States Veterans

Kerry L Ivey, Xuan-Mai T Nguyen, Ruifeng Li, Jeremy Furtado, Kelly Cho, John Michael Gaziano, Frank B Hu, et. al. *Am J Clin Nutr.* 2023 Oct;118(4):763-772. doi: 10.1016/j.ajcnut.2023.07.014. Article link

Significance: Unlike trans- and conjugated fatty acids, not all classes of fat are associated with increased risk of cardiovascular disease. This suggests that general conclusions on individual fatty acids' effect on health cannot always be drawn.

Background: Atherosclerotic cardiovascular diseases (ASCVDs) are the leading cause of worldwide adult mortality. Although broad classes of dietary fats have been shown to alter ASCVD risk, the roles that individual dietary fatty acids play in influencing ASCVD risk are unclear. **Objectives:** The aim of this prospective cohort study was to examine the relationships of the total fat classes and individual fatty acids with the risk of ASCVD. **Methods:** The Million Veteran Program is a prospective cohort whereby dietary intake of fatty acids was assessed in 158,198 participants that had enrolled between January 2011 and November 2018 and were free of ASCVD at baseline. Incident ASCVD was ascertained from the Veterans Affairs electronic health records and the National Death Index. Multivariable-adjusted hazard ratios (HRs) for the relationship between fat intake and ASCVD risk were computed using Cox regression models. **Results:** The mean age was 61 years, 88% were males. A total of 11,771 ASCVD events were identified during the follow-up. When compared with the lowest quintile, participants in the highest quintile of dietary trans-monounsaturated fats and conjugated linoleic acids had an increased risk (HR [95% CI]) of ASCVD events: 1.10 (1.04, 1.17) and 1.11 (1.05, 1.18), respectively. When compared with low consumers, participants in the highest quintile of total cis-polyunsaturated fatty acid intake had a lower risk of experiencing an ASCVD event 0.93 (0.87, 0.99). **Conclusion:** Although higher intakes of specific trans-fatty acids and conjugated linoleic were associated with an increased risk of ASCVD, the same cannot be said for all other fat classes. This work suggests that care must be taken when drawing general conclusions regarding the health effects of dietary individual fatty acids.

Sodium

Application of Umami Tastants for Sodium Reduction in Food: An Evidence Analysis Center Scoping Review

Kristi M Crowe-White, Megan Baumler, Erica Gradwell, Vijaya Juturu, Dana Angelo White, Deepa Handu. *J Acad Nutr Diet.* 2023 Nov;123(11):1606-1620.e8. doi: 10.1016/j.jand.2022.08.002. Article link

Significance: Additional systematic and prospective studies are warranted to better understand the role that umami tastants play in improving adherence to dietary salt reduction.

Background: Sodium chloride intake far exceeds the guidelines from health and regulatory agencies. Acknowledging the positive relationship between sodium intake and blood pressure, interest in substances that assist in sodium reduction, while contributing to a savory taste such as umami, are highly investigated. **Objective:** The objective of this scoping review was to identify and characterize studies investigating umami tastants on sodium reduction in food, with the goal of informing future research. **Methods:** A literature search was conducted in Ovid MEDLINE, Ovid Embase, Ovid Cochrane Database of Systematic Reviews, EBSCO PsycInfo, PROSPERO, National Institutes of Health RePORTER, ClinicalTrials.gov, and the World Health Organization International Clinical Trials Registry Platform and completed in March 2022 to identify peer-reviewed publications among adults (18 years and older) with interventions focusing on umami tastants to reduce sodium content. **Results:** The literature search identified 52 studies, among which monosodium glutamate was the most studied umami tastant or food. Furthermore, most of the research on umami was represented through cross-sectional sensory studies to determine acceptability of foods with part of the original sodium chloride replaced with umami tastants. Only 1 study investigated the use of an umami tastant on overall daily sodium intake. **Conclusions:** To assist individuals in adhering to sodium reduction intake goals set forth by regulatory agencies and their guiding policies, these findings indicated that additional research on umami tastants, including systematic reviews and prospective trials, is warranted. In these prospective studies, both intermediate outcomes (ie, dietary pattern changes, daily dietary intake of sodium, and blood pressure) and hard outcomes (ie, incidence of hypertension or stroke, as well as cardiovascular composite outcomes) should be considered.

