Nutrition Briefs



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Dietary Patterns

Aligning Environmental Sustainability, Health Outcomes, and Affordability in Diet Quality: A Systematic Review

Clarissa L Leydon, Ursula M Leonard, Sinéad N McCarthy, Janas M Harrington. Adv Nutr. 2023 Nov;14(6):1270-1296. doi: 10.1016/j.advnut.2023.07.007. Article link

Significance: Healthier diets can reduce environmental impacts but depending on the choice of indicators selected, incongruities between population and planetary health can occur.

Improving diet quality while simultaneously maintaining planetary health is of critical interest globally. Despite the shared motivation, advancement remains slow, and the research community continues to operate in silos, focusing on certain pairings (diet-climate), or with a discipline-specific lens of a sustainable diet, rather than examining their totality. This review aimed to summarize the literature on adherence to a priori defined dietary patterns in consideration of diet quality, metabolic risk factors for noncommunicable diseases (NCDs), environmental impacts, and affordability. A methodology using PRISMA guidelines was followed, and searches were performed in 7 databases as of October 2022. The Appraisal tool for Cross-Sectional Studies (AXIS) and the National Institutes of Health (NIH) quality assessment tool for observational cohort studies were employed for quality appraisal. The evidence was narratively synthesized according to the characteristics of the diet quality metrics. The review includes 24 studies published between 2017-2023. Thirteen distinct diet quality scores were identified, with those measuring adherence to national dietary guidelines the most reported. Thirteen distinct environmental impact indicators were identified, with greenhouse gas emissions (n=23) reported most. All studies reported on body mass index, and 7 studies assessed the cost of adherence. Our results are consistent with previous findings that healthier diets can reduce environmental impacts; however, incongruities between population and planetary health can occur. Hence, the "sustainability" of dietary patterns is dependent on the choice of indicators selected. Further, healthy, lower impact diets can increase financial cost, but may also provide a protective role against the risk of obesity. Given the Global Syndemic, strategies to reduce obesity prevalence should emphasize the win-win opportunities for population and planetary health through dietary change. Research should identify diets that address multiple envi

Carbohydrates

Inulin-Type Fructans and 2'fucosyllactose Alter both Microbial Composition and Appear to Alleviate Stress-Induced Mood State in a Working Population Compared to Placebo (Maltodextrin): the EFFICAD Trial, a Randomized, Controlled Trial

Peter Pj Jackson, Anisha Wijeyesekera, Claire M Williams, Stephan Theis, Jessica van Harsselaar, Robert A Rastall. Am J Clin Nutr. 2023 Nov;118(5):938-955. doi: 10.1016/j.ajcnut.2023.08.016. Article link

Significance: A 5-week study in adults with depression found beneficial effects of oligofructose and combination of oligofructose/2'fucosyllactose intake on gut microbial composition and mood state parameters.

Background: There is increasing interest in the bidirectional relationship existing between the gut and brain and the effects of both oligofructose and 2'fucosyllactose to alter microbial composition and mood state. Yet, much remains unknown about the ability of oligofructose and 2'fucosyllactose to improve mood state via targeted manipulation of the gut microbiota. Objectives: We aimed to compare the effects of oligofructose and 2'fucosyllactose alone and in combination against maltodextrin (comparator) on microbial composition and mood state in a working population. Methods: We conducted a 5-wk, 4-arm, parallel, double-blind, randomized, placebo-controlled trial in 92 healthy adults with mild-to-moderate levels of anxiety and depression. Subjects were randomized to oligofructose 8 g/d (plus 2 g/d maltodextrin); maltodextrin 10 g/d; oligofructose 8 g/ plus 2'fucosyllactose (2 g/d) or 2'fucosyllactose 2 g/d (plus 8 g/d maltodextrin). Changes in microbial load (fluorescence in situ hybridization-flow cytometry) and composition (16S ribosomal RNA sequencing) were the primary outcomes. Secondary outcomes included gastrointestinal sensations, bowel habits, and mood state parameters. Results: There were significant increases in several bacterial taxa including Bifidobacterium, Bacteroides, Roseburia, and Faecalibacterium prausnitzii in both the oligofructose and oligofructose/2 fucosyllactose interventions (all P ≤ 0.05). Changes in bacterial taxa were highly heterogenous upon 2'fuscoyllactose supplementation. Significant improvements in Beck Depression Inventory, State Trait Anxiety Inventory Y1 and Y2, and Positive and Negative Affect Schedule scores and cortisol awakening response were detected across oligofructose, 2'fucosyllactose, and oligofructose/2'fucosyllactose combination interventions (all P ≤ 0.05). Both sole oligofructose and oligofructose/2'fuscosyllactose combination interventions outperformed both sole 2'fucosyllactose and maltodextrin in improvements in several mood state parameters (all P ≤ 0.05). Conclusion: The results of this study indicate that oligofructose and combination of oligofructose/2'fucosyllactose can beneficially alter microbial composition along with improving mood state parameters. Future work is needed to understand key microbial differences separating individual responses to 2'fucosyllactose supplementation.

