Nutrition Briefs

Diet Patterns

Does the Concept of "Ultra-Processed Foods" Help Inform Dietary Guidelines, Beyond Conventional Classification Systems? Debate Consensus.

Arne Astrup, Carlos A Monteiro. *Am J Clin Nutr*. 2022 Dec 19;116(6):1489-1491. doi: 10.1093/ajcn/nqac230. **Article link**

"No" position paper. **Article link**

"Yes" position paper. **Article link**

Significance: There is a growing need to have a standardized approach to define and classify processed foods. The Novo food system — though widely used to define and classify ultra-processed foods — has been criticized for lack of validation. This paper provides insightful perspectives from two authors on the strengths and weaknesses of the Novo food classification system, and future options for evidence-based validation.

The participants in this debate agree that food processing vitally affects human health, and that the extent of food processing significantly affects diet quality and health outcomes. They disagree on the significance of ultra-processing, as defined within the Nova food classification system. The YES position holds that the concept is well-founded, clear, and supported by a wealth of investigations, as demonstrated by systematic association between ultra-processed food (UPF) intake and various diseases and disorders, and the persistence of these associations with control for critical nutrients. The NO position argues that the concept of UPF is poorly defined; gives rise to misclassification of foods; is without clear mechanisms of action; and that the observed associations with obesity are likely confounded. The YES position argues that the Nova system is therefore crucial to inform dietary guidelines and also public policies designed to reduce production and consumption of UPFs, whereas the NO position argues that the system adds no value to conventional nutrient metrics and existing nutrient profiling systems, pointing instead to the need to develop an evidence-based system to characterize obesogenic foods.

Carbohydrates

Gastrointestinal Effects and Tolerance of Nondigestible Carbohydrate Consumption

Annemarie R Mysonhimer, Hannah D Holscher. *Adv Nutr*. 2022 Dec 22;13(6):2237-2276. doi: 10.1093/advances/nmac094. **Article link**

Significance: Findings from 103 clinical trials of adults concluded that tolerance for nondigestible carbohydrates is product specific, with recommended levels ranging from 3.75 grams per day for alginate to 25 g/d for soy fiber. Future studies should include a broader range of NDC doses and ingredient forms (solid, liquid), and standardize protocols for studying tolerance and functional outcomes.

Nondigestible carbohydrates (NDCs) are food components, including nonstarch polysaccharides and resistant starches. Many NDCs are classified as dietary fibers by the US FDA. Because of their beneficial effects on human health and product development, NDCs are widely used in the food supply. Although there are dietary intake recommendations for total dietary fiber, there are no such recommendations for individual NDCs. NDCs are heterogeneous in their chemical composition and physicochemical properties-characteristics that contribute to their tolerable intake levels. Guidance on tolerable intake levels of different NDCs is needed because overconsumption can lead to undesirable gastrointestinal side effects, further widening the gap between actual

and suggested fiber intake levels.

In this review, we synthesize the literature on gastrointestinal effects of NDCs that the FDA accepts as dietary fibers (β-glucan, pectin, arabinoxylan, guar gum, alginate, psyllium husk, inulin, fructooligosaccharides and oligofructose, galactooligosaccharides, polydextrose, cellulose, soy fiber, resistant maltodextrin/dextrin) and present tolerable intake dose recommendations for their consumption. We summarized the findings from 103 clinical trials in adults without gastrointestinal disease who reported gastrointestinal effects, including tolerance (e.g., bloating, flatulence, borborygmi/rumbling) and function (e.g., transit time, stool frequency, stool consistency).

These studies provided doses ranging from 0.75-160 g/d and lasted for durations ranging from a single-meal tolerance test to 28 wk. Tolerance was NDC specific; thus, recommendations ranged from 3.75 g/d for alginate to 25 g/d for soy fiber. Future studies should address gaps in the literature by testing a wider range of NDC doses and consumption forms (solid compared with liquid). Furthermore, future investigations should also adopt a standard protocol to examine tolerance and functional outcomes across studies consistently.

