FOOD FOR HEALTH AND THE PLANET

Slovenian Dietary Guidelines 2025 (SDG2025)

Foundations based on scientific findings

Improving the sustainability of the Dietary Guidelines for Slovenia 2025

Environmental impacts of the Slovenian food system

REPUBLIC OF SLOVENIA
MINISTRY OF AGRICULTURE, FORESTRY AND FOOD

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PART I.

Slovenian Nutrition Guidelines 2025 (SNG2025) – Scientific Evidence Base

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We would like to thank **Marko Grobelnik, PhD,** from the Jožef Stefan Institute, for his assistance in translating the guidelines from the original English version into Slovenian.

Dear Citizens,

Food is an important part of our everyday lives. It influences our health, well-being and quality of life, while also representing an important part of Slovenian culture, tradition and social environment. Dietary choices have long-term consequences not only for individuals, but also for the healthcare system, rural development, food security and the environment.

Slovenia has a rich culinary heritage and diverse dietary characteristics shaped by different geographical, cultural and climatic environments. The tradition of home-prepared meals, local food production and seasonal foods remains an important part of the Slovenian way of life. At the same time, Slovenia is also facing changes in dietary habits, lifestyles and the food environment, all of which influence population health.

The national nutrition guidelines are based on the best available scientific evidence and contemporary knowledge on the relationship between nutrition, health and sustainable development. In their preparation, the authors considered international scientific evidence, including European recommendations such as the Austrian, German, Danish, and Nordic Nutrition Recommendations, while adapting them to the Slovenian context, dietary habits, and food availability.

The Guidelines are intended to support the people of Slovenia in developing balanced dietary habits. At the same time, they provide a professional framework for healthcare professionals, educational institutions, public institutions, food providers and all those involved in shaping the food environment in Slovenia.

Particular emphasis is also placed on the sustainability aspects of nutrition. The choice of local, seasonal and high-quality foods can significantly contribute to preserving natural resources, reducing environmental pressures and supporting Slovenian agriculture and rural areas.

We believe that these Guidelines will contribute to a better understanding of the importance of nutrition and support efforts towards a healthier, more inclusive and sustainable Slovenia.

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ABBREVIATIONS

ABO: Blood-Type diet
AICR: American Institute for Cancer Research
ALA: Alpha-linolenic acid (C18:3n-3)
BMI: Body mass index
CHD: Coronary heart disease
CVD: Cardiovascular disease
DASH: Dietary Approaches to Stop Hypertension
DHA: Docosahexaenoic acid (C22:6n-3)
E%: Energy percentage, i.e., percentage of total energy intake
EFSA: European Food Safety Authority
EMBASE: Excerpta Medica Database
EPA: Eicosapentaenoic acid (C20:5n-3)
ESC: European Society of Cardiology
FAO: Food and Agriculture Organization of the United Nations
FBDG: Food-based dietary guidelines
FMD: Fasting-mimicking diet
GHG: Greenhouse gases
GMO: Genetically modified organism
HbA1c: Glycated haemoglobin
HDL: High-density lipoprotein
IOM: Institute of Medicine (now the National Academy of Medicine), USA
IU: International unit
IPCC: Intergovernmental Panel on Climate Change
PCB: Polychlorinated biphenyl
$PM_{2.5}$: Fine particulate matter
PUFA: Polyunsaturated fatty acids
KJ: Kilojoule (1 kJ = 0.239 kcal)
Kcal: Kilocalorie (1 kcal = 4.184 kJ)
LA: Linoleic acid
LCA: Life Cycle Assessment
LCHF: Low-carb, high-fat diet
LDL: Low-density lipoprotein
LNCSB: Low- and no-calorie sweetened beverages
MA: Meta-analysis
MJ: Megajoule (1 MJ = 239 kcal)
MRL: Maximum residue limits
NH_3: Atmospheric ammonia
NNR: Nordic Nutrition Recommendations

n-3 LCP: n-3 long-chain polyunsaturated fatty acids
n-3 PUFA: n-3 polyunsaturated fatty acids
n-6 PUFA: n-6 polyunsaturated fatty acid
NCD: Non-communicable disease
OPEN: Open Platform for Clinical Nutrition
PAL: Physical activity level
PRI: Population Reference Intake
PubMed: Public Medline
RTC: Randomised Clinical Trial
qSR: Quality systematic review
SFA: Saturated fatty acids
SNG2025: Slovenian Nutrition Guidelines 2025
SO_2: Sulfur dioxide
SR: Systematic review
SSBs: Sugar-sweetened beverages
T2D: Type 2 diabetes
TFAs: Trans fatty acids
TRE: Time-restricted eating
UN: United Nations
UPFs: Ultra-processed foods
WCRF: World Cancer Research Fund
WFPB: Whole-food plant-based
WHO: World Health Organization

GLOSSARY

ABO blood-type diet (ABO diet): A dietary approach that recommends specific foods based on an individual's blood type, with the aim of optimising health.

Added sugars: Refined sugars such as sucrose, fructose, glucose, starch hydrolysates (e.g., glucose syrup, high-fructose syrup), and other isolated sugar preparations used as such or added during food preparation and manufacturing. Added sugars are included within the category of free sugars.

Carbon dioxide equivalents (CO2-eq): A metric used to assess the short-term global warming potential of different greenhouse gases by converting them into the equivalent amount of CO2 with the same global-warming potential. The total amount is then expressed as a single aggregated value.

DASH (Dietary Approaches to Stop Hypertension) diet: A dietary pattern emphasising fruit vegetables, whole grains, and lean proteins, with reduced sodium intake and higher consumption of potassium-rich foods, designed to lower blood pressure.

DALY (disability-adjusted life year): A measure of overall disease burden, expressed as the number of years lost due to ill-health, disability, or early death.

Free sugars: All monosaccharides and disaccharides added to foods and beverages by the manufacturer, cook, or consumer, as well as sugars naturally present in honey, syrups, fruit juices, and fruit juice concentrate.

'High in': A classification based on the Scoring System Model for Foods described in Table 1. The model identifies foods as either 'high in' sodium, saturated fatty acids (SFA), or dietary fibre, or as a 'source of' protein, n-3 polyunsaturated fatty acids (n-3 PUFA), and micronutrients. This scoring system is applied in Sections 3 and 4 of the SNG2025.

LCHF (low-carb, high-fat diet): A dietary pattern that restricts carbohydrate intake while increasing fat consumption, often including meat, dairy products, and vegetable oils.

Life Cycle Assessment: An ISO-standardised environmental management tool to quantitatively assess and compare the overall environmental performance of products, services, and technologies.

Mediterranean diet: A dietary pattern emphasising whole grains, fruit, vegetables, legumes, nuts, and olive oil, with moderate consumption of fish and dairy products, and limited intake of red meat.

Monoculture: Intensive large-scale cropping systems characterised by low diversity.

Net zero: A GHG emission regime in which no additional warming is caused (i.e., no net increase in total radiative forcing from atmospheric greenhouse gases).

Physical activity level: An expression of a person's total daily physical activity, used to estimate total energy expenditure.

Planetary diet: A dietary pattern proposed by the EAT-Lancet Commission to promote both human health and environmental sustainability. It emphasises predominantly plant-based foods, moderate amounts of animal-sourced foods, and a reduction of ultra-processed products and food waste. This comprehensive approach addresses the global burden of diet-related diseases while reducing environmental pressures.

Plant-based diet: Defined in this report as a dietary pattern primarily based on plant foods such as vegetables, fruit, whole grains, pulses, nuts, and seeds. Moderate amounts of animal foods, such as fish, white meat (poultry), red meat, and low-fat dairy products, may also be included.

Processed meats: Meat preserved through smoking, salting, curing, or the addition of chemical preservatives.

Pseudocereals: Non-grass plants with seeds consumed like cereals, including amaranth, buckwheat, and quinoa. These are naturally gluten-free.

'Source of': A classification based on the Scoring System Model for Foods described in Table 1. The model identifies foods as either 'high in' sodium, saturated fatty acids (SFA), or dietary fibre, or as a 'source of' protein, n-3 polyunsaturated fatty acids (n-3 PUFA), and micronutrients. This scoring system is applied in Sections 3 and 4 of the SNG2025.

Ultra-processed foods: Foods classified in Category 4 of the NOVA food classification system.

Vegetarian diet: A dietary pattern that excludes meat, poultry, fish, and seafood but includes eggs and dairy products (sometimes referred to as the lacto-ovo vegetarian diet).

Vegan diet: A dietary pattern that exclude all foods of animal origin.

Chapter 1. Slovenian Nutrition Guidelines: Impact on Health and Sustainability

1.1. What Are the Slovenian Nutrition Guidelines?

The Slovenian Nutrition Guidelines (SNG2025) are food-based dietary guidelines (FBDG) structured around food groups. They provide evidence-based recommendations for promoting foods and nutrients associated with improved health outcomes and sustainable environmental impacts (Part II). Dietary guidance empowers informed decision-making among individuals and populations, thus supporting health and well-being. Globally, nutrition policies prioritise dietary recommendations that are easy to understand, built on food-based targets and public supported by clear communication of trusted science [1,2].

The SNG2025 provide recommendations based on the best available scientific evidence. They inform people what to eat daily, optimise energy and essential nutrient intake, and minimise the risk of diet-related illness. They also offer practical advice for creating well-balanced and sustainable diets, promoting healthy eating habits, and advocating universal access to nutritious food. The guidelines are designed to support policymakers, healthcare professionals, and the food industry in shaping healthier food environments and improving public health outcomes. The recommendations and targets are expressed in a user-friendly way, making it easier for individuals to understand which food groups to consume more of and which to limit. Concise messages, presented as dietary recommendations based on food groups, help individuals in creating balanced and healthy meals.

The SNG2025 were developed under the auspices of the Ministry of Health by a multidisciplinary expert group (covering the fields of nutrition, medicine and public health, pharmacy, environmental science, agriculture, and information science) through peer review, professional consultation and public input. They were prepared in response to appraisals of current dietary patterns and the prevalence of non-communicable diseases (NCDs) in the adult Slovenian population, taking into account the food system, eating culture, and lifestyle. In Slovenia, the Mediterranean diet – promoting the higher consumption of vegetables and fruit and, at the same time, lower intake of saturated fatty acids (SFA) from animal sources and processed foods – has been recommended for approximately 20 years [3,4]. While the Mediterranean diet is already predominantly plant-based, recent scientific evidence supports a further shift towards plant-based diets, highlighting the health benefits, positive environmental impacts, and contribution to food-system sustainability [5].

Globally, similar moves towards plant-based dietary recommendations have been adopted, as evidenced by the EAT-Lancet Commission [6,7], FAO and WHO [8,9], the United Kingdom's 'Eatwell Guide' [10], Canada's dietary guidelines [11], Spain's healthy and sustainable dietary recommendations [12], and, to a lesser extent, the Nordic Nutrition Recommendations (NNR) 2023 [13], the Danish FBDG [14], and the more recent German FBDG [15,16] and Austrian FBDG [17].

The SNG2025 provide a wide range of dietary options that can be customised to suit individual unique needs. By tailoring food groups to personal requirements, sustainable and healthy eating habits can be promoted among adults of all ages. The guidelines also provide valuable information on essential nutrients and, more significantly, on meal planning and food preparation. They further encourage regular physical activity as an essential major determinant of a healthy lifestyle, forming part of the comprehensive national strategy to promote health and prevent NCDs to the highest possible level for almost two decades [3,18,19] (Appendix A).

In summary, the SNG2025 recommend a predominantly plant-based diet, with a high intake of vegetables, fruit, whole grains, pulses, potatoes, nuts, and seeds; moderate intakes of dairy products, eggs, and fish; limited intakes of meat; and minimal (ideally no) intakes of processed meat, alcohol, and ultra-processed foods (UPFs) high in saturated fats, salt, refined starches/grains, and added/free sugar. Water, mineral water and unsweetened tea are recommended as the primary beverages. Daily intakes across the whole diet should stay within the following limits: <10% of energy from saturated fats, <5% from free sugars (≈0–31 g), <0.5% from trans fats, and <5 g salt. These limits apply to the total diet, not only to individual food groups.

1.2. Who Can Benefit from the SNG2025?

The SNG2025 are intended to provide information and recommendations for adults (individuals aged 18 or older), including those at increased risk of developing NCDs, such as cardiovascular diseases (CVDs), type 2 diabetes (T2D), and cancer. Patients with established and/or advanced CVDs, T2D, cancer, or other conditions requiring specific and/or clinical nutritional interventions should be managed according to disease-specific guidelines and by nutritional experts in line with state-of-the-art clinical practice standards.

The recommendations primarily focus on the prevention of NCDs and their risk factors, which are widespread, particularly among middle-aged adults and older people (aged 65 years and over) [20]. Policymakers, healthcare professionals, and institutions, including hospitals and care homes, should also refer to the SNG2025 when developing nutrition policies, programmes, and resources. The guidelines should also be used to plan menus for public institutions, including those serving employees. It has to be emphasised that public institutions and care facilities for older people have a responsibility to prioritise providing accessible and nutritious dietary options to create a healthier food environment [21].

The United Nations advocates the use of FBDG to create a foundation for public policies related to food, nutrition, health, agriculture, and nutrition education programmes. The SNG2025 provide recommendations on foods, food groups, and dietary patterns to ensure that the general public receives the necessary nutrients to promote good health and prevent chronic diseases [22].

1.3. Addressing NCDs through the Slovenian FBDG

The SNG2025 acknowledge the overwhelming evidence linking unhealthy lifestyles to the incidence of NCDs, especially CVDs and cancer. CVDs accounted for 33% of all deaths and remain the leading cause of mortality among women in Slovenia [23]. The vast majority of the adult Slovenian population is at risk for CVDs because of the high prevalence of modifiable (major) risk factors – with an estimated 59% of adults and 74% of older adults being overweight or obese, 56% having dyslipidaemia, and 48% having arterial hypertension [23–27]. Cancer has surpassed CVDs as the leading cause of mortality in men in Slovenia, with lifestyle-associated risk factors, such as overweight and obesity, smoking, and alcohol consumption, identified as major modifiable drivers of the increasing incidence [28,29].

In terms of dietary intake, the current diets of Slovenians are marked by imbalances characterised by the excessive consumption of animal-derived foods, particularly red and processed meats (preserved by smoking, salting, curing, or the addition of chemical preservatives), alongside high intakes of alcohol, unhealthy fats (trans and saturated), refined grains, sugars, and salts. Conversely, the intake of plant-based foods, including fruit, vegetables, pulses, whole grains, nuts, and seeds, remains notably insufficient when compared to the planetary diet [6,30].

Achieving the '5 a day' recommendation for fruit and vegetables is particularly challenging in Slovenia. In 2019, only 5% of Slovenians consumed at least five portions of fruit and vegetables daily, one of the lowest rates in the EU. By comparison, the EU average was 12%, with countries like Ireland (33%), the Netherlands (30%), Denmark (23%), and France (20%) reporting much higher compliance [31]. In addition, a significant proportion of the Slovenian adult population has inadequate intakes of several key nutrients, including fibre (90% of adults and 84% of older adults), vitamin B12 (32% of adults and 46% of older adults), folate (88% of both adults and older adults), vitamin D (100%), and the trace element iron (33% of adults, and 76% of women aged 18–50 years) [24,32–34]. Detailed discussions of current food and nutrient consumption in Slovenian adults and the elderly, together with recommended intakes, are provided in Sections 2 and 3.

1.4. Methods and Procedures

The SNG2025 were developed within the methodological framework of the Slovenian manual for guideline development [35]. Slovenian recommendations for evidence-based guideline development propose reviewing, selecting, updating and/or adapting existing high-quality, evidence-based guidelines through a systematic process that includes the involvement of interdisciplinary guideline groups (core/drafting groups for nutrition/health impact and environmental impact, and an extended/reviewing group), delineation of the guideline remit, systematic appraisal of existing guidelines, selection of appropriate guidelines, identification of specific issues that need to be updated and/or adapted, the systematic search for and critical appraisal of potential studies for inclusion in the final guideline document, and drawing recommendations on best available evidence by considered judgement. Overall, the Slovenian guideline development process aims to provide high-quality recommendations supported by the existing scientific evidence which may be effectively implemented in Slovenia.

Based on the systematic appraisal and considered judgement of existing guidelines, three high-quality guidelines were selected initially: EAT-Lancet [6], NNR [13], and the Canadian FBDG [11]. Major criteria for guideline selection were a comprehensive remit (addressing health outcomes, nutritional concerns, and environmental impact) and scientific validity (a robust methodological approach based on the highest level of scientific evidence available when developing). The core group members reached a consensus to update specific recommendations based on newly available scientific evidence and to align them with the current nutritional status of the Slovenian population.

Evidence (systematic review (SR), meta-analysis (MA), and original research/individual studies referenced in the selected guidelines) was independently appraised by at least two members of the core groups and reviewed by all members. Additional relevant and more recent evidence was also compiled, including a systematic search of EMBASE and PubMed from January 2022 to March 2024, also carried out by the Institute of Biostatistics and Medical Informatics, Faculty of Medicine, University of Ljubljana. The search was restricted by language (English) and publication type (the search strategy with keywords is provided in the supplementary material, Appendix B).

The guideline content was revised and supplemented on the basis of feedback received in May and June 2024 from five international reviewers, and suggestions from nine Slovenian experts contributing to the review. To strengthen the scientific foundation and ensure alignment with the latest evidence and expert consensus, 121 new references were added during the revision process. These covered topics including glycaemic index, oxalates, alcohol and health, vitamin B12 in animal feed, the link between diet and mental health, environmental impacts of food systems, sustainability in aquaculture and agriculture, protein quality, plant-based alternatives, ultra-processed foods, dementia, addiction, salt and cancer, and Mediterranean and planetary dietary patterns. In addition, 18 further references were added between April 2024 and June 2025, based on a joint consensus of the core writing team, to reflect newly published systematic reviews, updated data on food policy and chronic disease prevention, and to align with EFSA, WHO, and national recommendations (Appendix C). Mendeley reference management software was used to identify and eliminate duplicate entries from the preliminary search results.