740 15th Street NW Washington, DC 20005 Tel: 202.659.0184, Ext. 135 Fax: 202.659.3859 iafns@iafns.org

Protein

Dose-Response of Myofibrillar Protein Synthesis To Ingested Whey Protein During Energy Restriction in Overweight Postmenopausal Women: A Randomized, Controlled Trial

Mads S Larsen, Oliver C Witard, Lars Holm, Paula Scaife, Rikke Hansen, Kenneth Smith, Kevin D Tipton, et. al. *J Nutr.* 2023 Nov;153(11):3173-3184. doi: 10.1016/j.tjnut.2023.08.011. <u>Article link</u>

Significance: Maximal myofibrillar protein synthesis was achieved with 35 grams whey protein intake in overweight, postmenopausal women following caloric restriction, irrespective of exercise regimen.

Background: Diet-induced weight loss is associated with a decline in lean body mass, as mediated by an impaired response of muscle protein synthesis (MPS). The dose-response of MPS to ingested protein, with or without resistance exercise, is well characterized during energy balance but limited data exist under conditions of energy restriction in clinical populations. **Objective:** To determine the dose-response of MPS to ingested whey protein following short-term diet-induced energy restriction in overweight, postmenopausal, women at rest and postexercise. **Design:** Forty middle-aged (58.6±0.4 y), overweight (BMI: 28.6±0.4), postmenopausal women were randomly assigned to 1 of 4 groups: Three groups underwent 5 d of energy restriction (~800 kcal/d). On day 6, participants performed a unilateral leg resistance exercise bout before ingesting either a bolus of 15g (ERW15, n = 10), 35g (ERW35, n = 10) or 60g (ERW60, n = 10) of whey protein. The fourth group (n = 10) ingested a 35g whey protein bolus after 5 d of an energy balance diet (EBW35, n = 10). Myofibrillar fractional synthetic rate (FSR) was calculated under basal, fed (FED) and postexercise (FED-EX) conditions by combining an L-[ring-13C6] phenylalanine trace infusion with the collection of bilateral muscle biopsies. **Results:** Myofibrillar FSR was greater in ERW35 (0.043±0.003%/h, P = 0.013) and FED-EX (0.048 ± 0.003%/h), P < 0.001) than BASAL (0.027 ± 0.003%/h), but no differences were detected between FED and FED-EX (P = 0.732) conditions. No differences in myofibrillar FSR were observed between EBW35 (0.042 ± 0.003%/h) and ERW35 (0.043 ± 0.003%/h, P = 0.732) conditions. No differences in myofibrillar FSR were observed between EBW35 (0.042 ± 0.003%/h) and ERW35 (0.043 ± 0.003%/h, P = 0.744). **Conclusion:** A 35 g dose of whey protein, ingested with or without resistance exercise, is sufficient to stimulate a maximal acute response of MPS following short-term energy restriction in overweight, postmenopausal women, and thus may provide a per serving prote

Low-and No-Calorie Sweeteners

Relative Validity of Habitual Sugar and Low/No-Calorie Sweetener Consumption Assessed by FFQ, Multiple 24-h Dietary Recalls and Urinary Biomarkers: An Observational Study within the SWEET Project

Marion E C Buso, Hendriek C Boshuizen, Novita D Naomi, Walid Maho, Marlies Diepeveen-de Bruin, Michiel G J Balvers, et. al. Am J Clin Nutr. 2023 Nov pre-proof:S0002-9165(23)66290-2. doi: 10.1016/j.ajcnut.2023.11.019. Article link

Significance: Self reports and urinary biomarkers are useful methods for assessing sugar and Low- and No-Calorie Sweetener intakes, but underestimation of LNCS intake can occur with self-reports.