Scoping Review and Evidence Map of the Relation between Exposure to Dietary Sweetness and Body Weight-Related Outcomes in Adults

Kelly A Higgins, Rita Rawal, David J Baer, Lauren E O'Connor, Katherine M Appleton. *Adv Nutr*. 2022 Dec 22;13(6):2341-2356. doi: 10.1093/advances/nmac090. **Article link**

Significance: There are limited studies available to provide definitive evidence on the association between total dietary sweetness and body weight.

Numerous governmental and health organizations recommend reduced intake of added sugars due to the health risks associated with excess intake, including the risk of obesity. Some organizations further recommend avoiding dietary sweetness, regardless of the source. A scoping review and evidence map were completed to characterize the research that investigated associations between dietary sweetness and body weight. The aim was to identify and map published studies that have investigated total dietary sweetness, sweet food/beverages, sugar, or sweetener intake, and body weight-related outcomes and/or energy intake. Using preregistered search terms (osf.io/my7pb), 36,779 publications (duplicates removed) were identified from PubMed, Cochrane Library, and Scopus and screened for inclusion. Eligible studies were clinical trials, longitudinal cohorts, case-control studies, cross-sectional studies, and systematic reviews conducted among adults (age ≥18 y), which were performed to investigate associations between dietary sweetness, sweet foods/beverages, sugar, or sweetener (energetic or nonenergetic) intake and body weight, BMI, adiposity, and/or energy intake. A total of 833 eligible publications were identified, detailing 804 studies. Only 7 studies (0.9% of included studies; 2 clinical trials, 4 cross-sectional studies, and 1 with another design type) investigated associations between total dietary sweetness and body weight-related outcome and/or energy intake. An additional 608 (75.6%) studies investigated intakes of sweet foods/beverages, sugar, or sweetener, and body weight-related outcomes and/or energy intake, including 225 clinical trials, 81 longitudinal cohorts, 4 case-control studies, and 280 cross-sectional studies. Most studies (90.6%) did not measure the sweetness of the diet or individual foods consumed. Ninety-two (11.4%) publications reported data from studies on dietary patterns that included sweet foods/beverages alongside other dietary components and 97 (12.1%) systematic reviews addressed different but related research questions. Although there is a breadth of evidence from studies that have investigated associations between intakes of sweet foods and beverages, sugars, and sweeteners and body weight, there is a limited depth of evidence on the association between total dietary sweetness and body weight.

Protein

The Impact of Dietary Protein Supplementation on Recovery from Resistance Exercise-Induced Muscle Damage: A Systematic Review with Meta-Analysis

Alice G Pearson, Karen Hind, Lindsay S Macnaughton. *Eur J Clin Nutr*. 2022 Dec 13. doi: 10.1038/s41430-022-01250-y. **Article link**

Significance: A systematic review with meta-analysis finds peri-exercise protein intake following resistance exercise helps maintain maximal muscle strength and lowers creatine kinase levels. However, it does not reduce

muscle soreness. Conflicting findings may be due to design/methodological differences, necessitating the adoption of standardized methods and data reporting in future studies.

Background: It is unknown whether dietary protein consumption can attenuate resistance exercise-induced muscle damage (EIMD). Managing EIMD may accelerate muscle recovery and allow frequent, high-quality exercise to promote muscle adaptations. This systematic review and meta-analysis examined the impact of peri-exercise protein supplementation on resistance EIMD. **Methods:** A literature search was conducted on PubMed, SPORTDiscus, and Web of Science up to March 2021 for relevant articles. PEDro criteria were used to assess bias within included studies. A Hedges' g effect size (ES) was calculated for indirect markers of EIMD at h post-exercise. Weighted ESs were included in a random effects model to determine overall ESs over time. **Results**: Twenty-nine studies were included in the systematic review and 40 trials were included in ≥1 meta-analyses (16 total). There were significant overall effects of protein for preserving isometric maximal voluntary contraction (MVC) at 96 h (0.563 [0.232, 0.894]) and isokinetic MVC at 24 h (0.639 [0.116, 1.162]), 48 h (0.447 [0.104, 0.790]), and 72 h (0.569 [0.136, 1.002]). Overall ESs were large in favour of protein for attenuating creatine kinase concentration at 48 h (0.836 [-0.001, 1.673]) and 72 h (1.335 [0.294, 2.376]). Protein supplementation had no effect on muscle soreness compared with the control. **Conclusion**: Peri-exercise protein consumption could help maintain maximal strength and lower creatine kinase concentration following resistance exercise but not reduce muscle soreness. Conflicting data may be due to methodological divergencies between studies. Standardized methods and data reporting for EIMD research are needed.