SRs and meta-analyses of large observational or randomised controlled studies appraising the effect of food groups on health outcomes in the general (apparently healthy) adult population (all-cause mortality, cause-specific mortality, the incidence of overall and/or CVDs, incidence of cancer overall and/or particular types of cancers, and specific outcomes, such as bone fractures) were considered the gold standard for synthesising scientific evidence. Evidence from individual, high-quality observational cohorts was considered where SRs and meta-analyses were unavailable. Studies assessing the effects of food groups on surrogate endpoints (e.g., body composition, blood lipids, blood pressure, blood glucose and other risk factors, bone mineral density) were treated as supporting evidence for mechanistic and/or causal relationships of associations derived from high-quality SRs of observational studies.

The appraisal of evidence also took into account disclosures of any direct industry funding or financial relationships, including employment, consultancies, or previous industry funding. Any disagreements regarding study results arising from potential or known conflicts of interest were resolved by consensus. The final list of referenced literature is as comprehensive and consistent as possible, with any dilemmas resolved through mutual agreement within the core group.

1.5. Development Process: National Strategy, Scientific Foundation, and International Collaboration

A series of key national and international activities supported the development of the SNG2025. These efforts included policy integration, expert consultations, scientific presentations, and peer-reviewed publications. Together, these activities contributed to the transparency, stakeholder engagement, and scientific rigour of the SNG2025. Below is an overview of the most relevant outputs:

National Strategic Relevance and the Initiative for Guideline Development:

The development of the SNG2025 was based on the work of the Slovenian Strategic Council for Nutrition and its initiative to promote healthy and sustainable diets [27].

Inclusion in national policy frameworks:

The guideline development was formally included in the Action Plan for the Implementation of the Resolution on the National Programme on Nutrition and Physical Activity for Health 2015–2025 [36].

Scientific dissemination at a national conference:

The core methodological approaches and preliminary results were presented at the 25th Slovenian Forum on Cardiovascular Disease Prevention in March 2024. Three contributions addressed the strategic, health, and environmental dimensions of the SNG2025 [37–40].

International expert consultations:

Two expert meetings were held during the development process:

- February 2024 (online): Presentation of the draft scientific evidence base in collaboration with the WHO Regional Office for Europe (Februarski posvet 2024 – Predstavitev osnutka strokovnih izhodišč) [41].
- May 2024 (in-person): Expert meeting hosted by the Ministry of Health, the Ministry of Environment, Climate and Energy, and the National Institute of Public Health involving national and international experts (Majski posvet 2024 – Vključenost strokovne javnosti) [42].

Peer-reviewed publication of the overall process:

A comprehensive summary of the methodological framework, evidence base, and national process was published in the *Foods* journal [43].

1.6. The Role of FBDG in Enhancing Health and Sustainability

The estimated cost of NCDs is projected to reach 44 trillion euros globally by 2030 [44]. The good news is that a healthy diet and lifestyle can prevent up to 95% of common NCDs [45–49]. Furthermore, combining a healthy diet and maintaining a recommended body mass with other healthy lifestyle factors, such as strong social networks, can increase NCD-free life expectancy by up to 10 years [50,51].

The SNG2025 utilise food group categorisation to simplify understanding of what to eat more of, what to eat less of, and how to maintain a balanced diet [52]. The idea is to plan delicious, convenient, and affordable meals while obtaining enough energy and nutrients. This means eating whole, predominantly plant-based foods that are either natural or minimally processed. The goal is to ensure a balanced energy intake, macronutrients (protein, carbohydrates, fats, and fibre), micronutrients (vitamins, minerals, and trace elements) and water. Consuming a diet that is high in fibre and has a low glycaemic index can help reduce hunger and prevent weight gain [53,54]. This is particularly important since the overconsumption of palatable, energy-dense processed foods, combined with a sedentary lifestyle (prolonged sitting and physical inactivity), has led to an obesity pandemic [55,56]. Emotional eating, characterised by increased food intake in response to negative emotions, has been linked to overweight and obesity in adults. It is influenced by various factors, including depression, sleep duration, and genetic predisposition [57]. Obese individuals reported higher levels of depression, emotional eating, and symptoms of food addiction compared with individuals of normal weight and those who were overweight [58]. Emotional dysregulation and negative emotions were found to affect BMI through emotional eating [59] indirectly. These findings highlight the complex relationship between emotional eating, psychological factors, and obesity, emphasising the need for comprehensive approaches in weight management interventions. A high-fibre dietary pattern can result in spontaneous energy restriction [60,61], which is beneficial for managing body mass and reducing the risk of specific NCDs and all-cause mortality [62–64]. It is important to recognise that controlling body mass during early and middle adulthood, such as transitioning from obese to overweight, significantly lowers the risk of premature death compared to persistently remaining obese [65].

There are various dietary patterns (see Section A.4. for details on dietary patterns popular in Slovenia and described in the scientific literature), including the most common mixed omnivorous diet [13,66,67], the Mediterranean diet [68–71], the DASH diet [72–74], various forms of vegetarian diets [75–78], dietary approaches with reduced carbohydrate and higher fat intake (such as the low-carb, high-fat diet (LCHF), and the ketogenic diet) [79–82], and the ABO blood-type diet [83–85]. Numerous scientific studies emphasise that healthy, whole-food plant-based (WFPB) dietary patterns offer significant health and environmental sustainability benefits [6,78,86–96]. As dietary guidelines continue to evolve towards more sustainable eating patterns, it is essential to prepare for these changes. Given the current food system and growing environmental challenges, returning to past dietary norms is no longer a viable option [97]. However, unsustainable eating patterns exacerbate issues related to unhealthy lifestyles, NCDs, and food production systems. Notably, dietary patterns associated with better health are also environmentally sustainable [98,99]. The proposed advanced dietary model takes into account physiological, sociological, cultural, geographical, political, and economic factors and offers diverse options for healthy eating [100].

A predominantly plant-based diet significantly reduces environmental impact by lowering land and water use, greenhouse gas emissions, and eutrophication, with reductions of up to 70–80% in some cases (see Part II). This dietary shift is also associated with substantial health benefits, including lower risks of obesity, chronic diseases, and all-cause mortality, due to higher consumption of fibre-rich plant foods and reduced intake of animal products and highly processed foods. However, for a predominantly plant-based diet to be both environmentally and nutritionally sustainable, strategic policy interventions and consumer preferences for local, minimally processed plant foods are essential [86,95,101,102].

To implement a healthy and sustainable diet, individuals require access to reliable information, the autonomy to make informed choices, and support from political and expert sources. We intend to build recommended sustainable dietary patterns using a comprehensive, holistic approach. Also, we are aware that, due to various objective challenges and limitations within society (sociological, physiological, cultural, geographical and economic), a simple shift towards a healthier dietary pattern cannot be a 'one-way street'; there is no one-size-fits-all solution [100].

Healthy eating patterns are closely associated with healthier lifestyle behaviours in general [103,104]. We are therefore striving to encourage better choices, beginning with recommendations to reduce the excessive intake of unhealthy foods (meat and UPFs) and increase the intake of vegetables, whole grains, pulses, fruit, nuts, and seeds. This can reduce the risk of common NCDs and benefit the environment [78,105]. As an example, such an approach was also acknowledged with the most recent (updated) guidelines for the management of CVDs in patients with diabetes, developed by the European Society of Cardiology (ESC). The nutrition section of this document has also been updated to include a new recommendation for lowering cardiovascular risk. In addition to adhering to the Mediterranean diet pattern, which is rich in plant-based foods and unsaturated fats, the guidelines now also recommend adopting a plant-based diet [106].

However, simply reading about healthy diets is not enough for most people to make significant and lasting changes in their everyday eating habits. Access to nutrition experts for consultation and a supportive food environment are also essential [107–111].

1.7. Embracing the Planetary Diet for Health and Sustainability

A healthy diet should optimise and promote health as complete physical, mental, and social well-being, not merely the absence of disease. In addition, a healthy diet is defined in terms of food groups while ensuring nutritional adequacy. This effectively connects food production and health. Global diets and food systems influence human health and environmental sustainability [99]. It is essential to recognise that personal, population and planetary health are closely intertwined and threatened by low-quality diets and environmental degradation [112]. Therefore, a healthy and sustainable diet is crucial for both human health and the environment [99,113].

A holistic approach to health must also consider the interconnectedness of humans, animals, and ecosystems. **One Health** is a unifying framework that highlights these interdependencies, emphasising the need for multidisciplinary collaboration in public health, veterinary medicine, environmental science, and food systems to address complex health challenges [114]. This approach is particularly relevant in food production, where sustainable agricultural practices influence both human nutrition and environmental well-being. Addressing zoonotic diseases, antimicrobial resistance, and ecosystem degradation through coordinated surveillance, research, and policy-making aligns with the goals of the **planetary diet**, which seeks to balance nutritional adequacy with sustainability [115,116]. By integrating **One Health principles**, resilient food systems can be developed that support both public health and planetary well-being.

On this basis, dietary patterns that encompass health benefits and environmental sustainability are recommended for the Slovenian population [6,96,117,118]. One such dietary pattern is represented by the planetary diet, a comprehensive approach designed to address unhealthy eating and environmental challenges simultaneously

[78,93–95,99]. Adherence to the planetary diet (EAT-Lancet index) is associated with a reduced risk of mortality [119] and improved body mass management [120]. Furthermore, the global SR of 28 publications, including over 2.21 million participants, suggests that following the planetary diet is significantly associated with a reduced risk of diabetes, CVD, cancer, and mortality [121]. This diet offers various options suitable for everyone and tailored to individual needs, ensuring improved health. The planetary diet sets intake ranges for each food group, allowing flexibility to accommodate different cultural, geographical, and personal preferences. This approach ensures inclusivity, following the principle that 'no one is left behind'. While supporting both human and planetary health, individuals must ensure adequate nutrient intake by replacing any reduced or omitted food groups with suitable alternatives [6,7,122,123].

Since most contemporary dietary guidelines are based primarily on food groups [6,13], a healthy diet is also defined in terms of food groups, while considering nutritional adequacy. A daily energy intake of 2,500 kcal is commonly used as a standard for various dietary plans. This amount of daily energy consumption is equivalent to the average energy requirements of a 70 kg man and a 60 kg woman, who are 30 years old and engage in moderate to high levels of physical activity. Therefore, the individual intake is adjusted according to the body mass or composition of the person and their nutritional needs in connection with physical activity [6]. To follow a healthy and planet-friendly diet, it is recommended to shift towards consumption of more plant-based foods and fewer animal-based foods [6,7]. This is similar to the diet of our ancestors, who consumed more plant-based foods in times of greater abundance and practised lifestyles with more daily physical activity [124–126]. The planetary diet emphasises a significantly higher consumption of whole grains, legumes, vegetables, potatoes, fruit, nuts, and seeds. Reducing the intake of red and processed meat, dairy, eggs, unhealthy oils/fats (trans and saturated), refined grains, and added or free sugars is also crucial [6,117]. Free sugars are defined as all monosaccharides and disaccharides added to foods and beverages by manufacturers, cooks, or consumers, as well as sugars naturally present in honey, syrups, unsweetened fruit juices, and fruit juice concentrate [127]. Such a dietary pattern has been shown to have a favourable impact on reducing the risk of NCDs and contributes to a healthier environment [78,95,96,105,128–131]. The most significant gains in life expectancy can be achieved by shifting from a typical Western diet to the planetary diet [131,132]. One food recommendation in SNG2025 that differs from the EAT-Lancet Commission is a higher intake of potatoes, with the reasons presented in the chapter on potatoes (see Section 2.2.).

Due to health and environmental concerns, there is a growing need to decrease the intake of animal-based foods in Slovenia [6,24], a measure already implemented by numerous other countries (see Section 1.1.). The quantity and types of animal products that are both healthy and environmentally sustainable vary according to each nation's specific circumstances and health priorities. The transition towards greater consumption of plant-based foods may evolve as societies progress, and as health concerns and new technologies make alternative foods more accessible and socially acceptable [6,133].

A planetary diet based on plant foods can be delicious, healthy, affordable, and beneficial without necessarily excluding all animal foods [6,134–138]. Adherence to this pattern is consistent with the Mediterranean diet and other cultural traditions, and it has been associated with better health outcomes in diverse populations [139,140]. However, such an approach represents an important and progressive shift from the dietary guidelines still in use for Slovenia's healthy general adult population based on an omnivorous diet. The SNG2025 are further supplemented with recommendations to follow more plant-based Mediterranean dietary patterns to protect individuals′ health and prevent NCDs [3,15,18,113,117,141]. This change could be significant considering Slovenians′ current average dietary habits [24,142]. While the SNG2025 proposes only a modest shift from the Mediterranean diet, the gap between recommended and actual dietary patterns in Slovenia appears to be widening as trends move in the opposite direction. This underscores the need for more urgent and systemic health policy interventions, as well as greater accessibility and availability of plant-based foods to support adherence to dietary recommendations.

The health status of workers is also crucial for maintaining their productivity, which can, in turn, impact their output per capita [143]. Since many people spend much of their time at work, the workplace can serve as an ideal setting for introducing healthy dietary habits. Employers have a responsibility to support the health of their employees, as it affects productivity and the costs associated with absenteeism, sick leave, and disability. Obesity, along with other risk factors for common chronic diseases and a weakened immune system, can contribute to increased absenteeism [144]. Beyond absenteeism, workplace productivity can also be affected by **presenteeism**, a phenomenon in which employees, regardless of weight status, are physically present at work but experience reduced efficiency due to various health-related factors. **Presenteeism** includes issues such as difficulty concentrating, repeating tasks, working at a slower pace, feeling fatigued, or being unable to complete work effectively [145]. While presenteeism can be influenced by a range of health conditions, improving workplace nutrition has been identified as an effective strategy for enhancing employee well-being and productivity. Implementing workplace nutrition programmes that emphasise plant-based meals has demonstrated positive health outcomes, including reduced body mass, decreased depression and anxiety, improved cardiovascular health, higher employee morale, and an overall better quality of life [53,111,144,146–149]. Introducing nutritious meals based on whole food groups instead of energy-dense, nutrient-depleted options high in trans and saturated fats, salt and sugar has been shown to improve body mass, blood biomarkers, self-efficacy, and reduce risky health behaviours [143]. Moreover, integrating improved dietary options, physical activity programmes, and health education within the workplace can increase productivity and workability, especially in sedentary occupations. This creates a healthier work environment and contributes to overall well-being at work [149,150]. Employer-based wellness programmes have also been shown to improve employee health and reduce healthcare costs [111,151–153]. Therefore, employers are encouraged to actively implement the proposed dietary pattern and to use the provided working materials to support healthier and more nutritious meals in workplace settings. Moreover, policymakers are urged to promote corporate responsibility by ensuring that multinational corporations prioritise public health alongside profits. Currently, some corporations pose a significant threat to public health due to their exclusive focus on profit-driven motives [154].

As with any dietary recommendations, achieving complete nutritional adequacy for the entire population through the planetary diet is not possible or feasible. Therefore, the focus is on promoting the consumption of more (not necessarily exclusive) plant-based whole foods to bridge the current nutritional gaps and improve the population's health and the unsustainable food system. The SNG2025 promote a healthy diet for the Slovenian population, recommending the daily consumption of a variety of nourishing foods, including vegetables, fruit, whole grains, nuts, seeds, and protein-rich foods, with a preference for plant-based protein sources such as legumes. It is essential to limit the intake of UPFs. When such foods are consumed, they should be accompanied by fruit and vegetables to improve nutritional balance. Drinking water or unsweetened tea is recommended as the primary beverage and checking food labels to limit high-added sugar, high-sodium, and high-SFA foods is encouraged. Attention should also be paid to food marketing and overall eating patterns.

Regarding food (in general) or meals, it is important to prioritise quality over quantity, use healthy meal preparation techniques, and consider the appropriate proportions of different food groups. Integrating traditional Slovenian dietary practices into the national guidelines is crucial to ensure their acceptance and practical implementation. Although traditional and modern eating habits continuously evolve, their definitions remain inconsistent [155]. The primary goal should be to promote health based on the strongest scientific evidence. SNG2025 must extend beyond cultural familiarity and be grounded in public health priorities, environmental sustainability, and food system research. Traditional foods and cultural dietary patterns are valuable when they align with health-promoting principles. However, when scientific evidence indicates that dietary changes are necessary to improve health outcomes, guidelines should support these transitions, even if they challenge long-standing, disease-promoting dietary habits [156,157].

In summary, transitioning to a diet that emphasises plant-based foods and reduces animal-based products provides substantial benefits for health and environmental sustainability (Part II). It can decrease the risk of chronic diseases, improve overall well-being, and mitigate environmental damage. Additionally, healthier eating habits can increase productivity and lower healthcare costs, positively impacting the Slovenian economy. However, achieving this transition requires more than just SNG2025; it demands education and supportive policies to successfully shift towards a healthy and sustainable diet.

Chapter 2. Food Groups

2.1. Cereals

DIETARY INTAKE
CEREALS (GRAINS)
WHOLE GRAINS:
- **Seeds:**
  barley, maize, oats, millet, rice, rye, sorghum/durra, teff, wheat and wild rice
- **Pseudo-cereals:**
  amaranth, buckwheat, and quinoa

WHOLEGRAIN PRODUCTS:
- Whole grain:

> 50% of dry matter

REFINED GRAINS:
- White rice, white flour

'SOURCE OF'
- Protein
- Vitamins: B1(thiamine), B2 (riboflavin), B3 (niacin), B5 (pantothenic acid), B6 (pyridoxine), B7 (biotin) and B9 (folate)
- Minerals: calcium, iron, zinc, magnesium, phosphorus

'HIGH IN'
- Dietary fibre

HEALTH AND ENVIRONMENTAL EFFECTS

Beneficial health effects
Whole grain consumption lowers the risks of obesity, T2D, CVD, colorectal cancer, and all-cause mortality.