Background: Studies investigating associations between sweeteners and health yield inconsistent results, possibly due to subjective self-report dietary assessment methods. **Objective:** We compared the performance of a food frequency questionnaire (FFQ), multiple 24h dietary recalls (24hRs) and urinary biomarkers to estimate intake of sugars and low/no-calorie sweeteners (LNCS). **Method:** Participants (n=848, age 54 ± 12 years) from a 2-year observational study completed one semi-quantitative FFQ and at least three non-consecutive 24hRs. Both methods assessed intake of sugars (mono and disaccharides, sucrose, fructose, free and added sugars) and sweetened foods and beverages (sugary foods, fruit juice, and sugar or LNCS-containing beverages (SSB and LNCSB)); 24hRs also included LNCS-containing foods and tabletop sweeteners (LNCSF). Urinary excretion of sugars (fructose+sucrose) and LNCS (acesulfame K+sucralose+steviol glucuronide+cyclamate+saccharin) were simultaneously assessed using UPLC-MS/MS in 288 participants with three annual 24-h urine samples. Methods were compared using a.o. validity coefficients (VCs, correlations corrected for measurement error). **Results:** Median (IQR) FFQ intakes ranged from 0 (0-7) g/d for LNCSB to 94 (73-117) g/d for mono-disaccharides. LNCSB use was reported by 32% of participants. Median LNCSB+LNCF intake using 24hRs was 1 (0-50) g/d and reported by 58%. Total sugar excretions were detected in 100% of samples (56 (37-85) mg/d) and LNCS in 99% of urine samples (3 (1-10) mg/d). Comparing FFQ against 24hRs showed VCs ranging from 0.38 (fruit juice) to 0.74 (LNCSB). VCs for comparing FFQ with urinary excretions were 0.25 to 0.29 for sugars and 0.39 for LNCSB; for 24hR they amounted to 0.31 to 0.38 for sugars and to 0.37 for LNCSB and 0.45 for LNCSF. **Conclusions:** The validity of the FFQ against 24hRs for the assessment of sugars and LNCSB ranged from moderate to good. Comparing self-reports and urine excretions showed moderate agreement, but highlighted an important underestimat

Cognitive Health

The Role of Methionine-Rich Diet in Unhealthy Cerebrovascular and Brain Aging: Mechanisms and Implications for Cognitive Impairment

Anna Ungvari, Rafal Gulej, Boglarka Csik, Peter Mukli, Sharon Negri, Stefano Tarantini, Andriy Yabluchanskiy, et. al. *Nutrients*. 2023 Nov 3;15(21):4662. doi: 10.3390/nu15214662. <u>Article link</u>

Significance: This review presents the connection and potential pathway between methionine-heavy diet and accelerated cerebrovascular and brain aging, emphasizing their potential roles in cognitive impairment.



Background: As aging societies in the western world face a growing prevalence of vascular cognitive impairment and Alzheimer's disease (AD), understanding their underlying causes and associated risk factors becomes increasingly critical. A salient concern in the western dietary context is the high consumption of methionine-rich foods such as red meat. The present review delves into the impact of this methionine-heavy diet and the resultant hyperhomocysteinemia on accelerated cerebrovascular and brain aging, emphasizing their potential roles in cognitive impairment. Through a comprehensive exploration of existing evidence, a link between high methionine intake and hyperhomocysteinemia and oxidative stress, mitochondrial dysfunction, inflammation and accelerated epigenetic aging is drawn. Moreover, the microvascular determinants of cognitive deterioration, including endothelial dysfunction, reduced cerebral blood flow, microvascular rarefaction, impaired neurovascular coupling, and blood-brain barrier (BBB) disruption, are explored. The mechanisms by which excessive methionine consumption and hyperhomocysteinemia might drive cerebromicrovascular and brain aging processes are elucidated. By presenting an intricate understanding of the relationships among methionine-rich diets, hyperhomocysteinemia, cerebrovascular and brain aging and cognitive impairment, avenues for future research and potential

Lipids

Safety of Supplementation of Omega-3 Polyunsaturated Fatty Acids: A Systematic Review and Meta-Analysis of Randomized Controlled Trials

Jane Pei-Chen Chang, Ping-Tao Tseng, Bing-Syuan Zeng, Cheng-Ho Chang, Huanxing Su, Po-Han Chou, Kuan-Pin Su. Adv Nutr. 2023 Nov;14(6):1326-1336. doi: 10.1016/j.advnut.2023.08.003. Article link

Significance: Subjects taking ω -3 PUFAs were at higher odds of experiencing adverse health effects compared to placebos, warranting further future review to detect minor/subtle adverse effects associated with ω -3 PUFAs.