Low and No-Calorie Sweeteners

The Combined Effects of Aspartame and Acesulfame-K Blends on Appetite: A Systematic Review and Meta-Analysis of Randomized Clinical Trials

Kirnjot Mehat, Yi Chen, Christopher Peter Corpe. *Adv Nutr*. 2022 Dec 22;13(6):2329-2340. doi: 10.1093/advances/nmac072. **Article link**

Significance: A singular conclusion cannot be drawn on how ASP/Ace-K blends impact appetite and associated biomarkers due to small study samples and subject heterogeneity. Future studies with healthy Type 2 Diabetics or obese subjects are important. In addition, testing products with reduced added sugar content but contain NNS to maintain palatability is key.

Aspartame (Asp) and acesulfame-K (Ace-K) are nonnutritive sweeteners (NNSs) commonly used in combination to replace added sugars in reduced- or low-calorie foods and beverages. Despite Asp/Ace-K blends having negligible calories, their effects on appetite have not been reviewed systematically. We therefore undertook a systematic review and meta-analysis of the metabolic effects of Asp/Ace-K blends on energy intake (EI), subjective appetite scores, blood glucose, and the incretin hormones glucose-dependent insulinotropic peptide and glucagon-like peptide. MEDLINE, Web of Science, and Cochrane CENTRAL databases (Embase, PubMed, and CINAHL) were searched (May 2021) for randomized controlled trials (RCTs). Human RCTs using Asp/Ace-K blends compared with sugar and water controls were included, whereas isolated cell and animal studies were excluded. An overall 4829 publications were identified and 8 studies, including 274 participants, were retrieved for review. The Asp/Ace-K group's EI was significantly reduced compared with sugar [mean difference (MD): -196.56 kcal/meal; 95% CI: -332.01, -61.11 kcal/meal; P = 0.004] and water (MD: -213.42 kcal/meal; 95% CI: -345.4, -81.44 kcal/meal; P = 0.002). Meta-analysis of subjective appetite scores and incretins could not be undertaken due to inconsistencies in data reporting and insufficient data, respectively, but of the 4 studies identified, no differences were observed between Asp/Ace-K blends and controls. The Asp/Ace-K group's blood glucose was nonsignificantly reduced compared with sugar (MD: -1.48 mmol/L; 95% CI: -3.26, 0.3 mmol/L; P = 0.1) and water (MD: -0.08 mmol/L; 95% CI: -0.62, 0.47 mmol/L; P = 0.78). Lower EI in participants who were predominantly healthy and assigned to Asp/Ace-K blends could not be reliably attributed to changes in subjective appetite scores. Blood glucose and incretins were also generally not affected by Asp/Ace-K blends when compared with controls. Additional short- and long-term RCTs using NNSs and sugars at dietarily relevant levels are needed.

Cognitive Health

Associations of Erythrocyte Omega-3 Fatty Acids with Cognition, Brain Imaging and Biomarkers in the Alzheimer's Disease Neuroimaging Initiative: Cross-Sectional and Longitudinal Retrospective Analyses

Laure Rouch, Kelly Virecoulon Giudici, Christelle Cantet, Sophie Guyonnet, Julien Delrieu, Philippe Legrand, Daniel Catheline, et. al. *Am J Clin Nutr*. 2022 Dec 19;116(6):1492-1506. doi: 10.1093/ajcn/nqac236. **Article link**

Significance: A low ω-3 index was associated with lower cognition and higher tau accumulation among ApoE ε4 carriers, though no associations were cross-sectionally found in the whole population.