There is less evidence for refined grains. Available evidence does not indicate similar beneficial associations as for whole grains.

Adverse health effects
No adverse effects were found from high intakes of whole grains.

Environmental impacts
Compared to animal-based food, cereals for direct human consumption have a lower environmental impact. Slovenian cereals have a low land footprint due to high efficiency and yield. However, cereals can cause adverse environmental impacts related to fertiliser and pesticide use, and imported cereals in particular can require high water use. Most cereals in Slovenia, produced and imported, are used for animal feed, which is an unsustainable use of cereals.

Science advice and helpful tips
It is recommended that at least 230 g of whole grains per day (dry mass) be included in flavourful dishes or meals and distributed across at least three meals. Intact whole grains and wholegrain products (buckwheat, millet porridge, oatmeal, rye bread, wholegrain cereals and wholegrain pasta) should be prioritised over refined products (white-flour products, flaked and puffed grains, polished white rice), as processing reduces the nutritional value and increases the glycaemic index. Refined products should not form part of dietary patterns that include red and processed meat, sugar-sweetened beverages, French fries, high-fat dairy products and/or indulgent grain-based foods (brownies, cookies, croissants, fritters, doughnuts, sweet rolls, muffins, coffee cakes, and pizza) which are high in added saturated and trans fats, as well as added sugar, while low in fibre and nutrient density.

Dietary sources. Cereals (grains) comprise seeds from the grass family: barley, maize, millet, oats, teff rice, rye, sorghum/durra, wheat, and wild rice and 'pseudo-cereals' (non-grass plants with seeds consumed like cereals, all gluten free): amaranth, buckwheat, and quinoa [158,159]. Cereals include whole grains and refined grains. Whole grains are intact or processed grains that contain endosperm, germ, and bran in the same proportion as intact grains [160]. In wholegrain products, more than half of the dry mass comes from whole grains [161]. Refined grains (white rice, white flour) contain only the starchy endosperm, while the nutrient-rich bran and germ have been removed [13].

Dietary composition: Cereals (grains) are 'sources of' protein, vitamins (B1 (thiamine), B2 (riboflavin), B3 (niacin), B5 (pantothenic acid), B6 (pyridoxine), B7 (biotin) and B9 (folate)) and minerals (calcium, iron, magnesium, phosphorus and zinc) and 'high in' dietary fibre [162–168]. Cereals contain an average of 11 to 15 grams of protein per 100 grams of dry mass [165,169].

Dietary intake. The average intake of total grains (refined and whole grains, such as bread, pasta, rice, and breakfast cereals) in Slovenian adults is 307 g per day for men and 239 g per day for women [24].

Health effects. Several SRs and/or meta-analyses are available on the role of cereals (grains) and health outcomes [128,170–183]. There is a dose-response association between high intakes of whole grains and lower risk of CVDs, T2D [171,178,179], colorectal [175,183] and breast cancer as well as all-cause mortality [128,184]. In prospective cohort studies, every 10 g increase in whole grain intake per day was associated with a 4% reduction in the risk of CVD mortality [173]. In two large prospective cohort studies in US men and women (the Nurses' Health Study and the Health Professionals Follow-Up Study), each serving (28 g per day) of whole grain intake was associated with a 9% lower CVD mortality or a 5% lower total mortality [185].

Higher intake of whole grains is also associated with lower body mass [128], reduced risk of CVD, T2D, coronary heart disease, total cancer and mortality from all causes (respiratory and infectious diseases, and all non-cardiovascular, non-cancer causes), [171] as well as lower risks for site-specific cancers (colorectal, colon, gastric, pancreatic and oesophageal) [179] and for total cancer mortality. Intake of 15–90 g of whole grains per day is associated with a 3–20% lower risk for total cancer mortality [175]. In several studies, the benefits of whole-grain consumption are most apparent with a consumption of 60–90 g per day. In contrast, the relationship between refined grain intake and cancer risk is inconclusive [175,186].

Refined grain intake is often assumed to be associated with adverse health outcomes, including increased risk for CVD, T2D, and obesity. Such results are largely based on studies that examined dietary patterns, not separate food groups (Western dietary pattern with red and processed meat, sugar-sweetened beverages and foods, French fries, high-fat dairy products and refined grains) and/or studies where refined grains also included indulgent grain-based foods (cookies, brownies, doughnuts, sweet rolls, scones, croissants, fritters, muffins, coffee cakes, and pizza) that are high in saturated and trans fats and sugar, while low in fibre and nutrient density. From such studies, it is not possible to determine the separate contributions of staple grain-based foods (such as bread, cereals, and pasta) compared with indulgent grain-based foods to obesity [180,186]. When evaluated as a distinct food category, 11 meta-analyses of prospective cohort studies show that intakes of up to 180–210 g of refined grains per day is not associated with a higher risk of cancer, CHD, CVD, hypertension, T2D, stroke, weight gain, or all-cause mortality [186,187].

Consumption of up to 50% of all grain-based foods as refined-grain foods without high levels of added saturated/trans fats, added sugar, or sodium is not associated with increased disease risk. Eating more whole-grain foods remains an important health recommendation, ideally reducing the consumption of refined grains to < 50% of total grain intake [187].

Environmental impacts. Compared with animal-based food items, cereals for direct human consumption have low environmental impacts. GHG emissions in high-yield cereal production regions are low per unit of output. For example, 1 kg of main cereal products (wheat, rye, barley, and maize) emit only 0.7 kg of CO_2-eq [188–190]. However, rice's GHG emissions can be much higher due to high methane emissions from flooded rice systems (the global mean is 4.5 kg of CO_2eq/1kg) [189]. At the same time, this applies only if cereals are not produced on drained peatlands, as otherwise the climate impact is significantly higher. Emissions related to transport due to cereal imports (Slovenia imports around 100,000 tonnes of cereals per year, depending on the climatic conditions) are presumed to be low, as most of them are imported from neighbouring countries. Other environmental impacts can vary depending on the intensity and efficiency of production. Slovenia has high cereal productivity and mainly imports them from neighbouring countries with similarly high efficiency, meaning that they require less space than other countries globally (for example, the Slovenian wheat yield is 5.8 t/ha, compared to 3.5 t/ha globally). Therefore, cereals are also efficient in terms of land use, which in turn means they contribute relatively little to deforestation or other land conversion. Cereal production can be associated with large-scale monocultures with huge field sizes, low presence of natural features, reduced biodiversity, and potentially higher negative impacts on soil health [189]. Most cereals produced in Slovenia are grown on smaller fields, as nearly half of the arable land is on farms smaller than 10 hectares [191]. Therefore, the negative environmental impacts of cereals in Slovenia are particularly related to high fertiliser and pesticide use, as well as intensive monocultures with simplified crop rotations. These negative impacts could, however, be lowered through the increased cultivation of organic cereals, which have lower impacts on soil quality, biodiversity and water quality, mostly due to lower erosion and pesticide leaching [192,193]. Imported cereals also potentially require high amounts of water for irrigation. However, most cereals produced in Slovenia are not used directly for human consumption, as around 70% of cereals (mainly maize) are used for animal feed [194]. Such indirect use of cereals is inefficient in environmental terms, as due to feed conversion, many of the nutrients and energy that could have been provided directly to humans are lost in the conversion.

Risk groups. Individuals with celiac disease and non-celiac gluten sensitivity [195] are at risk of low cereal intake. To meet their energy and nutrient needs, they should consult a physician and/or dietitian before consuming certified gluten-free cereals (amaranth, buckwheat, maize, millet, oats, quinoa, rice, sorghum, and teff).

Science advice:

Based on health outcomes: It is recommended to consume various whole grains (including whole grains in products) [6], while reducing the consumption of refined grains. Refined grains should be prepared without high levels of added fat, sugar, or sodium, and should make up <50% of all grain consumption [187].

Based on environmental impacts: Cereals (except flooded rice) have overall low climate impacts and are vital in a more sustainable and climate-friendly diet. However, depending on the intensity of production (in terms of inputs and outputs), cereal production can also be associated with the loss of biodiversity and soil health. Choosing cereals produced in organic systems can increase the overall sustainability of cereal production.

Overall science advice: It is recommended to consume at least 230 g per day of whole grains (dry weight), which, corresponds to approximately 600 g when cooked.

2.2. Potatoes and Other Starchy Tubers

DIETARY INTAKE

- White potato
- Sweet potato
- Jerusalem artichoke
- Yam
- Cassava

'SOURCE OF'

- Vitamin: vitamin C
- Mineral: potassium

'HIGH IN'

- Dietary fibre (resistant starch and inulin in Jerusalem artichoke)

HEALTH AND ENVIRONMENTAL EFFECTS

Beneficial health effects
Lowers the risk of chronic diseases such as obesity, T2D, CVDs and cancer.

Adverse health effects
Intake of deep-fried potatoes (French fries), but not boiled potatoes, is associated with hypertension.
Intake of deep-fried potatoes (French fries) with added butter or margarine is associated with an increased risk of obesity, T2D, CVDs and cancer.

Environmental impacts
Potatoes and other tubers have low environmental impacts. Negative impacts of Slovenian potato consumption relate to pesticide, fungicide, fertiliser use, and imports from regions with high water stress.

Science advice and helpful tips
Potatoes can be part of a healthy and environmentally friendly diet. Consuming up to 200 g of potatoes or starchy vegetables daily is recommended, boiled and/or baked with added spices (rosemary, garlic, onion and/or lemon), without added saturated and trans fats or with a small amount of vegetable oil and iodised salt. Intake of crisps, deep-fried potatoes, and potatoes with added butter, lard (crackling) or margarine should be limited.

Dietary sources. Potatoes have long been consumed as a carbohydrate-rich staple food in Slovenia and in many other cultures for centuries. Today, they are among the most widely consumed foods globally, second to grains (rice, wheat, and maize) [196]. In addition to the typical white potato (*Solanum tuberosum*), smaller amounts of sweet potatoes (*Ipomoea batatas*), Jerusalem artichoke (*Helianthus tuberosus*), yam (*Dioscorea spp.*) and cassava (*Manihot esculenta*) are used [197–199]. Potatoes are not included in the vegetable food group due to their high starch content [13].

Dietary composition. Potatoes are a 'source of' vitamin C and mineral potassium. Within this group Jerusalen artichoke is 'high in' dietary fibre [162,163,165–167,200]. However, they also contain proteins, complex carbohydrates, and polyphenols (phenolics and carotenoids) [165,199,201].

Dietary intake. The average total intake of potatoes (mostly *Solanum tuberosum*) in the Slovenian adult population ranges from 76 to 99 g per day in men and women. Potatoes are often consumed in processed forms with added fat and salt, such as French fries and mashed potatoes [24].

Health effects. Several SRs are available on the role of potatoes and health outcomes [177,202–205]. Cohort studies on potato consumption did not always report on the cooking methods (boiled, fried, mashed, roasted, and baked), which could confound associations between potato intake and health outcomes. Moderate intake of potatoes (fried or non-fried) is not associated with an increased risk of obesity, T2D, CHD, CVD, hypertension, stroke, cancer or all-cause mortality [202–208]. The association between potato intake and decreased CVD mortality was found among Japanese women [209] and three counties in Norway [210]. There is no association between each 100 g per day increase in potato intake and the risk of all-cause and cancer mortality [202]. Intake of non-fried potatoes is associated with better diet quality compared to refined grains, preventing T2D without adversely affecting cardiometabolic risk [211,212]. Potatoes provide slightly higher nutritional value than refined grains, but studies show that substituting them for whole grains and a variety of vegetables is associated with a reduced risk of developing type 2 diabetes. In contrast, replacing potatoes with protein sources like poultry or red meat may increase this risk [212]. Intake of non-fried potatoes up to 150 g daily results in higher diet quality, primarily due to potassium and fibre intake, without adverse health effects [205,211]. French fries may be associated with increased risks of obesity and T2D [203], as well as with an increased mortality risk if consumed 2–3 times per week or more [203]. In addition, sweet potatoes, including sweet potato leaves and yams, are excellent sources of various nutrients essential for normal body function and the prevention of some chronic diseases, particularly cancer [201,213,214].

Environmental impacts

Like many other plant-based food items, potatoes and other tubers have low environmental impacts. They produce only 0.1–0.3 kg of CO_2eq/kg and have a low land-use footprint, low use of pesticides and fertilisers, and low water demands [188,189,215]. Moreover, potatoes can be stored for extended periods and grown in most parts of Slovenia, making them easily accessible. Slovenian tuber consumption's negative environmental impacts relate mainly to fungicide use and the higher likelihood of potatoes accumulating pesticide residues compared to other plant-based foods [216]. Additionally, potato consumption can impact water resources globally, especially as Slovenia has to import over half of the potatoes consumed [217].

More than half (55%) of the imported potatoes come from regions with high water stress, such as Cyprus, Egypt, Israel, Italy, and Spain [218] which can impact water resources and ecosystems in other countries.

Risk groups. No risk groups were identified [13].

Science advice:

Based on health outcomes: Potatoes comprise a common staple food in Slovenia. It is recommended to consume moderate amounts of potatoes (up to 200 g of potatoes per day) prepared in a healthy way [6]. Consumption of non-fried potatoes results in higher diet quality, primarily due to potassium and fibre intake, without adverse health effects [205,219]. The intake of crisps, fried potatoes, and potatoes with added butter, lard (crackling), or margarine should be limited. Slovenia implemented a regulation banning the sale of foods with more than 2 g of industrial trans fats per 100 g of fat (see Section 3.2.4. Fat).

Based on environmental impacts: Potatoes and other tubers have a low environmental impact, making them an important part of a more sustainable, plant-based diet.

Overall science advice: Potatoes are a valuable part of the diet from both a health and environmental perspective. Up to 200 g of boiled and/or baked potatoes prepared without added saturated or trans fats, and with only small amounts of oil and iodised salt may be consumed daily. Crisps, fried potatoes, and potatoes with added butter, lard, or margarine should be limited.

2.3. Pulses and Legumes

DIETARY INTAKE
LEGUMES:
- Peanuts (included in the nuts and seeds food group)
- Fresh green beans
- Fresh green peas
- Soybeans
- Pulses (ripened (or dried)):
    - Beans (excluding coffee and cacao beans)
    - Chickpeas
    - Lentils
    - Peas

'SOURCE OF'
- Protein
- N-3 polyunsaturated fatty acids, ALA
- Vitamins: B3 (niacin), B5 (pantothenic acid), B6 (pyridoxine), B9 (folate) and vitamin K)
- Minerals: calcium, iron, magnesium, phosphorous, potassium and zinc

'HIGH IN'
- Dietary fibre

HEALTH AND ENVIRONMENTAL EFFECTS

Beneficial health effects

Decrease risk of obesity, CVD, cancer (breast, colorectal, gastric and lung) and mortality.

Protective effects on established risk factors for T2D and CVD.

Adverse health effects

No adverse effects were found from high intakes of legumes.

Environmental impacts

Pulses have low environmental impacts and low GHG emissions compared with other protein-rich products. While their impacts on water, pesticide, and fertiliser use can vary per location and system, they can benefit soil enrichment through nitrogen fixation.

Science advice and helpful tips

Legumes are amongst the most affordable foods, providing more nutrients per kcal than almost any other food. It is recommended to consume at least 50 g of (dry weight) beans, lentils, and peas daily (equivalent to about 100 g of cooked), and at least 25 g of (dry weight) soy foods [6]. To reduce digestive discomfort, it is advisable to start with small portions, eat slowly, chew thoroughly and drink plenty of water, allowing the gut to adapt to the increased fibre and oligosaccharide content. Soaking legumes overnight and draining water before cooking, cooking with herbs and/or spices (cumin, fennel, turmeric, ginger, seaweed), fermenting, and sprouting can improve digestibility and reduce cooking time [220,221].

Dietary sources. The terms 'legumes' and 'pulses' are often used interchangeably. Legumes is the collective term for plants under the Fabaceae botanical family. This includes fresh green beans, fresh green peas, and soybeans, as well as pulses such as ripened/dried beans, chickpeas, lentils, and peas. Peanuts, although botanically legumes, are included in the nuts and seeds food group [221].

Dietary composition. Legumes are a 'source of' protein (soybeans provide all essential amino acids, which makes soy a valuable protein source, especially for muscle maintenance and growth), n-3 PUFA (ALA), vitamins (B_3 (niacin), B_5 (pantothenic acid), B_6 (pyridoxine), B_9 (folate) and K) and minerals (calcium, iron, magnesium, potassium, phosphorous, zinc; healthy blood and immune function) [162,163,165–167,200]. They are also 'high in' soluble and insoluble fibres [165–168], important for digestive health, healthy blood sugar levels and weight management [222]. Legumes also contain complex carbohydrates and phytonutrients, which support health and well-being. They do not contain gluten. They contain only small amounts of SFA and have a low caloric density and glycaemic index due to their high fibre content [165,223].

Dietary intake. In the adult Slovenian population, the average daily intake of cooked legumes is 12 g for men and 15 g for women [24].