There is no comprehensive review of the evidence to support omega-3 polyunsaturated fatty acids (PUFAs) as a relatively safe and tolerable intervention. This study aimed to provide a meta-analytic and comprehensive review on the adverse effects of all kinds of ω -3 PUFA supplementation reported in randomized controlled trials (RCTs) in human subjects. A systematic review of RCTs published between 1987 and 2023 was carried out based on searches of 8 electronic databases. All RCTs that compared the adverse effects of ω -3 PUFAs containing eicosapentaenoic acid, docosahexaenoic acid, or both compared with controls (a placebo or a standard treatment) were included. The primary outcome was the adverse effects related to ω -3 PUFA prescription. A total of 90 RCTs showed that the ω -3 PUFA group, when compared with the placebo, had significantly higher odds of occurrence of diarrhea (odds ratio [OR] = 1.257, P = 0.010), dysgeusia (OR = 3.478, P < 0.001), and bleeding tendency (OR = 1.260, P = 0.025) but lower rates of back pain (OR = 0.727, P < 0.001). The subgroup analysis showed that the prescription ω -3 PUFA products (RxOME3FAs) had higher ω -3 PUFA dosages than generic ω -3 PUFAs (OME3FAs) (3056.38 ± 1113.28 mg/d compared with 2315.92 ± 1725.61 mg/d), and studies on RxOME3FAs performed more standard assessments than OME3FAs on adverse effects (63% compared with 36%). There was no report of definite ω -3 PUFA-related serious adverse effects may help to detect minor/subtle adverse effects associated with ω -3 PUFAs.

Sodium

Switching the World's Salt Supply-Learning from Iodization to Achieve Potassium Enrichment

Katrina R Kissock, Greg S Garrett, Penjani Mkambula, James D Bullen, Kathy Trieu, Laura J Fisher, Ellie Paige, et. al. Adv Nutr. 2023 Nov 15:100148. doi: 10.1016/j.advnut.2023.100148. Article link

Significance: Many of the opportunities and challenges to universal salt iodization will likely also be applicable to switching the global salt supply to iodized and potassium-enriched salt.

Sodium is an essential dietary component, but excess sodium intake can lead to high blood pressure and an increased risk of cardiovascular disease. Many national and international bodies, including the World Health Organization, have advocated for population-wide sodium reduction interventions. Most have been unsuccessful due to inadequate sodium reduction by food industry and difficulties in persuading consumers to add less salt to food. Recent research highlights potassium-enriched salt as a new, feasible, acceptable, and scalable approach to reducing the harms caused by excess sodium and inadequate potassium consumption. Modeling shows that a global switch from regular salt to potassium-enriched salt has the potential to avert millions of strokes, heart attacks, and premature deaths worldwide each year. There will be many challenges in switching the world's salt supply to potassiumenriched salt, but the success of universal salt iodization shows that making a global change to the manufacture and use of salt is a tractable proposition. This in-depth review of universal salt iodization identified the importance of a multisectoral effort with strong global leadership, the support of multilateral organizations, engagement with the salt industry, empowered in-country teams, strong participation of national governments, understanding the salt supply chain, and a strategic advocacy and communication plan. Key challenges to the implementation of the iodization program were costs to government, industry, and consumers, industry concerns about consumer acceptability, variance in the size and capabilities of salt producers, inconsistent quality control, ineffective regulation, and trade-related regulatory issues. Many of the opportunities and challenges to universal salt iodization will likely also be applicable to switching the global salt supply to iodized and potassium-enriched salt.



Gut Health

The Gut Microbiome Modulates Associations Between Adherence to a Mediterranean-Style Diet, Abdominal Adiposity, and C-reactive Protein in Population-Level Analysis

Amy Jennings, Tilman Kühn, Nicola P Bondonno, Sabina Waniek, Corinna Bang, Andre Franke, Jan Kassubek, et. al. Am J Clin Nutr. 2023 Nov 4:S0002-9165(23)66236-7. doi: 10.1016/j.ajcnut.2023.11.001. Article link

Significance: An association between aMed scores, lower abdominal adipose tissue, and inflammation was linked to an abundance of *Porphyromonadaceae* and *Peptostreptococcaceae* families in the gut.