Gut Health

Experimental Capacity of Human Fecal Microbiota to Degrade Fiber and Produce Short-Chain Fatty Acids Is Associated with Diet Quality and Anthropometric Parameters

Anna M Malinowska, Malgorzata Majcher, Guido Jej Hooiveld, Hanna Przydatek, Marta Szaban, Agata Kurowiecka, Marcin Schmidt. *J Nutr.* 2023 Oct;153(10):2827-2841. doi: 10.1016/j.tjnut.2023.08.007. Article link

Significance: Elevated intake of fiber-rich products is positively linked to the capacity of fecal microbiota to degrade both soluble and insoluble dietary fiber.

Background: Short-chain fatty acids (SCFAs) are considered beneficial to human health. The associations between bacterial capacity to produce SCFAs, diet, and health are not fully understood. **Objective:** We aimed to evaluate the capacity of human fecal microbiota to produce SCFAs and to metabolize soluble and insoluble fiber and to study its associations with human diet, anthropometric parameters, and carbohydrate and lipid metabolism. **Methods:** A cross-sectional study was carried out with 200 adult participants. Diet was evaluated using food records. Capacity to produce acetate, butyrate, and propionate and to degrade soluble fiber were assessed in an ex vivo experiment where fecal samples were inoculated in a pectin-containing broth. Fecal β-glucosidase activity was measured to assess potential to degrade insoluble fiber. **Results:** The main dietary determinants of high capacity to metabolize

fiber were high intake of vegetables, fruits, nuts, and seeds. After adjusting analyses for confounders, glucose and lipid parameters were not significantly associated with any of the studied microbial capacities, but the capacity to produce propionic acid was significantly associated with hip circumference (β = -0.018, P = 0.044), which was seen especially in people eating healthy. **Conclusions:** We confirmed that high intake of fiber-rich products is positively associated with the capacity of fecal microbiota to degrade soluble and insoluble dietary fiber and that people eating healthy food might benefit from enhanced microbial capacity to produce propionic acid.

Emerging Science Areas

Emerging Areas: Nutrition

A Neural Mechanism in the Human Orbitofrontal Cortex for Preferring High-Fat Foods Based on Oral Texture

Putu A. Khorisantono, Fei-Yang Huang, Michael P. F. Sutcliffe, Paul C. Fletcher, I. Sadaf Farooqi, Fabian Grabenhorst. *J. Neurosci* 16 October 2023, DOI: https://doi.org/10.1523/JNEUROSCI.1473-23.2023. Article link

Significance: A novel technology approach combining food-engineering and functional neuroimaging identifies the involvement of the human frontal cortex in reward valuation and behavior. It accomplishes this by evaluating textures to mediate preference and eating experiences for high-fat foods.

Although overconsumption of high-fat foods is a major driver of weight gain, the neural mechanisms that link the oral sensory properties of dietary fat to reward valuation and eating behavior remain unclear. Here we combine novel food-engineering approaches with functional neuroimaging to show that the human orbitofrontal cortex (OFC) translates oral sensations evoked by high-fat foods into subjective economic valuations that guide eating behavior. Male and female volunteers sampled and evaluated nutrient-controlled liquid foods that varied in fat and sugar ('milkshakes'). During oral food processing, OFC activity encoded a specific oral-sensory parameter that mediated the influence of the foods' fat content on reward value: the coefficient of sliding friction. Specifically, OFC responses to foods in the mouth reflected the smooth, oily texture (i.e., mouthfeel) produced by fatty liquids on oral surfaces. Distinct activity patterns in OFC encoded the economic values associated with foods, which reflected the subjective integration of sliding friction with other food properties (sugar, fat, viscosity). Critically, neural sensitivity of OFC to oral texture predicted individuals' fat preferences in a naturalistic eating test: individuals whose OFC was more sensitive to fat-related oral texture consumed more fat during ad libitum eating. Our findings suggest that reward systems of the human brain sense dietary fat from oral sliding friction, a mechanical food parameter that likely governs our daily eating experiences by mediating interactions between foods and oral surfaces. These findings identify a specific role for the human OFC in evaluating oral food textures to mediate preference for high-fat foods.

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