Health effects. Several SRs and/or meta-analyses are relevant for the role of legumes and health outcomes, seven on legumes [224–229] and eight specifically on soy and isoflavones [230–237]. The intake of legumes is associated with a reduced risk of CVD and CHD. An intake of 57 g per day provides the optimal cardiovascular benefit [224]. According to observational studies, low legume consumption does not influence the risk of T2D and CVD. In contrast, meta-analyses of randomised controlled trials (RCTs) suggest a protective effect on risk factors for T2D and CVD (glycaemic markers and blood lipids), which supports recommendations for the prevention of CVD and T2D [225]. In controlled feeding studies, legume consumption has been shown to reduce low-density lipoprotein (LDL) cholesterol and blood pressure [225,238]. In the prospective studies, the highest legume intake was associated with a reduced risk of CVD and CHD (compared with red meat) but not stroke [6,224,239,240]. An MA of cohort studies supports an association between a higher legume intake and a reduced risk of colorectal [228] and prostate cancer [229]. For each 20 g per day increase in legume intake, the risk of prostate cancer was reduced by 3.7% [229]. In an RCT of 121 participants with T2D, incorporation of 1 cup (80 g dry weight) of legumes per day improved glycaemic control and reduced CHD risk [223].

High regular legume intake is one of the most protective dietary factor, associated with lower causes of mortality and stroke [224,226,241]. In a longitudinal study of elderly people across five cohorts, each 20 g per day increase in legume intake reduced the risk of death by 7–8% [224]. In a larger SR of 32 cohorts involving 1,141,793 participants, a 50 g per day increase in legume intake was associated with a 6% reduced risk of all-cause mortality [226].

Regular legume intake is also associated with effective weight management [227,242,243]. An analysis of 21 RCTs showed that consuming 132 g pulses per day (~1 serving per day) resulted in a significant weight reduction of 0.34 kg compared with diets without a dietary pulse intervention. Weight reduction was observed in both weight-loss and weight-maintaining diets [227].

Pulses often contain anti-nutritional compounds such as amylase inhibitors, phytates, and tannins, which can interfere with nutrient absorption in the body but may also have positive health effects when consumed in moderation. Proper preparation methods can help mitigate the effects of these compounds and make pulses more nutritious and digestible. Some ways to reduce or eliminate anti-nutritional compounds in pulses and improve overall nutrient absorption are soaking (in water for several hours/overnight and discarding the soaking water), fermentation, sprouting (germinating), cooking (boiling or pressure cooking), and combining with other foods such as grains and vegetables. Additionally, pulses can be incorporated into various dishes (salads, sprouts, stews, soups, pasta, patties/burgers, spreads, and pastries) [220,221].

Phytic acid (phytates) can reduce the absorption of ispicesron, zinc, and calcium. However, moderate consumption can have health benefits. Phytic acid has antioxidant properties and has been associated with a reduced risk of colon cancer and a lower risk of kidney stone formation due to binding to calcium in the digestive tract [244,245]. Tannins can interfere with protein digestion and reduce the bioavailability of certain minerals. Nonetheless, they also have antioxidant properties and reduce the risk of heart disease and cancer [245,246]. Lectins can interfere with nutrient absorption and cause gastrointestinal discomfort in large amounts. However, they also reduce the risk of colon cancer and support the immune system [245,247]. Saponins can interfere with nutrient absorption but also have anti-inflammatory and cholesterol-lowering effects, contributing to better cardiovascular health [248,249].

Soybeans are a distinct type of legume. Soybeans and soy-based products like tempeh, edamame, tofu, and soy milk are rich sources of various nutrients and phytochemicals, including complete protein, phytoestrogens (particularly isoflavones), calcium and n-3 fatty acids. Studies indicate that regular consumption of soy foods is crucial for reducing the risk of various health conditions, including CVDs, T2D, cancers (ovarian, prostate, breast, colorectal, gastric, lung and endometrial), kidney disease, better cognitive function, healthy weight and improved bone health in women (tofu fortified with calcium) [230,231,233,250–252]. The qSR of an RCT found that incorporating soy protein into the diet, particularly as a replacement for dairy proteins, can help lower total and LDL cholesterol levels, which is beneficial for heart health [237]. Concerns about the hormonal effects of soy have been raised, but extensive research has shown that soy consumption does not significantly alter male or female hormones, fertility, or thyroid function in most individuals. Isoflavones in soy have not been classified as hormone disruptors [235,236,250].

Environmental impacts. Pulses for direct human consumption have low environmental impacts, with low GHG emissions (0.5 to 0.9 kg of CO_2eq/kg of product in highly efficient agriculture) [189,215,253]. Due to their relatively high protein content, they also perform well in terms of environmental impacts when compared to other high-protein food items, such as meat [189]; in particular, soy, peas and chickpeas are often considered among the main plant-based sources of protein in terms of environmental impacts [254,255]. While their impacts on water, pesticide, and fertiliser use can vary per location and system, they benefit the soil by enriching it through nitrogen fixation, which also reduces fertiliser demand [256]. While the general public often expresses concern about consuming genetically modified legumes, particularly as some of the main global GMO crops, such concerns are not supported by scientific evidence. Soy cultivated for direct human consumption in the EU is not genetically modified. The opposite is true for pulses and legumes used as animal feed. Specifically, soybeans produced in Brazil and Argentina are predominantly genetically modified, with GMO soy covering 99% of the total soybean area in Brazil [257]. Most worryingly, soy for animal feed has been one of the main drivers of deforestation of (sub)tropical forests in the past decades, which are important for global carbon storage, water cycling, and biodiversity. Since 2015, Slovenia has imported 100,000 tonnes of soy annually (mostly from Brazil and Argentina) for use as animal feed [258], primarily for poultry (74%), with the remainder being fed to pigs and cattle [259]. Brazilian soy exported to Slovenia is associated with a lower risk of deforestation; however, estimated deforestation exposure varies annually and can still amount to tens of hectares (with much higher rates in the peak years of 2015 and 2018, presenting potentially hundreds of hectares of deforestation related to soy exported to and used in Slovenia) [260].

Risk groups. For individuals with soy allergy, non-soy legumes are recommended and product labels should be read carefully to avoid soy [251,261,262].

Science advice:

Based on health outcomes: Pulses are packed with essential nutrients, including high-quality protein, dietary fibre, B vitamins, minerals such as iron and zinc, and phytonutrients. Regular consumption of pulses may help lower the risk of certain cancers, reduce mortality rates, and support healthy weight management. It is recommended to consume at least 50 g of dry beans, lentils, and peas per day (~100 g of cooked) and at least 25 g of soy foods per day [22]. Soaking, fermentation, and sprouting of pulses improve their digestibility, reduce cooking time, and help reduce anti-nutritional compounds.

Based on environmental impacts: Pulses have a low environmental and climate impact and will play a key role in ensuring a more sustainable diet.

Overall science advice: It is recommended to consume at least 100 g of cooked pulses and 25 g of soy foods per day [22]. Pulses are rich in protein, fibre, iron, and zinc, and when prepared correctly, they can be a healthy and sustainable source of nutrition.

2.4. Fruit

DIETARY INTAKE

- Berries (blackberries, blueberries, cranberries, goji berries, raspberries, strawberries
- Citrus fruits (grapefruit, lemon, lime, mandarins, oranges, pomelo)
- Melons (cantaloupe, honeydew, watermelon)
- Pome fruit (apples, pears)
- Stone fruits (apricots, cherries, nectarines, peaches, plums)
- Tropical and exotic (bananas, kiwifruit, lychees, mangoes and passionfruit)
- Other fruits (figs)
- Excluding fruit juice

'SOURCE OF'

- Vitamins: C, B7 (biotin) and K (notably in blueberries)
- Minerals: calcium

'HIGH IN'

- Dietary fibre

HEALTH AND ENVIRONMENTAL EFFECTS

Beneficial health effects

Increased intake beneficially lowers obesity, T2D, CVD, stroke, coronary heart disease, cancers (especially aerodigestive, breast, colorectal, in the gastric system, lung, and oral) and overall mortality.

Adverse health effects

Available evidence indicates that fresh fruit intake is not associated with significant adverse health effects.

Canned fruit intake is positively associated with CVD and all-cause mortality.

Environmental impacts

Fruit production can be intensive with regard to greenhouse gas emissions. Overall, the environmental impacts of fruit are low, but some production systems may utilise high levels of pesticides and fertilisers. To reduce environmental impacts, the purchase of organic fruit should be encouraged where feasible. Bananas may be associated with recent deforestation. Fruit waste can be reduced by promoting seasonal and locally produced options. However, as Slovenia imports more than 70% of its fruit, achieving this remains challenging.

Science advice and helpful tips

It is recommended to consume at least 200 g of fruit per day (range 100–300 g). A variety of fruits, including berries, should be consumed, preferably fresh or thawed. Intake of products prepared with free or added sugars (e.g., canned fruits) should be limited. Fruit juice does not count towards the recommended daily fruit intake due to its low fibre content and high sugar concentration.

Dietary sources. Fruit can be grouped into several subcategories: berries (blackberries, blueberries, cranberries, goji berries, raspberries, strawberries), citrus fruits (grapefruit, lemon, lime, mandarins, oranges, pomelo), melons (cantaloupe, honeydew, watermelon), pome fruits (apples, pears), stone fruits (apricots, cherries, nectarines, peaches, plums), tropical and exotic fruits (bananas, kiwifruit, lychees, mangoes and passionfruit), other fruits (figs). Some fruits, such as apricots, dates, figs, and raisins, are also consumed in dried form. Fruit juices derived from fruits and berries constitute a separate food group [184].

Dietary composition. Fruits are a 'source of' vitamin C and B7 (biotin), K (blueberries) and calcium (dry figs) and are 'high in' dietary fibre [162–168]. Most fruits contain a high percentage of water, which helps hydrate the body. Fruits also contain numerous other nutrients, such as simple carbohydrates and polyphenols [165,263].

Dietary intake. The average total intake of fruits (fresh, canned and dry) in Slovenian adults ranges from 162 g per day for men to 226 g per day for women, with fresh fruits accounting for 141 g per day for men and 198 g per day for women [24].

Health effects. Six qSRs are available on the role of fruits and health outcomes [170,264–268] and eight on the role of vegetables and fruits combined and health outcomes [268–275].

Fruits have potential health-promoting effects beyond providing basic nutrients, such as reducing inflammation and preventive effects on chronic diseases. Data from the SR and mostly observational studies support the intake of certain fruits, particularly citrus fruits and dark-coloured berries, which have superior effects on biomarkers, surrogate endpoints, and outcomes of chronic diseases [272]. The qSR from WCRF/AICR [272] found strong (probable) evidence for higher consumption of fruit with a lower risk of aerodigestive cancers (malignancies that develop in the tissues lining the respiratory and upper digestive tracts, such as the mouth, throat, voice box, and oesophagus). Numerous qSRs on dietary patterns in which fruits are a major component demonstrate beneficial health effects, including lower risk of CVD breast and colorectal cancer [276] and favourable body mass outcomes [13,170,265,277]. Furthermore, whole, fresh fruit does not contribute to obesity and may have a place in the prevention and management of excess adiposity [13].

An umbrella review of fruit consumption and multiple health outcomes suggests that each additional daily serving of fruit may decrease the risks of CVD, stroke, coronary heart disease and oral cancer (moderate-quality evidence). In addition, an increase of 200 g of fruit intake per day is associated with a lower risk of breast cancer [264]. **The MA of RCTs shows that** increasing the intake of fresh and dried fruit reduces the fasting blood glucose concentration [268]. The MA of cohort studies found a weak inverse association between the intake of apples, blueberries, grapefruit, grapes, pears, and raisins, and T2D risk [271]. With a fruit intake of 100–500 g per day, the risk of T2D could be reduced by 8–12% (moderate-quality evidence) [264]. Furthermore, the qSR and MA show that increased berry intake, especially freeze-dried strawberries, improves metabolic syndrome risk factors and reduces the risk of CVD [266,267]. In a MA of prospective studies, fruit intake (especially apples, pears, and citrus fruits) is associated with reduced risk of CVD and all-cause mortality [273,275], as well as total cancer risk [273]. Also relevant to the intake of fruits is the evidence that consuming foods containing dietary fibre is likely to lower all-cause mortality, CHD, and colorectal cancer [184]. Consuming seasonal, local, and organically grown fruit is an element of sustainable nutrition [278–280]. In an SR of MA of the global burden of diseases, intakes of canned fruit were positively associated with all-cause and CVD mortality [274]. Research shows that daily prune consumption of 50–100 g can improve or preserve bone mineral density, particularly in postmenopausal women [281].

Environmental impacts. In general, fruits and berries have lower climate and other environmental impacts compared to some other food items (particularly animal-based), as greenhouse gas emissions for different fruit types range from 0.1 to 0.4 kg of CO_2eq/kg of fruit [215,253,274,282]. Fruit consumption and production can also have synergies with carbon sequestration, as fruit orchards capture and store carbon and can, therefore, also contribute to climate change mitigation [283,284]. Fruit grown in intensive systems can have higher impacts related to pesticide use. Slovenia has nearly halved the use of pesticides (mostly fungicides) since 1992 and has, compared to other EU countries, among the lowest application rates of pesticides per hectare [285]. Nevertheless, the application rates of plant pharmaceuticals vary depending on the type of cropland, with the highest levels applied to permanent crops. For instance, in Slovenia, around 28 kg of plant pharmaceuticals are applied per hectare of apple orchards [286]. Slovenia imports 70% of the fruit consumed, mostly from neighbouring countries [287], some of which have considerably higher pesticide application rates. Slovenia most frequently imports bananas, citrus fruits (oranges, lemons, mandarins), and apples. These fruits either do not grow well in Slovenia's climate or are not produced in sufficient quantities domestically. Neighbouring Italy, from which Slovenia imports over 2,500 tonnes of apples annually, has among the highest pesticide application rates in the EU. In the region of South Tyrol, one of the major apple production regions of Europe, reportedly, over 30 kg of pesticides are applied per hectare [288]. However, most of the pesticides used in Slovenia are applied to permanent crops, including orchards [285]. Many of the imported fruits need to be irrigated or grown in greenhouses due to being grown in less humid environments, meaning they can have a higher carbon and water footprint than domestic fruit; this is particularly valid for strawberries, citrus and temperate fruits imported from other Mediterranean countries like Italy, France, Greece and Spain [289]. Greenhouse gas emissions of fruit imported from such countries can also be higher due to emissions related to irrigation [289]. Some contexts, such as strawberry production in greenhouses in southern Spain, have also recently emerged as potentially being produced through farm worker exploitation [290], a trend also observed in many other parts of Europe from which Slovenia imports fruit outside the traditional seasons [291]. Moreover, emissions of fruit produced in passive (unheated) and heated greenhouses can be 2 to 6 times higher compared to field-grown fruit [215,253,292]. In addition, tropical fruits, such as bananas, can be associated with environmental degradation due to forest clearing, high pesticide use, and human rights issues [293]. When it comes to land use change, bananas produce virtually no greenhouse gas emissions [189]. From an environmental and social perspective, consuming seasonal fruit and fruit with a longer shelf life, as well as fruit produced in nearby regions, makes the most sense, as otherwise there is a danger of degradation of water and biodiversity in distant places, as well as higher shares of fruit waste.

Risk groups. Patients needing glycaemic control should not restrict their fruit intake [268,294]. Individuals with specific allergies or sensitivities within the food group (citrus fruits, strawberries) should choose alternative fruits.

Science advice:

Based on health outcomes: It is recommended to consume 200 g of fruits per day (range 100–300 g) [6] distributed across two to three distinct meals. Fruit juice does not count towards the recommended daily fruit intake.

Based on environmental impacts: From an environmental perspective, consuming seasonal fruits with longer shelf life and those produced in nearby regions makes the most sense. While fruits and berries have lower environmental impacts, reducing their potential negative impacts on water use and pesticides can be achieved through seasonal and diverse fruit consumption.

Overall science advice: It is recommended to consume 200 g of fruits per day (range 100–300 g).

2.5. Vegetables

DIETARY INTAKE

NON-STARCHY VEGETABLES
(excluding potatoes and pulses):
- Allium vegetables: garlic, leeks, onions
- Yellow/orange/red vegetables: beets, carrots, parsnips, swedes, turnips
- Cruciferous vegetables:
  - Dark green leafy varieties: arugula (rocket), bok choy, collard greens, kale, mustard greens, turnip greens, watercress
  - Other varieties: broccoli, Brussels sprouts, cabbage, cauliflower, horseradish, kohlrabi, radish, rutabaga, turnips
- Green leafy (non-cruciferous) vegetables: beet greens, lettuce, spinach, Swiss chard
- Mushrooms (fungi, not plants)

'SOURCE OF'
- Proteins and n-3 polyunsaturated fatty acids (ALA) in green leafy vegetables such as spinach and arugula (rocket), and in brassica vegetables such as broccoli
- Vitamins: β-carotene*, vitamin C and vitamin K
- Mineral: calcium in cabbage and iron in spinach and carrot

'HIGH IN'
- Dietary fibre
- Added salt (pickled or canned vegetables)

HEALTH AND ENVIRONMENTAL EFFECTS

Beneficial health effects

(especially green leafy, cruciferous, and green-yellow vegetables and salads).

Increased intake effects beneficially on lowering CVD, cancers (especially aerodigestive, breast, colorectal, oesophageal, renal, and non-Hodgkin lymphoma), obesity and all-cause mortality.

Adverse health effects

Available evidence indicates no significant adverse health effects with fresh vegetable intake. However, high salted, pickled, or canned vegetable intake is associated with adverse health effects (CVD, stomach cancer, etc.).

Environmental impacts

Vegetables have low environmental impacts, with low emissions and land use footprints, particularly if grown on fields and organic cultivation.

Potential negative impacts are mainly related to energy-intensive systems such as greenhouses and irrigation water of vegetables imported from less humid regions.

Science advice and helpful tips
It is recommended to consume at least 300 g of vegetables per day, including green leafy vegetables, cruciferous vegetables, and green-yellow vegetables.

* The vitamin A content of foods is expressed as retinol equivalents (RE). Conversion factors are as follows: 1 mg RE = 1 mg of retinol = 6 mg of total-trans-β-carotene = 12 mg of other provitamin A carotenoids = 1.15 mg of total-trans-retinyl acetate = 1.83 mg of total-trans-β-retinyl palmitate; 1 IU = 0.3 µg retinol [166,167].