Background: The association between omega-3 (ω-3) PUFAs and cognition, brain imaging and biomarkers is still not fully established. **Objectives**: The aim was to analyze the cross-sectional and retrospective longitudinal associations between erythrocyte ω-3 index and cognition, brain imaging, and biomarkers among older adults. **Methods**: A total of 832 Alzheimer's Disease Neuroimaging Initiative 3 (ADNI-3) participants, with a mean (SD) age of 74.0 (7.9) y, 50.8% female, 55.9% cognitively normal, 32.7% with mild cognitive impairment, and 11.4% with Alzheimer disease (AD) were included. A low ω-3 index (%EPA + %DHA) was defined as the lowest quartile (≤3.70%). Cognitive tests [composite score, AD Assessment Scale Cognitive (ADAS-Cog), Wechsler Memory Scale (WMS), Trail Making Test, Category Fluency, Mini-Mental State Examination, Montreal Cognitive Assessment] and brain variables [hippocampal volume, white matter hyperintensities (WMHs), positron emission tomography (PET) amyloid-β (Aβ) and tau] were considered as outcomes in regression models. **Results**: Low ω-3 index was not associated with cognition, hippocampal, and WMH volume or brain Aβ and tau after adjustment for demographics, ApoEε4, cardiovascular disease, BMI, and total intracranial volume in the cross-sectional analysis. In the retrospective analysis, low ω-3 index was associated with greater Aβ accumulation (adjusted β = 0.02; 95% CI: 0.01, 0.03; P = 0.003). The composite cognitive score did not differ between groups; however, low ω-3 index was significantly associated with greater WMS-delayed recall cognitive decline (adjusted β = -1.18; 95% CI: -2.16, -0.19; P = 0.019), but unexpectedly lower total ADAS-Cog cognitive decline. Low ω-3 index was cross-sectionally associated with lower WMS performance (adjusted β = -1.81, SE = 0.73, P = 0.014) and higher tau accumulation among ApoE ε4 carriers. **Conclusions**: Longitudinally, low ω-3 index was associated with greater Aβ accumulation and WMS cognitive decline but unexpectedly with lower total ADAS-Cog cognitive decline. Although no associations were cross-sectionally found in the whole population, low ω-3 index was associated with lower WMS cognition and higher tau accumulation among ApoE ε4 carriers.

Lipids

Association of Omega-3 and Omega-6 Fatty Acid Intake with Leukocyte Telomere Length in US Males

Bojung Seo, Keming Yang, Ka Kahe, Abrar A Qureshi, Andrew T Chan, Immaculata De Vivo, Eunyoung Cho, et. al. **Article link**

Significance: Increased intakes of DHA and canned tuna are positively associated with longer leukocyte telomere length (LTL) in a study of US males.

Background: Omega-3 (n-3) and omega-6 (n-6) fatty acids may contribute to oxidative stress and inflammation, which are related to telomere shortening. Evidence supporting an association between intake of n-3 or n-6 fatty acids and leukocyte telomere length (LTL) in males has been limited. **Objectives**: We conducted a cross-sectional study to examine the associations of total or individual n-3 or total n-6 fatty acid intake with LTL in US males. **Methods**: We included 2,494 US males with LTL measurement from 4 nested case-control studies within the Health Professionals Follow-Up Study. Individuals with previous histories of cancers, diabetes, and cardiovascular diseases at or before blood collection were excluded. Blood collection was performed between 1993 and 1995, and relevant information including n-3 and n-6 intake was collected in 1994 by questionnaire. The LTL was log-transformed and Z scores of the LTL were calculated for statistical analyses by standardizing the LTL in comparison with the mean within each selected nested case-control study. **Results**: We found that consumption of DHA (22:6n-3) was positively associated with LTL. In the multivariable-adjusted model, compared with individuals who had the lowest intake of DHA (i.e., first quartile group), the percentage differences (95% CIs) of LTL were -3.7 (-13.7, 7.5), 7.0 (-4.3, 19.7), and 8.2 (-3.5, 21.3) for individuals in the second, third, and fourth quartiles of consumption, respectively (P-trend = 0.0498). We did not find significant associations between total n-3 or total n-6 fatty acid intakes and LTL. In addition, we found that males who consumed canned tuna had longer LTL than those who did not; in the multivariable-adjusted model, the percentage difference of LTL was 10.5 (95% CI: 1.3, 20.4) (P = 0.02). **Conclusions**: Our results suggest that higher intakes of DHA and canned tuna consumption are associated with longer LTL.