Background: Adherence to a Mediterranean-style dietary pattern is likely to have variable effects on body composition, but the impact of gut microbiome on this relationship is unknown. **Objectives:** To examine the potential mediating effect of the gut microbiome on the associations between Alternate Mediterranean Diet (aMed) scores, abdominal adiposity, and inflammation in population-level analysis. **Design:** In a community-based sample aged 25 to 83 y (n = 620; 41% female) from Northern Germany, we assessed the role of the gut microbiome, sequenced from 16S rRNA genes, on the associations between aMed scores, estimated using validated food-frequency questionnaires, magnetic resonance imaging-determined visceral (VAT) and subcutaneous (SAT) adipose tissue and C-reactive protein (CRP). **Results:** Higher aMed scores were associated with lower SAT (-0.86 L (95% CI: -1.56, -0.17), P = 0.01), VAT (-0.65 L (95% CI: -1.03,-0.27), P = 0.01) and CRP concentrations (-0.35 mg/L; β : -20.1% (95% CI: 35.5, -1.09), P = 0.04) in the highest versus lowest tertile after multivariate adjustment. Of the taxa significantly associated with aMed scores, higher abundance of *Porphyromonadaceae* mediated 11.6%, 9.3%, and 8.7% of the association with SAT and CRP levels. Of the individual components of the aMed score, moderate alcohol intake was associated with lower VAT (-0.2 (95% CI: -0.4, -0.1), P = 0.01) with a higher abundance of *Oxalobacteraceae* and lower abundance of *Burkholderiaceae* explaining 8.3% and 9.6% of this association, respectively. **Conclusion:** These novel data suggest that abundance of specific taxa in the *Porphyromonadaceae* and *Peptostreptococcaceae* families may contribute to the association between aMed scores, lower abdominal adipose tissue, and inflammation.

Emerging Science Areas

Emerging Areas: Nutrition

Perspective: A Research Roadmap about Ultra-Processed Foods and Human Health for the United States Food System: Proceedings from an Interdisciplinary, Multi-Stakeholder Workshop

Lauren E O'Connor, Kelly A Higgins, Katarina Smiljanec, Robert Bergia, Andrew W Brown, David Baer, Cindy Davis, et. al. *Adv Nutr.* 2023 Nov;14(6):1255-1269. doi: 10.1016/j.advnut.2023.09.005. Article link

Significance: Uncertainty and complexity related to ultra-processed food intake necessitates further complementary and interdisciplinary causal, mechanistic, and methodological research related to obesity and CMD risk. This may be required before food classification by degree of processing can be applied, according to an expert workshop report.

Our objective was to convene interdisciplinary experts from government, academia, and industry to develop a Research Roadmap to identify research priorities about processed food intake and risk for obesity and cardiometabolic diseases (CMD) among United States populations. We convened attendees at various career stages with diverse viewpoints in the field. We held a "Food Processing Primer" to build foundational knowledge of how and why foods are processed, followed by presentations about how processed foods may affect energy intake, obesity, and CMD risk. Breakout groups discussed potential mechanistic and confounding explanations for associations between processed foods and obesity and CMD risk. Facilitators created research questions (RQs) based on key themes from discussions. Different breakout groups convened to discuss what is known and unknown for each RQ and to develop sub-RQs to address gaps. Workshop attendees focused on ultra-processed foods (UPFs; Nova Group 4) because the preponderance of evidence is based on this classification system. Yet, heterogeneity and subjectivity in UPF classification was a challenge for RQ development. The 6 RQs were: 1) What objective methods or measures could further categorize UPFs, considering food processing, formulation, and the interaction of the two? 2) How can exposure assessment of UPF intake be improved? 3) Does UPF intake influence risk for obesity or CMDs, independent of diet quality? 4) What, if any, attributes of UPFs influence ingestive behavior and contribute to excess energy intake? 5) What, if any, attributes of UPFs? Uncertainty and complexity around UPF intake warrant further complementary and interdisciplinary causal, mechanistic, and methodological research related to obesity and CMD risk to understand the utility of applying classification by degree of processing to foods in the United States.

Simple Dietary Substitutions Can Reduce Carbon Footprints and Improve Dietary Quality Across Diverse Segments of the US Population

Anna H. Grummon, Cristina J. Y. Lee, Thomas N. Robinson, Eric B. Rimm, Donald Rose. *Nature Food*. Nov. 2023. doi.org/10.1038/s43016-023-00864-0. Article link

Significance: Substituting high-carbon footprint foods with lower-carbon substitutes can improve diet quality from 4-10% and reduce the carbon footprint in the US by 35%.

Changing what foods, we eat could reduce environmental harms and improve human health, but sweeping dietary change is challenging. We used dietary



intake data from a nationally representative sample of 7,753 US children and adults to identify simple, actionable dietary substitutions from higher- to lowercarbon foods (for example, substituting chicken for beef in mixed dishes such as burritos, but making no other changes to the diet). We simulated the potential impact of these substitutions on dietary carbon emissions and dietary quality. If all consumers who ate the high-carbon foods instead consumed a lower-carbon substitute, the total dietary carbon footprint in the United States would be reduced by more than 35%. Moreover, if adopted, these substitutions would improve consumers' overall dietary quality by 4–10%, with benefits projected for all age, gender, and racial and ethnic groups. These results suggest that a 'small changes' approach could be a valuable starting point for addressing diet's impact on climate and health

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