Dietary sources: Non-starchy vegetables include allium vegetables (garlic, leeks and onions), yellow/orange/red vegetables (beets, carrots, parsnips, swedes and turnips), cruciferous vegetables (dark-green leafy varieties: arugula, bok choy, collard greens, kale, mustard greens, turnip greens and watercress; and the other varieties like broccoli, Brussels sprouts, cabbage, cauliflower, horseradish, kohlrabi, radish, rutabaga and turnips) and green leafy (non-cruciferous) vegetables (, beet greens, lettuce, spinach and Swiss chard. Potatoes and pulses are not included as non-starchy vegetables. Mushrooms are fungi, not plants, although they are commonly treated as vegetables in cooking [184].

Dietary composition: Vegetables (green leafy vegetables: spinach and arugula and brassica vegetables: broccoli) are a 'source of' proteins and n-3 polyunsaturated fatty acids (ALA). Vegetables are also 'sources of' vitamins β-carotene, C and K, and minerals calcium (cabbage) and iron (spinach and carrot). Vegetables are 'high in' dietary fibre. Pickled vegetables are 'high in' added salt [162–168]. Most vegetables contain a high percentage of water, which helps hydrate the body. Vegetables also contain carbohydrates, bioactive compounds, or phytochemicals. Cruciferous vegetables (broccoli, brussels sprouts, cabbage, cauliflower, kale, and turnips) and green leafy vegetables (arugula and spinach) are important sources of calcium [165,295]. Additionally, certain mushrooms are 'high in' dietary fibre (porcini and button mushrooms) and are a 'source of' vitamins (D: porcini); B3 (niacin: shiitake and button mushrooms; B5 (pantothenic acid: porcini, shiitake, and button mushrooms) and minerals: iodine (button mushrooms) and selenium (porcini and real bolete). However, pickled button mushrooms can be high in sodium [165].

Dietary intake. The average total intake of vegetables (fresh and preserved/canned) in Slovenian adults ranges from 157 to 163 g per day in men and women, out of which fresh vegetables account for 121 g and 129 g for men and women [24].

Health effects. Two qSRs are available on the role of vegetables and health outcomes [296,297] and several on the role of vegetables and fruits combined and health outcomes [184,269–275]. Vegetables have potential health-promoting effects beyond basic nutrient needs, such as reducing inflammation and preventive effects on several chronic diseases. Evidence suggests that vegetables have the most potent impact on preventing CVDs. Data from the SRs and mostly observational studies support the intake of certain vegetables, particularly cruciferous vegetables and dark-green leafy vegetables, which have superior effects on preventing chronic diseases [272]. Several SRs demonstrate beneficial health effects of consuming vegetables, including lower risk of CVD [272], breast and colorectal cancer [276] and favourable body mass outcomes [13,277]. SR and dose-response MA of prospective cohort studies show that a higher intake of vegetables is associated with a reduced risk of all-cause mortality, particularly cardiovascular mortality [273,275] and cancer [273]. Furthermore, the SR from WCRF/AICR reports strong (probable) evidence for a lower risk of cancers of the respiratory and digestive tract with a higher intake of vegetables [184]. The meta-regression shows the protective effects of the consumption of vegetables for ischemic stroke, ischemic heart disease, haemorrhagic stroke and oesophageal cancer [296]. A MA of cohort studies shows both inverse and positive associations between intake of several vegetable subtypes and T2D [271]. In an SR and MA of the global burden of diseases attributable to low vegetable intakes, the highest linear dose response for each 100 g per day increase in vegetable intakes was 0.88 for renal cell cancer and 0.89 for non-Hodgkin lymphoma. Nonlinear dose responses for the first 100 g per day of vegetable intake were 0.86 for CHD and 0.87 for all-cause mortality. In an SR and MA of the global burden of diseases attributable to low vegetable intakes, the highest linear dose response for each 100 g per day increase in vegetable intakes was 0.88 for renal cell cancer and 0.89 for non-Hodgkin lymphoma. Nonlinear dose responses for the first 100 g per day of vegetable intake were 0.86 for CHD and 0.87 for all-cause mortality. Increases in protective effects were with the intake of 200 g of vegetables daily. However, only a few additional health benefits were seen at intakes beyond 300 g of vegetables per day. Intake of pickled vegetables was positively associated with stomach cancer [274]. An umbrella review that included 41 MA of 303 studies shows associations between higher cruciferous vegetable intake and lower risk of gastric, lung and endometrial cancer, and all-cause mortality (suggestive evidence), as well as lower risk of bladder cancer, breast cancer, colorectal adenoma, colon cancer, colorectal neoplasm, endometrial cancer, ovarian cancer, non-Hodgkin lymphoma, lung cancer, prostate cancer, renal cell carcinoma, and total cancer (weak evidence) [297]. An SR and dose-response and MA of prospective studies show inverse associations between the intake of green leafy vegetables, cruciferous vegetables, and salads and CVD and all-cause mortality and between the intake of green-yellow vegetables and cruciferous vegetables and total cancer risk. Reductions in risk were observed up to 800 g per day for all outcomes except cancer (600 g per day) [273].

Environmental impacts. Vegetables, particularly those grown on fields, such as root vegetables, brassicas, onions, and leeks, have low environmental impacts, particularly in terms of greenhouse gas emissions and water use. However, like fruit, a large share (56%) of vegetables consumed in Slovenia are imported, often from countries with more intensive vegetable production systems, such as Italy, Spain and the Netherlands [298]. Some vegetables can have considerably higher GHG emissions and other environmental impacts, such as higher water demands, due to their production location. Fragile vegetables, such as lettuce and other salads, may require refrigeration during significant parts of their life cycle. Those produced in protected conditions, such as cucumbers, eggplants, and tomatoes grown in potentially heated greenhouses, can be grown in energy-intensive systems, making them more GHG-intensive [253,299]. Compared to field-grown vegetables, those grown in passive greenhouses (without heating) have twice as high emissions, while those in heated greenhouses have more than six times higher on average [253,292]. Nevertheless, even vegetables with the highest emissions have considerably lower emissions than animal-based food items [189,282]. Vegetables imported from areas where they are produced throughout the season, such as from Spain, can also be associated (similar to fruit) with worker exploitation [290]. For environmental reasons, it is, therefore, most important to consume seasonally available and locally produced vegetables as much as possible to reduce negative impacts associated with water use waste.

Risk groups. Individuals with specific allergies or vegetable sensitivity (tomatoes, pumpkin, or cucumber) [300,301] should choose alternative substitutes. Certain vegetables, especially high-oxalate ones like spinach, can increase the risk of kidney stones if consumed in excess. To reduce this risk, include a variety of leafy greens in your diet and use methods like soaking, boiling, or steaming to lower oxalate levels – especially when eating them with calcium-rich foods [245].

Science advice:

Based on health outcomes: It is recommended to consume at least 300 g of various vegetables per day [6], including green leafy vegetables, cruciferous vegetables, and green-yellow vegetables, distributed across three to four meals.

Based on environmental impacts: Vegetables have lower environmental impacts and significantly lower greenhouse gas emissions. The main issues related to vegetables are imports from areas with high amounts of water for irrigation and consumption of unseasonal vegetables with higher refrigeration demands and waste rates. Therefore, we recommend the consumption of seasonal vegetables.

Overall science advice: It is recommended to consume at least 300 g of vegetables per day. Whenever possible, it is best to choose seasonal vegetables.

2.6. Nuts and seeds

DIETARY INTAKE
NUTS AND SEEDS

- Tree nuts: almonds, Brazil nuts, cashew nuts, hazelnuts, pecans, pine nuts, pistachios, macadamias, walnuts
- Peanuts
- Seeds: chia, flax, pumpkin, sesame sunflower

'SOURCE OF'

- Protein
- N-3 polyunsaturated fatty acids, ALA (walnuts (oil), flaxseed, hemp and chia)
- Vitamins: B2 (riboflavin), B3 (niacin), B6 (pyridoxine), B7 (biotin), B9 (folate) (all listed) and vitamin E (hazelnuts, peanuts, pumpkin seed and walnuts)
- Minerals: calcium (almonds and chia seed), potassium, magnesium, phosphorus, iron, zinc (all listed), calcium (hazelnuts, flaxseed, and sesame seed) and selenium (Brazil nut, flaxseed, pumpkin seeds and sesame seed)

'HIGH IN'

- Dietary fibre

HEALTH AND ENVIRONMENTAL EFFECTS

Beneficial health effects

Reduced risk of cardiovascular risk factors and disease, and possibly cancer deaths and all-cause mortality.

Adverse health effects

Anaphylaxis reactions in individuals with nuts or seeds allergies.

Environmental impacts

Nuts and seeds have low greenhouse gas emissions. However, some nuts can have the highest land use footprints of all plant-based sources and can score particularly low regarding high water demands.

Science advice and helpful tips
Based on current intakes, the average consumption of nuts and seeds should be increased to achieve health effects. Individually, consumption of at least 30 g of nuts and seeds per day should be considered a part of a healthy diet.

Dietary sources. Nuts are botanically categorised as tree nuts, peanuts, and seeds. Nuts (almonds, walnuts, hazelnuts, cashews, Brazil nuts, macadamias, and pistachios) are dry fruits with an edible seed and a hard shell. Seeds such as chia, flax, pumpkin, sesame, and sunflower are related food groups [302].

Dietary composition. Nuts and seeds are 'sources of' protein, n-3 polyunsaturated fatty acid ALA (walnuts, flaxseed, hemp and chia), vitamins (B2 (riboflavin), B3 (niacin), B6 (pyridoxine), B7 (biotin), B9 (folate) (in all); and vitamin E (hazelnuts, peanuts, pumpkin seed and walnuts)) and minerals (potassium, magnesium, phosphorus, iron and zinc (in all); calcium (hazelnuts, almonds, flaxseed, chia seed and sesame seed) and selenium (Brazil nut, flaxseed, pumpkin seeds and sesame seed). Nuts and seeds are 'high in' dietary fibre [162–168]. Moreover, nuts and seeds are nutrient-dense and contain monounsaturated fatty acids and a range of active metabolites, such as polyphenols and phytosterols [165,166,302].

Dietary intake. The average daily total intake of nuts and seeds (fresh and processed) in Slovenia is 8 g for adult men and 9 g for adult women [24].

Health effects. SRs have shown an inverse dose-response relationship between nuts and seeds consumption and the risk of CVD (driven mainly by coronary artery disease) [302,303]. Randomised trials suggest mechanistic effects through cardiometabolic biomarkers, including blood lipids and glucose metabolism [302–307]. Further evidence also suggests a moderate association between nut consumption and lower all-cause mortality, cancer, respiratory disease and infectious disease mortality, cognitive decline and depression [302]. Despite high energy density, nut consumption does not seem to increase the risk of weight gain [308].

Environmental impacts. Nuts and seeds present a diverse food group with diverse environmental impacts. Tree nuts have low greenhouse gas emissions (0.4 kg of CO_2eq/kg), with high potentials for carbon sequestration (and potentially net negative emissions per product in some contexts) [189,282]. Nevertheless, due to relatively low yields, the land use footprint is high for tree nuts compared to other plant-based food items (albeit still considerably lower compared to animal-based products), meaning more space is necessary to produce tree nuts [189]. Tree nuts, such as cashew nuts, almonds, and pistachios, have particularly high water demands, with water needed to produce one kilogram of nuts higher than most animal-based sources. This is particularly problematic, as 63% of tree nuts are produced in areas with severe water stress [309]. Consuming local and traditional tree nuts, such as walnuts and hazelnuts, is therefore recommended, especially as these trees are part of many Slovenian cultural landscapes. Ground nuts can have eight times higher GHG emissions compared to tree nuts [189]; they take up 30% less land and have

56% lower water demands [189]. Due to the high water demands of some nuts, their sustainability compared to other plant-based items is lower, especially when considering climate change impacts on water availability in the future [310,311]. Slovenia has a high potential for consumption of seeds, such as flax, sunflower, and pumpkin seeds, as these crops have traditionally been cultivated in Slovenia.

Risk groups. Individuals with allergies to nuts and seeds (prevalence 1–2%) [302,312]. In addition, individuals with allergies or sensitivity to nuts and seeds, such as peanuts, walnuts, and sesame seeds [302,312,313], should choose alternative nuts and seeds they can safely consume.

Science advice:
Based on health outcomes: It is recommended to consume 30 g of nuts and seeds per day, including different tree nuts, peanuts, and seeds.

Based on environmental impacts: Nuts have lower greenhouse gas emissions than animal-based foods and low land demands. However, many tree nuts are primarily grown in water-scarce regions and require significant water. As a result, nuts imported from far away are less sustainable than local walnuts and hazelnuts and seeds from traditional sources, such as flax, sunflower, and pumpkin.

Overall science advice: Consumption of at least 30 g of nuts and seeds per day should be considered part of a healthy diet.

2.7. Fish and seafood

DIETARY INTAKE
FISH AND SEAFOOD:
- Fish: fatty, lean
- Shellfish (shrimp, crabs, and lobster)
- Molluscs (clams, oysters, and mussels)
- Cephalopods (squid and octopus)

'SOURCE OF'
- Protein
- N-3 long-chain polyunsaturated fatty acids (EPA and DHA)
- Vitamins (B12 (cobalamin), D and K (squid))
- Minerals (phosphorus (all listed), iodine (salmon, tuna), calcium, iron, and zinc (all three in sardines)

'HIGH IN'
- Sodium (canned fish)

HEALTH AND ENVIRONMENTAL EFFECTS

Beneficial health effects

Fish and seafood consumption is associated with overall cardiovascular health and protection from cognitive decline in adults.

Adverse health effects

A potential source of harmful environmental contaminants and a high prevalence of allergies (especially to shellfish).

Environmental impacts

Fish and seafood are a diverse group with varying environmental impacts. Farmed fish and shrimp can have high emissions and a significant land and water footprint associated with their feed, while caught fish are associated with negative environmental impacts such as depletion of ocean fish stocks, seabed degradation, and ocean plastic.

Science advice and helpful tips
Consuming 200 g (0–450 g) of fish and seafood per week is recommended as part of a healthy diet. It is advisable to prefer fatty fish, which are high in n-3 long-chain polyunsaturated fatty acids (n-3 LCP), such as docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) (salmon, mackerel, and sardines) while limiting the consumption of larger species high in pollutants, especially mercury (shark, swordfish, and king mackerel).
Prepare fish without added saturated or trans fats or with a minor amount of oil, seasoned with aromatics, herbs, and spices (oregano, rosemary, garlic, onion and/or lemon juice). The best ways to prepare fish, keeping it moist and tender while preserving nutrients, include steaming (in a steamer basket over boiling water, without added fat), poaching (cooking fish in a simmering water/broth) and baking in the oven (in foil/parchment paper). Pair fish with a variety of vegetables and whole grains.

Dietary sources. Seafood includes fish, shellfish (shrimp, crabs, and lobster), molluscs (clams, oysters, and mussels), and cephalopods (squid and octopus). Fish are divided into lean and fatty fish, according to the fat content in the flesh. A cut-off of 4 g per 100 g has been widely used to distinguish fatty (≥ 4 g per 100 g; salmon, tuna, herring, kippers, mackerel, eel, and sardines) from lean fish (< 4 g per 100 g; cod, hake, shellfish, and seabass) [314].

Dietary composition. Fish and other seafood are a 'source of' protein, n-3 LCP (EPA and DHA), vitamins ((B12 (cobalamin) and D (all listed) and K (squid)) and minerals (phosphorus (all listed); iodine (salmon and tuna); calcium, iron and zinc (all three in sardines)). Canned fish are generally 'high in' sodium [162–168].

Dietary intake. The average total intake of fish and fish products (fresh and canned) in Slovenia is 26 g for adult men and 18 g per day for adult women [24].

Health effects. Several SRs have investigated the effects of fish and seafood consumption and health outcomes. Fish consumption is associated with decreased risk of incident CVD (coronary artery disease, myocardial infarction, heart failure and stroke), cardiovascular mortality, and all-cause mortality; fish consumption may be associated with decreased risk of cognitive decline in adults (dementia and Alzheimer's disease) and gastrointestinal cancers [315–319]. Fish and seafood intake during pregnancy may be associated with improved cognitive development in young children [320]. The health effects of fish and seafood are primarily mediated through n-3 LCP, particularly EPA and DHA. However, fish and seafood may also contain contaminants, such as methyl mercury, cadmium, dioxins, and polychlorinated biphenyls (PCBs), which may be harmful already at low to moderate fish consumption. This is especially important for vulnerable populations such as pregnant and lactating women [318,321,322]. In addition, recent studies indicate concern about the high content of microplastic particles in small fish [323]. Nevertheless, current scientific literature indicates that there is insufficient conclusive evidence to generalise the adverse health effects of potential microplastic particles found in small fish. Therefore, consuming small fish, such as sardines and anchovies, as well as shellfish like mussels, remains recommended. These seafood options are often considered more sustainable due to their generally lower levels of contaminant bioconcentration and reduced environmental impact [324]. Hence, while the current body of evidence suggests that the potential health benefits of fish and seafood consumption outweigh the risks [318], caution should be exercised due to contaminants. The evidence for the beneficial effects of fatty vs. non-fatty intake is weaker than total fish intake. Still, the evidence for n-3 LCP impacts on health outcomes suggests that fatty fish intake should be prioritised [318]. For people who do not consume n-3 LCP-rich fish and seafood, other reliable sources of n-3 LCP should be considered [325–328]. However, certain food preparation (frying) may adversely affect health outcomes [329]. Notably, incorporating plant oils or soy into the feed for fish – such as salmon or rainbow trout, a common practice that significantly reduces feed costs – may also decrease their n-3 LCP content [330–332].