Sodium

Consumer Acceptance of Reduced Sodium White and Multigrain Bread: Impact of Flavor Enhancement and Ingredient Information on Sample Liking

Aubrey N Dunteman, Soo-Yeun Lee. J *Food Sci*. 2022 Dec 5. doi: 10.1111/1750-3841.16395. **Article link**

Significance: The consumer appeal of reduced sodium white and multigrain breads is enhanced with the addition of monosodium glutamate. More research is needed to fully understand the sensory attributes of full and reduced sodium products with and without MSG.

Chronic consumption of sodium in quantities exceeding recommendations has led to sodium being designated as a nutrient of health concern for overconsumption. As a result of the prevalence of sodium overconsumption, the Food and Drug Administration (FDA) released voluntary sodium reduction goals for a wide variety of products on both short- and long-term timespans. As food palatability may decrease when sodium is reduced, flavor enhancers such as monosodium glutamate (MSG) may provide a promising solution to mitigate such palatability loss. The objective of this research was to investigate consumer acceptance of white and multigrain breads with either a 43% or 60% reduction in sodium content and with and without MSG as well as to investigate the influence of information on consumer acceptance of these breads under blind, informed, and informed with education conditions. Seventy-eight frequent bread consumers participated in the evaluations. A significant difference was evidenced across breads with different levels of sodium content and MSG status, although no difference was seen across the different evaluation conditions. Consumer segmentation found multiple consumer clusters showing different liking patterns of the bread treatments for both white and multigrain breads. Breads with sodium content set at the FDA's long-term goal with and without MSG were liked no differently in nearly all attributes evaluated than the full-sodium bread demonstrating the feasibility of producing acceptable reduced-sodium breads. Future research characterizing the predominant sensory attributes of full-sodium and reduced-sodium breads with and without MSG would be valuable for identifying the drivers of liking in such products. Practical Application: The findings of our study suggest that consumer liking of reduced sodium white and multigrain breads could be improved with the addition of monosodium glutamate. Increasing the acceptance of reduced sodium food products could help to reduce the risk of hypertension and subsequently heart attacks and stroke for the American population.

Gut Microbiome

Probiotics' Effect on Visceral and Subcutaneous Adipose Tissue: A Systematic Review of Randomized Controlled Trials

Leonardo M Porchia, Gabriela Vazquez-Marroquin, Renata Ochoa-Précoma, Ricardo Pérez-Fuentes, M Elba Gonzalez-Mejia. *Eur J Clin Nutr*. 2022 Dec;76(12):1646-1656. doi: 10.1038/s41430-022-01135-0. **Article link**

Significance: A systematic review found that probiotics have a beneficial and specific effect on central adiposity. Single Lactobacillus-based probiotics reduced visceral and subcutaneous adiposity, whereas Bifidobacterium-based probiotics reduced visceral adiposity.