Environmental impacts. Environmental impacts vary considerably, depending on the product type and whether it is farmed or caught. Greenhouse gas emissions range from 0.8 kg of CO_2eq/kg for anchovies to 3.3. kg for salmon, 4.2 kg for trout, and 20.25 kg for lobster [215,253], making some items comparable to red meat. Emissions can even decrease in the case of frozen fish [215,253]. Farmed fish can also have large land use and water footprints. Land use of farmed fish ranges from 0.3 to 26.3 m^2 for a kg of fish, and water consumption from 600 to 12000 litres for a kg [189]. Farmed fish, such as salmon, can have negative environmental impacts. They can require large quantities of other fish caught and used for salmon feed. Over 2 million tonnes of wild fish are estimated to be caught yearly in West Africa, which is then provided as feed for Norwegian salmon farms [333]. Such large amounts threaten the food security and livelihoods of over 4 million inhabitants of West Africa, as these fish could otherwise be consumed directly by the local population [333]. In addition, farmed fish can threaten ecosystems and water quality through nutrient discharge and escaped fish [334]. Fish and shrimp farms can also be associated with high antibiotic use. Worldwide, antimicrobials – agents that inhibit the growth of microorganisms, including bacteria (i.e., antibiotics), viruses, fungi, and parasites – are used considerably more intensively in aquaculture (165 mg/kg of treated biomass) than in terrestrial food animal production (140 mg/kg) or patient care (91.7 mg/kg). Excessive use of antibiotics in aquaculture industry leads to the development of antimicrobial resistance, which poses an increasingly significant threat to human health [335]. This can be low even in commercial systems [336]; however, it can include even forbidden antibiotics for some items, such as shrimp, if coming from countries with difficulties enforcing health and environmental standards [337]. Because wild fish stocks are already so heavily exploited, in the last 10 years, aquaculture has provided more fish meat than fishing [338]. The adverse side effect of this is that animal welfare in aquaculture can't be as high as in the wild.

While greenhouse gas emissions and land and water footprints are lower for caught fish, these have other negative impacts. Fish consumption has led to overfishing of many parts of the oceans, depleting fish stocks and leading to the extinction of many marine species [339], leaving only 13% of the oceans intact [340,341]. Overfishing and climate change remain the main threats to ocean ecosystems [342]. Many commercial fishing practices can even impact the ocean floor through seabed trawl fishing [343]. In addition, most plastic in the oceans comes from fishing nets and other remains of the fishing industry, such as buoys, buckets, and bags [344].

Risk groups. Individuals with allergies or sensitivity to fish and seafood [345] should be advised to avoid these foods. Vulnerable populations (pregnant and lactating women) should be cautioned against potential high-level contaminants in fish and seafood (tuna, shark, king mackerel) [320]. Low- or non-consumers are advised to include reliable food 'sources of' iodine (described in the section on iodine), vitamin B12 (cheese, eggs, B12 enriched foods and/or B12 dietary supplements) as well as n-3 long-chain polyunsaturated fatty acids (n-3 LCP: EPA and DHA; microalgal oils) [162,163,165–167,200,318,325,326].

Scientific advice:

Based on health outcomes: Consumption of 200 g (0–450 g) of fish and seafood per week may be considered as part of a healthy diet [6]. Based on health effects, fatty fish and healthy fish preparation should be prioritised, while fish and seafood from polluted areas and/or high in contaminants should be limited, especially during pregnancy and lactation.

Based on environmental impacts: When considering the environmental impacts of seafood, we must exercise caution regarding the origin of the fish, whether it was farmed, and how it was caught. Environmental impacts can vary considerably, and priority should be given to fish from certified sources where degrading fishing or farming practices are not employed.

Overall science advice: Consumption of 200 g (0–450 g) of fish and seafood per week, considering both beneficial health effects as well as health risks due to environmental pollutants as well as environmental impacts, may be considered as part of a healthy diet [6,318]. Fish and seafood sourced from sustainable farms or wild stocks are encouraged, while species with a negative environmental impact should be limited. To ensure sufficient EPA and DHA intake, a more environmentally friendly solution is to supplement the diet proportionally with microalgal oils. These oils are less contaminated than fish and krill oils [325,326].

2.8. Milk and dairy products

DIETARY INTAKE
MILK AND DAIRY PRODUCTS
- Milk
- Fermented (yoghurt)
- Processed (cheese, cream, butter)

'SOURCE OF'
- Protein
- Vitamins: B_2 (riboflavin), B_{12} (cobalamin; cheese)
- Minerals: calcium (all, except cream), phosphorus, selenium and zinc (both in cheese)

'HIGH IN'
- Sodium (cheese)
- SFA (milk and cheese, except for mozzarella)

HEALTH AND ENVIRONMENTAL EFFECTS

Beneficial health effects

Probable inverse association with colorectal cancer.

Adverse health effects

Intake of milk and dairy products may increase the risk of prostate cancer. High intake of full-fat milk or dairy products may contribute to an increased risk of CVD.

Environmental impacts

Milk and dairy products can have considerable environmental impacts, which vary depending on the product type. While milk has lower impacts, processed products such as cheese and yoghurt are among the items with the highest greenhouse gas emissions of all food products. Depending on the production system, milk and dairy can also be problematic regarding animal welfare.

Science advice and helpful tips
A reasonable daily intake may include 250 g (0–500 g) of milk or "milk calcium equivalents"* Fermented dairy products or low-fat milk should be preferred, whereas products with added sugar and/or salt should be limited.

* ″Milk calcium equivalents″ (approximately 300 mg of calcium): To match the calcium content of 250 ml of milk or 250 g of yogurt you can also consume: (i) 250 ml of a calcium-fortified plant-based alternative (e.g. fortified soy drink or soy yogurt), (ii) 50-75 g of soft cheese (e.g. brie, camembert), or (iii) 27-42 g of hard/semi-hard cheese (e.g. Parmesan, ≈ 27 g; cheddar/ aged Tolminc (zorjeni tolminc) ≈ 42 g) [165].

Dietary sources. Milk for human consumption is produced by ruminants and can be consumed as milk (pasteurised) or as dairy products, which are processed (cheese, cream, butter) or fermented (yoghurt) [346]. It is important to note that butter, despite being a dairy product, is classified as a fat or oil due to its unique nutritional composition.

Dietary composition. Milk and dairy products are a ʻsource of′ proteins, vitamins (B2 (riboflavin), B12 (cobalamin; cheese) and minerals (calcium (all, except cream), phosphorus (all listed), selenium and zinc (both two in cheese). However, they are ʻhigh in′ sodium (cheese) and SFA (milk and cheese, except mozzarella) [162–168]. In addition, milk and dairy products also contain simple carbohydrates (lactose). Dairy products may contain various free/added sugars (dairy beverages and sweetened yoghurts) [165].

Dietary intake. The average daily intake of milk and dairy products in Slovenian adult men and women is as follows: a) 80 g and 84 g of milk; b) 35 g and 32 g of cheese; c) 72 g and 95 g of yoghurt and milk cream [24]. This corresponds to approximately 315 ml milk equivalents in men and 323 ml in women [165]. However, it is worth noting that 14% of adults in Slovenia do not consume milk. Moreover, the daily intake of butter and other animal fats in the adult Slovenian population is 8 g for men and 7 g for women [24]. Notably, 23% of Slovenian adolescents, adults, and older adults have an allergy or intolerance to a specific food ingredient, with 39% of them being lactose intolerant [347].

Health effects. The health effects of milk and dairy products have been extensively studied both as a source of potentially beneficial nutrients and as a source of potentially harmful SFA, added sugars, and salt [348]. Several SRs have investigated the association between milk and health outcomes but yielded inconclusive and/ or heterogeneous results for all-cause mortality, cardiovascular mortality, CVD, or T2D [173,349–352]. The dose-response, type of dairy product (milk, cheese, yoghurt, or butter), and type of fat content (low- vs high-fat) analyses further confirm the lack of association between dairy product consumption and all-cause mortality [351]. Intake of low-fat dairy products or lower intake of full-fat dairy products may be associated with lower cardiometabolic risk [353]. Two SRs have suggested that the consumption of milk and dairy products is associated with a lower risk of colorectal cancer, primarily attributed to their calcium content [319,354]. Still, it may confer a higher risk of prostate cancer [319,355]. As a 'source of' calcium, milk and dairy products may be associated with decreased mineral bone density loss [356]. However, it has not been consistently demonstrated that they lower the risk of bone fracture [348,353,357,358]. Due to the inconsistent yield of health effect studies and SRs, existing SNG2025 do not offer an evidence-based recommendation for the quantity of milk and dairy intake. Instead, they focus on addressing challenges in the local environment, such as nutrient deficits associated with under-consumption or the risk of chronic non-communicable diseases related to over-consumption [359].

Environmental impacts. Milk and dairy are diverse products with diverging impacts on the environment. Milk and yoghurt are among the animal-based products with the lowest emissions, ranging from 1.1 to 1.9 kg of CO_2eq/kg of product for milk and yoghurt produced in central Europe (grass-fed) [215,253,282,360], with emissions potentially higher for some cattle housing systems [361]. Compared to plant-based food products, the land use footprint is much larger; however, it also ranges based on the type of feed [361]. Slovenian dairy cows are predominantly fed grass and hay from grasslands managed for centuries, meaning lower greenhouse gas emissions, land use footprints, and water use, compared to more intensive dairy systems of western Europe [362]. Compared to other food items, milk products have a relatively high share of emissions associated with processing, packaging, transport and retail, particularly due to different heating and refrigeration measures necessary to maintain the quality and safety of the product, which can exceed 20% of total emissions [189]. Cheese and related products have considerably higher environmental impacts, mostly because cheese production requires large quantities of milk (for example, to produce 1 kilogram of cheese, 5–10 litres of cow milk are required). Cheese is, therefore, among the food products with the highest emissions, land footprint and water use, with some environmental impacts up to 10 times higher compared to milk (although the differences can be smaller when accounting for nutritional value, for example, protein content) [189,215,253,282].

Another aspect related to milk and dairy is animal welfare. The Slovenian cattle sector is less intensive compared to its European counterparts: the most utilised agricultural land in Slovenia (around 58%) is permanent grasslands [363], much higher than the EU average. Slovenian cattle farms are among the smallest in the EU, and the share of cattle in large farms (with more than 500 livestock units of cattle on a single farm) is the lowest in the EU, at 1.3% [364]. Nevertheless, this does not mean that most cattle are grazing pastures. Only 34% of cattle in Slovenia have access to outdoor pastures, with the majority being permanently kept indoors. Many other EU member states have considerably higher shares of cattle grazing outdoors [365]. While keeping animals indoors can increase efficiency and could lead to lower environmental impacts per kilogram of product, it has implications for animal welfare. A final negative aspect of milk and dairy is eutrophication due to excess nutrients in the soil and water, contributing to 5% of total eutrophication in Europe [366].

Risk groups. Individuals with milk allergy and lactose intolerance [352,367] should be advised on alternative food sources. Low- or no-consumers should include other 'sources of' calcium: flaxseed, hazelnuts, sesame seeds and sardines [162,163,165–167,200]. Calcium can also be obtained from almonds, beans, Brazil nuts, figs, dark green leafy vegetables (broccoli, kale, collard greens) and/or fortified plant-based alternatives (milk or yoghurt) without added sugar (preferably soy milk, or also almond, cashew hemp, oat, pea and/or rice drink/milk) [165].

Science advice:

Based on health outcomes: Consumption of milk and dairy products should be individually determined based on the overall intake of nutrients from other sources. A reasonable daily intake may include 250 g (0–500 g) of milk or dairy products or calcium-fortified plant-based drinks providing an equivalent amount of calcium as milk [6]. Milk and dairy products are also major dietary sources of SFA (followed by oils and meat products) [368], and they can also be sources of added sugar and salt [165].

Based on environmental impacts: While milk generally has lower environmental impacts than other animal-based food products, cheese and similar products have the most severe impacts on emissions, land use footprint, water use, and eutrophication.

Overall science advice: Consumption of milk and dairy products should be individually determined based on the overall intake of nutrients from other sources. Reduced-fat milk or dairy products should be preferred, whereas products with added sugar or salt should be limited. A reasonable daily intake may include 250 g (0–500 g) of milk or dairy products or calcium-fortified plant-based drinks providing an equivalent amount of calcium as milk [6]. Calcium-fortified plant-based drinks and yogurt without added sugar can both be considered alternatives to dairy milk and yogurt [369,370]. However, the nutritional composition of plant-based drinks varies depending on ingredients – grains, legumes, nuts, seeds, or blends – and production methods. Therefore, they must be fortified with essential nutrients like protein, calcium, vitamin D, vitamin B12, and iodine to serve as effective dairy alternatives. SNG2025 recognise unsweetened, calcium-fortified soy drink as the most suitable milk alternative, as it also has a comparable protein content. Other plant-based drinks are often marketed as milk alternatives, but their natural nutritional composition typically differs substantially from that of milk. They are not nutritionally equivalent unless appropriately fortified. Individuals who do not consume milk or dairy products may include adequately fortified plant-based drinks in their diet. However, they must ensure proper replacement of key nutrients, otherwise long-term consumption may lead to deficiencies in calcium, vitamin B12, and protein [371–373].

2.9. Meat and processed meat

DIETARY INTAKE

MEAT
- Red meat: beef, pork, lamb, and goat
- White meat: poultry, chicken, duck, turkey, and rabbit
- Processed meat: meat preserved by smoking, salting, curing, or meat adding chemical preservatives

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'SOURCE OF'
- Protein (red, white, and processed meat, except blood sausage)
- Vitamins: B2 (riboflavin: red and white meat), B6 (pyridoxine: red and white meat) and B12 (cobalamin: red meat and karst pancetta)
- Minerals: iodine (processed meat, if iodised salt is used), iron (beef, blood sausage and 'tea' sausage), phosphorus (red, white, and processed meat), selenium (blood sausage) and zinc (red, white, and processed meat)

'HIGH IN'
- Sodium (processed meat)
- SFA (processed meat)

HEALTH AND ENVIRONMENTAL EFFECTS

Beneficial health effects

No specific health benefits were found for meat or processed meat.

Adverse health effects

Red and processed meat intake is associated with the risk of cancer (especially colorectal), CVD, and T2D.

Environmental impacts

Beef has the highest environmental impact of all meats due to its large land and water footprint, greenhouse gas emissions, and eutrophication. Pork has lower environmental impacts than beef but is still higher than plant-based food. Poultry has the lowest emissions among all meats but can negatively impact the environment through feed production and emissions of commercial production systems.

Science advice and helpful tips
The suggested amount of meat intake for an individual should be decided based on their overall diet quality. A reasonable total meat intake may include 43 g (0–86 g) per day with a preference for white meat while reducing the consumption of red and processed meat. Aim to limit total meat intake to no more than 300 g per week.

Dietary sources: Consistent with WCRF/AICR, red meat is defined as beef, pork, lamb, and goat. Processed meat refers to red or white meat preserved by smoking, salting, curing, or meat-adding chemical preservatives [374,375]. Given that there was no definition of white meat in the WCRF/AICR report, the SNG2025 define white meat as poultry, chicken, duck, turkey, and rabbit based on previous studies' definitions of white meat [374,376].

Dietary composition: Meat and processed meat are a 'source of' protein (red, white and processed meat, except blood sausage), vitamins (B2 (riboflavin; red/white meat), B6 (pyridoxine; red/white meat) and B12 (cobalamin; red meat and karst pancetta) and minerals (iodine; processed meat, if iodised salt used), iron (beef, blood sausage and 'tea' sausage), phosphorus (red, white and processed meat), selenium (blood sausage) and zinc (red, white and processed meat). Meat can help meet the nutritional needs of individuals on an omnivorous dietary pattern. However, processed meat is 'high in' sodium and SFA [162–168]. Meat and processed meat also contain dietary cholesterol [377]. The human body does not require dietary cholesterol, because it can produce and regulate its own cholesterol levels [378,379]. In addition, cured or processed meats such as bacon, sausage, hot dogs, ham and parts of meats like chicken, turkey, roast beef, and salami often contain added nitrates and nitrites [380]. These additives help prevent the growth of harmful bacteria, add a salty flavour, and preserve the red or pink colour of the meat [319,381].

Dietary intake. The average daily meat intake in Slovenia is 209 g for adult men (137 g of red meat and 72 g of poultry) and 141 g for adult women (76 g of red meat and 65 g of poultry). The average daily intake of processed meat, such as sausages, salami, and other processed meats, is 52 g for men and 28 g for women. The total average intake of meat and processed meat is 261 g per day for men and 169 g per day for women [24].

Health effects. SRs appraising the association between meat consumption and health outcomes have mostly focused on red and processed meat. Red meat consumption is associated with an increased risk of colorectal cancer [382–384] and may be associated with an increased risk of breast and other cancers, CVD, and T2D [382,384–388]. The magnitude of these associations is especially significant with processed meat [319]. Dose-response analyses suggest that there may be no minimal intake of red meat that would be associated with beneficial health effects [382]. Therefore, processed meat is classified as cancerogenic for humans and red meat is classified as probably cancerogenic to humans by the International Agency for Cancer Research of WHO [389]. Conversely, dietary patterns with lower red and/or processed meats intake may be associated with a lower risk of all-cause mortality [389], CVD [390] and T2D [391]. The available evidence does not indicate any beneficial or detrimental role of white meat consumption in CVD or T2D [392].

Environmental impacts. Beef in Slovenia has lower environmental impacts than other beef production systems in the neighbouring countries. This is because most Slovenian cattle are from dairy stock and grass-fed, and their fodder often comes from pastures and meadows that have been managed for centuries. Often, these are hilly and mountainous areas where no other food can be produced due to terrain, soil, and climate limitations. Cattle rearing can contribute to landscape conservation and beef production with lower environmental impacts compared to more intensive systems [393]. This is reflected in the majority of utilised agricultural land in Slovenia (around 58%) being permanent grasslands [363], considerably more than the EU average. Emissions related to land use are particularly high in cases where cattle are fed grains or soy, and in some European countries, they are, therefore, much higher than in Slovenia [189,362]. In addition, beef from a dairy herd can have half the emissions compared to a beef herd, take up 83% less land, and have a 13% lower water footprint [189,394]. Nevertheless, due to relatively high methane emissions, even the most sustainable beef has emissions several times higher when compared to other meat, such as pork and poultry. The median emissions for bone-free meat are around 26 kg of CO_2eq/kg [253]. However, the range for beef is particularly high, as emissions can range from 11 to over 30 kg [189,282,360], making beef the food product with the highest variation in terms of its greenhouse gas emissions. Beef scores also poorly regarding other environmental indicators, as it has the highest land use footprint (ranging from 12 to over 100 m^2 per kg), water footprint (ranging from 190 to 700 litres of water per kg), and the highest impacts on eutrophication and acidification [189,190,215,360]. While many of these impacts can be reduced by ensuring feed with lower environmental impacts, maintaining proper stocking densities, and improving manure management [393,395], even the most sustainable beef (when looking at the impacts reported in the literature) performs worse compared to other meat and most food groups [189]. This has mostly to do with the fact that cattle have a very low protein conversion efficiency compared to pork or chicken [255]. The Slovenian cattle sector is considerably less intensive compared to most European countries, with Slovenian cattle farms among the smallest in the EU. In addition, the share of cattle in very large farms (with more than 500 livestock units of cattle on a single farm) is the lowest in the EU, at only 1.3% [364]. Still, only 34% of cattle in Slovenia are grazing outdoors, with the majority staying indoors, which is a lower share compared to many other European Union Member States [365]. Moreover, cattle (and other livestock) operations are problematic above groundwater resources, as most of Slovenia's water comes from groundwater. While increasing the share of outdoor grazing and other improvements related to emission, manure, and other effluent management could lead to lower environmental impacts per kilogram of Slovenian beef, it could lead to lower stocking densities and more land necessary to produce beef, meaning decreases in demands would be necessary to ensure that the difference is not met by increasing imports from countries with more intensive beef production. Decreasing beef consumption has been identified as one of the largest opportunities to reduce greenhouse gas emissions and land use impacts of the global food system [396,397]. Atmospheric ammonia (NH3) from agriculture significantly contributes to air pollution, particularly through its role in the formation of fine particulate matter (PM2.5). This occurs primarily when NH3 reacts with other pollutants such as sulphur dioxide (SO2) and nitrogen oxides (NOx), leading to the creation of secondary particulate matter. Exposure to NH3 and PM2.5 has been linked to a range of respiratory issues, including reduced lung function, throat and eye irritation, increased coughing, and early-onset asthma in children. PM2.5 can penetrate deeply into the lungs, contributing to chronic diseases such as chronic obstructive pulmonary disease and lung cancer, which result in significant health burdens and economic losses. Given that agriculture accounts for over 81% of global NH3 emissions, particularly from livestock, reducing these emissions is crucial for mitigating the health risks associated with PM2.5 pollution. Effective strategies for reducing NH3 emissions include improved manure management practices, dietary adjustments for livestock, and the use of inhibitors [398].

Pork has, compared to other red meat (particularly beef), up to 4.5 times lower greenhouse gas emissions with 5.7 kg of CO_2eq/kg, and uses more than 50% less water and land [189,215,253,360]. Pork fed with domestic feed (maize) or imported from neighbouring countries can have even lower impacts on the climate, water, and land use than pork imported from several EU Member States where a large share of pork feed is soy imported from Brazil. Thus, local pork presents a red meat alternative with lower environmental impacts compared to beef. Slovenia's pig sector is smaller and has countered European trends in increasing the number of animals housed in large farms (with over 500 livestock units, equivalent to 1000 breeding sows). Only 13.5% of pigs in Slovenia are reared in such very large systems, compared to the European average of 65.4% [364]. A considerable part of the improvement in the sustainability of Slovenian pig production was, however, due to the closure of large pig farms in the previous two decades, leading to a decrease of pigs reared in very large farms by 80.5% since 2005 [258,399]. The consumption of pig meat in the same period, however, did not decrease, meaning that Slovenia now imports over half of the consumed pork from neighbouring countries [400,401], where pigs are mostly housed in very large farms with high pig densities, lower animal welfare and health standards, and potentially higher environmental impacts, also due to travel and refrigeration-related impacts. Despite having relatively low (compared to beef) environmental impacts in terms of emissions, land use and water, pork still has high acidifying and atrophying emissions, as well as water consumption, especially when compared to plant-based food products [189]. Particularly worrying, intensive pork production was found to be associated with high emissions of ammonia and respiratory inorganics (fine particulate matter), with demonstrated negative impacts on the health of the people working in or living nearby pig farms [402–404].

When compared with other types of meat (particularly pork and beef), poultry has considerably lower greenhouse gas emissions with 3.9 to 7.5 kg of CO_2eq/kg: 30-32% lower than pork and 79–85% lower than beef [189,215,253]. A large share of total emissions of poultry meat can be attributed to processing, packaging, retail and losses (30%) and feed (25%) [189], which is considerably higher when compared to pork or beef. In Slovenia, a large share of chicken feed is imported soy, also from areas where it is produced with the highest emissions and impacts on biodiversity, such as Argentina and Brazil (due to the potential conversion of tropical forests to soy production areas) [399,400,405]. Poultry is associated with high eutrophying emissions, particularly when compared to plant-based products, but lower than pork and beef [189]. Compared to other types of meat, such as beef, poultry can be associated with lower levels of animal welfare, particularly due to a high share of animals housed in very large farms. While the share of Slovenia's chickens housed in intensive systems (farms with over 500 livestock units, equivalent to over 71000 broiler chickens) is lower than the EU average (61.1%), still 42.2% of chickens are housed in such systems [36]. There is a shift in Slovenia towards more free-range and antibiotic-free chicken, which, together with improved animal welfare, can lead to higher-quality meat [406]. At the same time, it can lead to lower animal weight, meaning that increases in quality and animal welfare should be accompanied by simultaneous reduction in meat consumption to achieve environmental gains.

Risk groups. High consumers of red and/or processed meat have an increased risk of colorectal cancer, CVD, and T2D. Low and non-consumers of meat may be at risk of iron, zinc, and vitamin B12 inadequacy. Reliable 'sources of' non-heme iron are grains, herbs and spices, nuts and seeds, pulses/legumes and vegetables (spinach, carrot), while heme iron includes red meat and fish such as sardines. Reliable 'sources of' zinc are grains, nuts and seeds, pulses/legumes, as well as cheese, eggs and sardines. Reliable 'sources of' vitamin B12 include eggs and cheese [165–168]. Individuals who practice predominantly plant-based diets risk becoming vitamin B12 deficient unless they consume dietary supplements or fortified foods [407].

Science advice:

Based on health outcomes: The suggested amount of meat intake for an individual should be decided based on their overall diet quality. A reasonable meat intake may include 43 g (0–86 g) per day, preferably opting for white meat while limiting the intake of red, especially processed meat. Aim to limit total meat intake to no more than 300 g per week.

Based on environmental impacts: Beef has the most significant environmental impact, even in sustainable production systems. Replacing it with other meats or reducing meat consumption can significantly reduce environmental impact. Pork is a better alternative to beef but still has a higher environmental footprint. Poultry has the lowest environmental impact among major types of meat, but eutrophying emissions, feed production, and animal welfare call for improvement.

Overall science advice: The suggested amount of meat intake for an individual should be decided based on their overall diet quality. A reasonable meat intake may include 43 g (0–86 g) per day, preferably opting for white meat while limiting the intake of red and processed meat. Aim to limit total meat intake to no more than 300 g per week.

2.10. Eggs

DIETARY INTAKE

- Chicken eggs
- Other eggs (duck, goose, ostrich, turkey, and quail)

'SOURCE OF'

- Protein
- Vitamins: A*, B2 (riboflavin), B5 (pantothenic acid), B7 (biotin), B12 (cobalamin)
- Minerals: iron, phosphorus, selenium and zinc

'HIGH IN'

- SFA

HEALTH AND ENVIRONMENTAL EFFECTS

Beneficial health effects

No specific health benefits were found for eggs.

Adverse health effects

Eggs increase plasma cholesterol and the LDL/high-density lipoprotein (HDL) ratio and adversely affect CVD, T2D, cancer, and all-cause mortality at an intake of 3 or more eggs per week.

Environmental impacts

Eggs are among the animal-based products with the lowest GHG emissions and are comparable even with some plant-based products. Most of the negative impacts of egg consumption are associated with feed production and eutrophying emissions.

Science advice and helpful tips
A moderate intake of eggs (0–25 g per day, which equals 0 to 3 eggs per week) may be part of a healthy and environment-friendly diet. This also includes eggs in different products, such as biscuits and pasta. Whenever possible, choose primarily organic eggs or opt for free-range eggs. Choose healthier cooking methods like boiling, poaching, or making an omelette with minimal oil.

* The vitamin A content of foods is expressed as retinol equivalents (RE). Conversion factors are as follows: 1 mg RE = 1 mg of retinol = 6 mg of total-trans-β-carotene = 12 mg of other provitamin A carotenoids = 1.15 mg of total-trans-retinyl acetate = 1.83 mg of total-trans-β-retinyl palmitate; 1 IU = 0.3 µg retinol [166,167].

Dietary sources. Chicken eggs are most commonly used. Other types, such as duck, goose, ostrich, turkey and quail eggs, are eaten in much smaller amounts [408].

Dietary composition. Eggs are a 'source of' protein, vitamins (A, B2 (riboflavin), B5 (pantothenic acid), B7 (biotin) and B12 (cobalamin)) and minerals (iron, phosphorus, selenium and zinc). However, the iron bioavailability of eggs is relatively low due to certain compounds that inhibit absorption. Eggs contain non-heme iron, which is absorbed less efficiently compared to heme iron. In particular, phosvitin in the egg yolk strongly binds to iron, while calcium and certain proteins in the egg white, such as ovotransferrin, compete for absorption. Although factors such as vitamin C and heme iron sources can improve the absorption of non-heme iron, the overall effectiveness depends on the broader dietary context and how various nutrients interact [409,410]. Eggs are also 'high in' SFA [162–168]. In addition, eggs contain cholesterol and choline. However, egg whites are 'source of' of protein without any SFA or cholesterol [165,411,412].

Dietary intake. The average daily intake of eggs (both fresh and incorporated into foods) in Slovenia is 43 g for adult men and 36 g for adult women [24]. For reference, a medium hen's egg weighs approximately 60 g [165].

Health effects. Several SRs found that consuming eggs (>3 eggs per week) increases blood LDL and total cholesterol levels [412,413] and may be associated with a higher risk of all-cause mortality [413–416], higher risk of cancer and cancer mortality [413,416–418] and T2D [419]. The severity of the effect varies between studies, as the studies differ in duration, number of eggs consumed and populations. Consumption of eggs was associated with an increased risk for CVD (mortality) in some [414,415,419], but not all SRs [413,416,420–422].

Environmental impacts. Compared to other animal-based food products (particularly pork and beef), eggs have considerably lower environmental impacts. GHG emissions are roughly 3 kg CO_2eq/kg of eggs [189,360]. Eggs have the highest share of feed contributing to their total emissions, as feed contributes nearly half [189]. This is why it is of utmost importance to ensure that feed is sourced from regions where it is produced with the lowest environmental impacts possible. In Slovenia, a large share of chicken feed is imported soy, also from areas where it is produced with the highest emissions and impacts on biodiversity, such as Argentina and Brazil (due to the potential conversion of tropical forests to soy production areas) [258,259]. Eggs contribute considerably more to terrestrial and aquatic ecotoxicity than plant-based products due to higher eutrophying emissions [423–425]. These higher environmental impacts are related mostly to intensive egg production systems, which can also have lower animal welfare and health standards. While the share of Slovenia's chickens housed in intensive systems (farms with over 500 livestock units of poultry, equivalent to over 35,000 laying hens) is lower than the EU average (61%), still 42% of chickens are housed in such systems [364]. There has been a shift in Slovenia towards more free-range eggs, which can improve animal welfare without compromising nutritional value [31], also due to changes in feed or conversion to organic [426]. Nevertheless, such systems could have lower chicken densities, meaning that appropriate egg-demand side measures should accompany increases in quality and animal welfare.

Risk groups. Among Slovenian adolescents and adults, 39% report a food allergy or intolerance, and 9% are allergic to eggs [347]. Although adult egg allergy is rare [426,427], those affected should consult a physician and work with a dietitian to find suitable alternatives and recipes for binding, leavening, and moisture. Online resources can also offer practical guidance for egg-free cooking, as traditional dishes like *potica* and modern recipes can be easily adapted. Additionally, individuals with hypercholesterolemia should limit their consumption of cholesterol-rich foods such as eggs.

Science advice:

Based on health outcomes: Consuming up to three eggs per week may be considered part of a healthy diet [428]. This includes eggs eaten scrambled, boiled, or raw, as well as eggs incorporated into other foods such as egg pasta, biscuits, cakes, baked goods, and pancakes. Organic eggs may provide health benefits due to a more favourable nutritional profile compared to conventional eggs, particularly cage-produced eggs, although further research is required to confirm these findings [429,430].

Based on environmental impacts: Eggs offer an alternative to other animal-based food products because they have lower environmental impacts. Most environmental issues related to egg production are related to eutrophying emissions, feed production, and animal welfare. However, these issues can be reduced to some extent by adopting new, more outdoor-based (free-range) systems and changing feed. As these systems have lower chicken densities, there may be a need to reduce egg consumption.

Overall science advice: It is recommended to limit egg consumption to an average of up to 25 g per day (equivalent to no more than three medium eggs per week, with one egg weighing approximately 60 g).

2.11. Fats and Oils

DIETARY INTAKE

-
- Vegetable oils
- Tropical oils/fats (coconut and palm)
- Margarine
- Butter and ghee
- Lard and crackling
- Cream

'SOURCE OF'

- N-3 polyunsaturated fatty acid ALA (oils: flax, hemp, pumpkin seed, rapeseed, walnut and soy)
- Vitamins: vitamin K (all listed), A (ghee), β-carotene (butter), vitamin E (vegetable oils and butter; not lard and tropical oils/fats)

'HIGH IN'

- SFA (butter, ghee, lard, tropical oils)

HEALTH AND ENVIRONMENTAL EFFECTS

Beneficial health effects

Vegetable oils rich in unsaturated fats contribute essential linoleic acid (n-6 PUFA) and bioactive components and, when used instead of butter, have a cardioprotective effect.

Rapeseed, linseed, soybean, hempseed, wheat germ, and walnut oils contribute to essential n-3 ALA intake.

Adverse health effects

Butter, cream, lard, and tropical oils (coconut and palm) are rich in SFA, which increase LDL cholesterol.

Oils and fats are among the most energy-dense foods and may contribute to obesity if consumed in large amounts.

Environmental impacts

The sustainability of fats and oils depends on the type, whether they are animal-based or plant-based, and where they are produced.

Fat obtained from palm oil is problematic due to its significant contribution to deforestation in Southeast Asia.

Science advice and helpful tips
Consuming up to 25 g of isolated fats per day is optional and not essential for a balanced diet. When added fats are used, non-tropical plant oils are preferable. However, it is generally recommended to prioritise healthy fat sources in whole foods, such as avocados, nuts and seeds, olives, and selected fatty fish. When consuming olives, low-sodium varieties are preferable; brined olives should be rinsed in water to reduce excess salt.

Dietary sources. Fats, which can be solid or liquid at room temperature, can be isolated (vegetable oils, tropical fats, margarine, butter, shortening) or part of other whole or unprocessed foods (nuts, seeds, olives, avocados, milk, meat, fatty fish) [377].

Dietary composition. Fats and oils are 'sources of' n-3 polyunsaturated fatty acid ALA (flax oil, hemp oil, pumpkin seed oil, rapeseed oil, soy oil and walnut oil) and vitamins (vitamin K (all listed), vitamin A (ghee), β-carotene (butter), vitamin E (vegetable oils and butter; not lard and tropical oils/fats). Some are, however, 'high in' SFA (butter, ghee, lard, tropical oils) [162–168]. While fats contain nutrients that are essential for the body's normal functioning, both fats and oils are highly concentrated energy sources that may increase the risk of obesity if consumed in excess. They support cell growth, protect organs, and absorb fat-soluble nutrients. Foods that contain fats of animal origin also contain dietary cholesterol [377], but dietary cholesterol is not considered essential to human nutrition, as the human body can produce and regulate its own cholesterol levels [378,379].

Dietary intake. The average daily intake of isolated fats and oils (vegetable oils, margarine, butter, and other animal fat) in Slovenia is 28 g for adult men and 23 g for adult women [24].

Health effects. A network MA of randomised trials showed that at a 10% isocaloric exchange, plant oils (safflower, sunflower, rapeseed, flaxseed, maize, olive, and soybean) were more effective in reducing LDL cholesterol than tropical fats (coconut and palm oil) in comparison to animal fat (lard, butter) [377]. In two SRs, coconut oil significantly raised LDL cholesterol compared with non-tropical plant oils and lowered it compared with animal oils [431,432]. However, consuming an adequate amount of healthy unsaturated fats, such as those present in olives and olive oil, nuts and seeds, avocados, and fatty fish, can benefit heart health [303,316,433–436]. In contrast, excessive consumption of TFA and SFA (commonly found in animal-origin foods and tropical fats such as coconut and palm oil/fat [368]) increases the risk of CVD [431,432,437–442]. As a result, TFA have been regulated in Slovenia's packaged foods [443]. However, they may still be present in fried food and occur naturally in ruminant-derived fats like butter, ghee, and cream. Overall, the best available evidence suggests that plant oils (safflower, sunflower, rapeseed, flaxseed, maize, olive, and soybean) are more effective at reducing LDL cholesterol than both tropical fats (coconut and palm oil) and animal fat (lard and butter).