Probiotics are shown to alter the microbiota, leading to a favorable environment, in which weight loss and metabolic parameters are improve. However, the results on probiotics' effect on specific types of central adipose tissues, mainly visceral (VAT) and subcutaneous adipose tissue (SAT), are conflicting. Therefore, we conducted a systematic review, aimed to evaluate the effects of probiotics on VAT and SAT. PubMed, SCOPUS, EBSCO, and LILACS databases were searched for studies that investigated the effect of probiotics on VAT and SAT. Fixed effects were used to calculate the pooled difference in means (DM) and 95% confidence intervals (95%CI). Fourteen publications met the inclusion criteria, which consisted of 1523 participants. For VAT, overall, there was a significant decrease (DM = -3.63 cm2, 95% CI: -5.08 to -2.17, p < 0.001). When stratified by type of probiotic, single Bifidobacterium (DM = -4.49 cm2, 95% CI:-7.37 to -1.61, p = 0.002) and single Lactobacillus probiotics (DM = -3.84 cm2, 95% CI:-5.74 to -1.93, p < 0.001) resulted in significant reductions. Mixed probiotics had no effect. For SAT, overall, there was a significant decrease (DM = -2.91 cm2, 95% CI:-4.82 to -1.01, p = 0.003), and when stratified by type of probiotic, single Lactobacillus (DM = -3.39 cm2, 95% CI:-5.90 to -0.88, p = 0.008) and mixed probiotics (DM = -5.97 cm2, 95% CI:-10.32 to -1.62, p = 0.007) resulted in a significant decrease. Single Bifidobacterium probiotics had no effect. Using meta-regression, no association was observed between the total daily probiotic dose and VAT or SAT reduction. This study shows that probiotics have a beneficial effect on central adiposity. Single Lactobacillus-based probiotics reduced VAT and SAT, whereas Bifidobacterium-based probiotics reduce VAT.

Emerging Science Areas

Emerging Areas: Nutrition

Machine Learning in Nutrition Research

Daniel Kirk, Esther Kok, Michele Tufano, Bedir Tekinerdogan, Edith J M Feskens, Guido Camps. *Adv Nutr*. 2022 Dec 22;13(6):2573-2589. doi: 10.1093/advances/nmac103. **Article link**

Significance: The use of machine learning tools to advance nutrition research is growing in interest as

demonstrated in its use in obesity, metabolic and malnutrition studies. This paper outlines a framework to guide and provide the necessary resources to help researchers integrate machine learning into their research.

Data currently generated in the field of nutrition are becoming increasingly complex and high-dimensional, bringing with them new methods of data analysis. The characteristics of machine learning (ML) make it suitable for such analysis and thus lend itself as an alternative tool to deal with data of this nature. ML has already been applied in important problem areas in nutrition, such as obesity, metabolic health, and malnutrition. Despite this, experts in nutrition are often without an understanding of ML, which limits its application and therefore potential to solve currently open questions. The current article aims to bridge this knowledge gap by supplying nutrition researchers with a resource to facilitate the use of ML in their research. ML is first explained and distinguished from existing solutions, with key examples of applications in the nutrition literature provided. Two case studies of domains in which ML is particularly applicable, precision nutrition and metabolomics, are then presented. Finally, a framework is outlined to guide interested researchers in integrating ML into their work. By acting as a resource to which researchers can refer, we hope to support the integration of ML in the field of nutrition to facilitate modern research.

Emerging Area: Nutrition and Food Security

NSF Spurs Use-Inspired Research and Technology Development to Address Food and Nutrition Security Challenges

National Science Foundation, Dec. 13, 2022. **Article link**

Significance: NSF announced 11 million dollars in new funding from its Convergence Accelerator program directed towards use-inspired research and technology development to address food and nutrition security challenges.

NSF's transdisciplinary program hopes to encourage "synergistic efforts that advance regenerative agriculture practices, reduce water usage, provide equitable access to nutritious and affordable food for disadvantaged communities, and spur technology and job creation." To date 16 research awards have been given towards precision agriculture in vegetable production amidst climate change, a dairy protein hub, and rapid detection technologies and decision-support systems to mitigate food supply chain threat. Resources are also dedicated to combating climate extremes on the global food system, food and nutritional security education, local sourcing of nutrient dense foods, rapid detection technologies and decision-support systems to mitigate food supply chain threats.

Engage with IAFNS

January 18, 2023
3:00 - 4:00 pm ET

- "**Logical Fallacies in the Food and Nutrition Conversation: How to Spot Them and Diffuse Them**," featuring Leah McGrath, RD, LDN (Buildup Dietitians) and Melanie Trecek-King (Massasoit Community College and Thinking is Power). Learn about how recognizing logical fallacies related to food dialogue helps with identifying misinformation.

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