Environmental impacts. Fats and oils are a diverse food group, with a large variation and diversity of their environmental impacts. In terms of greenhouse gas emissions, plant-based fats have lower emissions, which range from 1 kg CO_2eq/

kg for sunflower oil to 3.2 kg of CO_2eq/kg for olive oil. Processed plant fats such as margarine emit an average of 1.4 kg CO_2eq/kg [215,253]. Animal-derived fats, such as butter, have considerably higher emissions, emitting 8.9 kg of CO_2eq/kg of product [215,253] and higher land use requirements [189,190]. Recently, palm oil has become a major driver of deforestation and biodiversity loss, especially as the palms are cultivated in some of the most biodiverse areas, such as Indonesia and Peru [444,445]. While palm oil has the lowest land use footprint among all fats and oils due to high yields, conversions of forests for palm oil cultivation is among the reasons for relatively high greenhouse gas emissions compared to other plant-based fats and oils, which can be twice as high compared to sunflower [189].

Risk groups. Individuals who are overweight, obese, or at risk of becoming so should use fats and oils in moderation, preferably from unprocessed, plant-based sources – such as nuts, seeds, olives, and avocados – instead of energy-dense oils.

Science advice:

Based on health outcomes: It is recommended to consume up to 25 g of fats per day from whole foods (avocados and olives) and/or plant oils (olive, sunflower, rapeseed, maize, pumpkin, flax, and/or walnut oil), in addition to 30 g of nuts and seeds (see chapter 2.7). Consumption of animal fats (butter, lard, and ghee) and tropical oils or fats (coconut and palm oil) should be limited [6].

Based on environmental impacts: It is recommended to shift from using animal-based fats and oils to plant-based alternatives that are produced locally or sourced from neighbouring countries. Additionally, it is advised to avoid palm oil due to its contribution to deforestation.

Overall science advice: It is recommended to consume up to 25 grams of fats per day from whole foods, or/and non-tropical vegetable oils in addition to 30 g of nuts and seeds. Consumption of animal fats and tropical oils and fats should be limited [6].

2.12. Herbs and Spices

DIETARY INTAKE

- Basil, caraway, celery, cinnamon, cumin, dill, fennel, garlic, ginger, parsley, pepper marjoram, paprika, rosemary, thyme, turmeric, oregano, saffron
- Vinegar: apple cider, balsamic and wine

'SOURCE OF':

- Herbs and spices are consumed in small amounts and do not qualify as a primary nutrient source under the uniform Scoring System for classifying foods as 'high in' or a 'source of' specific nutrients.
- Vinegar is classified alongside herbs and spices due to its functional role as a condiment, contributing acidity and flavour complexity to culinary applications.

HEALTH AND ENVIRONMENTAL EFFECTS

Beneficial health effects

- The use of herbs and spices can help reduce the amount of salt in the diet.
- Many herbs and spices have antioxidative, antimicrobial and anti-inflammatory effect.

Adverse health effects

- Some spices can be irritating to the digestive tract in susceptible individuals.

Environmental impacts

Herbs and spices have a low environmental impact. Negative impacts may arise from importing spices from tropical areas cultivated on converted forest land.

Science advice and helpful tips

Extensive use of herbs and spices is recommended because they have the potential to reduce the need for salt in the diet and provide other health benefits.

Dietary sources. Herbs and spices are derived from various parts of the plants: leaves (basil, parsley, dill, fennel fronds, marjoram, rosemary, thyme, oregano), seeds (caraway, celery seeds, cumin, fennel seeds), roots and bulbs (garlic, ginger, turmeric), fruits or berries (pepper, paprika, juniper), bark (cinnamon), and flowers or floral parts (saffron) [446]. Vinegar mostly serves as a condiment, adding acidity and flavour complexity to dishes.

Dietary composition. Herbs and spices, as well as vinegars, are consumed in small amounts, so they do not qualify as a primary source of nutrients under the uniform Scoring System model for classifying foods as 'high in' or a 'source of' specific nutrients. Herbs and spices provide protein (parsley), vitamins [β-carotene (parsley); folate (vitamin B9) (parsley and rosemary); vitamin C (parsley, turmeric and rosemary); vitamins E and K (parsley and ginger)], and minerals [calcium (onion, parsley, cinnamon and rosemary); iron (all listed); magnesium (onion, parsley, ginger, cinnamon, turmeric, rosemary); potassium (turmeric); zinc (onion, parsley, ginger); selenium (garlic and ginger)]. Rosemary and turmeric also contain dietary fibre, but turmeric also SFA [162–168]. Balsamic vinegar may contain a considerable amount of free sugar [165].

Dietary intake. No specific data is available about the amounts of herbs, spices and vinegar consumed in Slovenia.

Health effects. Spices and herbs are important to the diet, imparting flavour and palatability to dishes while enhancing their nutritional value and serving as herbal medicine to treat various diseases [447,448]. Regular consumption is recommended due to their health benefits, including anti-inflammatory effects, support for digestive and cardiovascular health, blood sugar regulation, and immune function. These compounds may aid in chronic disease prevention and overall well-being while enhancing flavour without adding excessive calories [449–451]. These plant-based seasonings offer different health benefits attributed to their bioactive compounds, including antioxidants and anti-inflammatory agents [452–455]. Additionally, certain herbs and spices promote good health by improving insulin sensitivity, regulating blood pressure, reducing blood lipids and inflammatory markers, providing antimicrobial effects, and aiding digestion. Their significant health benefits, despite their low-calorie count, are noteworthy, particularly regarding dietary recommendations and reducing excessive salt intake. Nevertheless, the specific health benefits of each herb and spice may differ [447,448,452–454,456,457]. Traditionally fermented grain and fruit vinegars provide numerous health benefits, including antibacterial properties, infection prevention, antioxidants, blood glucose control, improved lipid metabolism regulation, reduced blood pressure, weight loss, and anticancer effects [458–462].

Environmental impacts. Exact evidence on the environmental impacts of herbs and spices is scarce and limited to some products such as chillies and ginger [215,253]. Environmental impacts are assumed to be low, as they are plant-based products that are also used in smaller quantities and, therefore, do not contribute significantly to the environmental impacts of an individual's diet. Nevertheless, herbs and spices produced locally in open fields, rather than in heated greenhouses or imported from distant regions, are likely have lower environmental impacts.

Risk groups. Individuals sensitive to certain herbs and spices, such as celery, mustard, pepper, or chilli, should choose alternative options. The regular consumption of commercial vinegar (e.g., two tablespoons per meal as dressing) is considered safe [463]. However, it is advisable to avoid consuming undiluted vinegar, as it may cause severe hiccups and potentially damage the oesophagus [464,465]. Care should therefore be taken when using vinegar in any form.

Science advice:

Based on health outcomes: Although determining the exact amount can be difficult due to the variety within food groups and how individuals respond to them, it is essential to recognise the significance of this group of food seasonings. For optimal human health, increase the consumption of herbs and spices, particularly those that have the potential to reduce the need for salt in their diet and provide health benefits. Incorporating diverse spices and herbs like parsley, celery, garlic, rosemary, thyme, basil, dill, marjoram, paprika, cinnamon, ginger, turmeric, oregano, saffron, caraway, cumin, fennel, and pepper into the diet can elevate the sensory appeal of foods, potentially reducing the excessive use of salt, sugar, or unhealthy saturated or trans fats [215,253,448].

Based on environmental impact: Herbs and spices produced locally are recommended instead of those imported from distant regions.xs**Overall science advice:** It is recommended to regularly add spices and herbs to meals, while avoiding excessive use of salt. While these ingredients have various health benefits, it is essential to be aware of any allergies or sensitivities and use them moderately to avoid overpowering the natural flavours of your food.

2.13. Sweets and Snacks

DIETARY INTAKE

SWEETS AND SALTY SNACKS:
- Sugar candy, chocolate, desserts, such as cakes, doughnuts, pies, brownies, biscuits, ice cream, puddings, and other treats high in fat and sugar, sugary spreads
- Crisps, salty crackers, pretzels

'HIGH IN'
- Sodium (crisps, salted nuts, salty crackers).
- SFA (many industrial baked goods: biscuits, cakes, pastries, and brownies).

HEALTH AND ENVIRONMENTAL EFFECTS

Beneficial health effects

Sweets and salty snacks do not offer any beneficial health effects.

Adverse health effects

Sweets and salty snacks, with their appealing taste and high sugar and fat content, drive an increase in calorie consumption, contributing to the obesity epidemic. High intake of foods rich in free/added sugar and SFA are associated with a range of adverse health outcomes, including metabolic diseases and dental decay. At the same time, salty snacks provide substantial sodium and unhealthy fat intake but little nutritional benefit.

Environmental impacts

The environmental impact of sweets and snacks varies and depends on their ingredients. Items with cocoa, milk, and butter have higher environmental impacts than those with a higher fruit or cereal content.

Dietary sources. Traditional sweets and salty snacks, often categorised as less healthy, include a wide range of tempting treats. These include chocolates, gummies, hard candies, and lollipops high in sugar and artificial additives. Baked goods like cookies, cakes, pastries, and doughnuts are also popular, as are ice cream and frozen desserts. Among salty snacks, items like potato crisps, tortilla chips, pretzels, and cheese puffs are commonly consumed [466].

Dietary composition. Consumption of sweets and salty snacks is frequently associated with high caloric content and added/free sugars, SFA, or sodium, alongside minimal essential nutrients and dietary fibre. Additionally, these products often contain preservatives and artificial flavours [467–471].

Dietary intake. In Slovenia, the average daily consumption of foods with high sugar, including sugar, confectionery, cakes, cookies, and desserts, stands at approximately 98 g for men and 106 g for women [24].

Health effects. Sweets and salty snacks contribute to higher caloric intake through high sugar, fat content, and palatability [472]. The definition of healthy or unhealthy sweets and snacks remains a topic of debate. Discussions continue around establishing a threshold to delineate what can be considered healthy or nutritious within this category [473]. Considering that adequate fibre intake is arguably one of the most important dietary recommendations, following the 'Five-to-One Fibre' rule for packaged foods is a practical approach. This rule proposes that the ratio of total carbohydrates to fibre in food should not exceed 5:1 [474].

Excessive consumption of sweets is a risk factor for poor dietary quality and reduced nutrient density [475], contributing to the obesity pandemic. Foods high in free/added sugar are an independent risk factor for cardiovascular abnormalities, such as elevated blood pressure and dyslipidaemia [476]. Moreover, SRs [477,478] found a clear and consistent association between sugar consumption and dental decay. Additionally, frequent intake of salty snacks can significantly contribute to the consumption of sodium and unhealthy fats, especially SFA and trans fats (see Sections 2.11.Fat and Oils and 3.3.9. Sodium), offering little nutritional value or benefit. However, if prepared from healthy whole-food ingredients, snacks can be a delicious and convenient source of protein, unsaturated fats, fibre, vitamins, minerals, and antioxidants and may help promote satiety [466,479,480]. Additionally, the cumulative evidence from MAs indicates that the ingestion of chocolate or cocoa-derived products, particularly those with a cocoa content of 70% or more, had no significant impact on body weight, BMI, waist circumference, triglyceride levels, HDL cholesterol, or HbA1c. Conversely, a noteworthy reduction was observed in total cholesterol, LDL cholesterol, fasting blood glucose levels, and systemic blood pressure [481].

Environmental impacts. The environmental impacts of sweets and desserts depend on their cocoa, milk, and butter content. Cocoa is among the commodities with the highest impacts on biodiversity (as it is often replacing tropical forests) and greenhouse gas emissions [482,483]. Sweets with high cocoa and milk content (such as chocolate) can, therefore, emit up to 3.6 kg of CO_2eq/kg of product, which is considerably higher compared to whole grain biscuits with fruit with 1.4 kg of CO_2eq/kg [253].

Snacks can have low environmental impacts if they consist mostly of cereals or potatoes and have a low-fat content. Those with higher palm oil content, for example, can have higher emissions and biodiversity impacts.

Risk groups. Individuals with low energy requirements who consume a diet rich in sweets and salty snacks but deficient in fruits, vegetables, and other unprocessed foods are at the highest risk of experiencing an imbalance characterised by low nutrient density and high caloric intake. Foods high in sugar, salt, and/or SFA/trans fats pose health risks for individuals who are overweight or obese or those who are already managing conditions associated with metabolic syndrome. These conditions can be exacerbated by high sugar and salt intake, which can lead to further adverse health effects.

Science advice: Based on health outcomes: It is recommended to limit sweets and salty snacks and substitute them with healthier options such as vegetables (avocados, carrots, celery); fresh, raw, or dried fruits (apples); whole-grain starchy foods (crackers, oatcakes, plain popcorn); unsalted nuts and seeds; hummus with whole-grain pita; roasted chickpeas; natural yogurt with fruit; and homemade energy bars made with nuts and dried fruits [480,484]. These choices provide energy and essential nutrients – such as vitamins, minerals, and dietary fibre – while offering natural sweetness without the harmful effects of excessive added sugars, unhealthy saturated/trans fats, and salt [485–487].

Based on environmental impact: Sweets and snacks with a lower cocoa, milk, butter, and palm oil content have considerably lower impacts than those with a higher share. Nevertheless, as sweets and snacks generally are not necessary to satisfy the need for nutrients, their consumption is recommended to be low.

Overall science advice: It is recommended to choose healthier snack options – such as whole fruits, vegetables, unsalted nuts, seeds, whole grains, and high-cocoa dark chocolate – which provide essential nutrients. In contrast, limit ultra-processed sweets and sugary snacks, as they are typically high in refined sugars, unhealthy fats, salt, and empty calories, and are often produced using unhealthy methods.

2.14. Water and Non-Alcoholic Beverages

DIETARY INTAKE

WATER AND BEVERAGES

- Water, mineral water
- Teas:
- Herbal teas: chamomile, fennel, ginger, hibiscus, lemon balm, rooibos, lavender, peppermint, rosehip
- Caffeine containing teas: green, black, oolong, white, yerba mate
- Coffee
- Fruit juices
- Sugar-sweetened beverages (SSBs)
- Artificially sweetened beverages

'SOURCE OF'

- Vitamins: B2 (riboflavin), B3 (niacin), B6 (pyridoxine) (fruit juice)
- Polyphenols (fruit juices)

HEALTH AND ENVIRONMENTAL EFFECTS

Beneficial health effects

Adequate hydration with water and unsweetened tea benefits cognitive function, physical performance, and overall metabolic health.

Both green and black tea have been associated with a reduced risk of dementia, including Alzheimer's disease and vascular dementia. Additionally, herbal teas offer various health benefits, such as antioxidative, anti-inflammatory, antimicrobial, and neuroprotective effects.

Consuming 2–4 cups of coffee/day (≤ 400 mg of caffeine), preferably without added sugars or artificial sweeteners, is linked to a lower risk of CVD, T2D, certain cancers, neurological and liver conditions, metabolic diseases, and reduced all-cause mortality.

Adverse health effects

Inadequate hydration can lead to dehydration, associated with the initiation and progression of chronic diseases. SSB consumption is associated with metabolic diseases and tooth decay, while energy drink consumption may compromise cardiovascular and neurological health.

Environmental impacts

Drinks like water have low environmental impacts compared to animal-based products. However, they can still have negative environmental impacts related to energy consumption in their processing and packaging and waste (especially plastic).

Science advice and helpful tips

It is recommended to drink around 1.5 L of water per day for adults, including pregnant women, while around 1.7 L of water per day for lactating women. The need for water is higher with intense sweating and/or heat. Healthy hydrating options include water, mineral water, and unsweetened teas. Limit caffeine consumption from all sources to 400 mg caffeine per day (up to 2–4 cups per day). Pregnant women should avoid coffee. Limit intake of fruit juice to up to 200 ml per day. Avoid the consumption of SSBs (sweet, carbonated drinks, concentrated fruit juices, fruit nectars, iced teas, flavoured waters, and other industrially and homemade sweet drinks/syrups), especially energy drinks. Individuals at risk of iron deficiency should wait at least one hour after eating before consuming green, black, or peppermint tea, but do not need to avoid other herbal teas.

Dietary sources. Water is fundamental for maintaining hydration. A healthy diet provides approximately 20–25% of daily water intake in the form of fruits, vegetables, and other high-moisture foods [488]. Recommended beverages include water, mineral water, and/or (fruit or herbal) tea without added sugars. Teas can be broadly categorised into herbal and non-herbal varieties. Non-herbal teas, such as green tea, black tea, and oolong tea, are made from the leaves of the *Camellia sinensis* plant and are rich in polyphenols, including catechins and tannins, known for their antioxidant properties. However, these compounds can also inhibit the absorption of non-heme iron. In contrast, herbal teas are prepared from various herbs, fruits, or flowers, and are not derived from *Camellia sinensis*. Herbal teas, such as chamomile, ginger, and peppermint, may offer various health benefits, such as supporting digestion or reducing stress and generally do not interfere with iron absorption in the same way as non-herbal teas [489]. Fruit juices are a 'source of' vitamins B2 (riboflavin), B3 (niacin) and B6 (pyridoxine) [162–168], and also contain polyphenols. SSBs (beverages or drinks that contain added caloric sweeteners (sucrose, high-fructose corn syrup, fruit juice concentrates) contain sugar in liquid form [165,490,491]. Energy drinks, a subgroup of SSBs, contain caffeine, taurine, herbal extracts, added sugar, and B vitamins [492–494]. Artificially sweetened drinks contain non-nutritive sweeteners (NNS or noncaloric sweeteners) which are low in calories or have no calories and include artificial sweeteners (aspartame, acesulfame-K, saccharin, sucralose, neotame, advantame), low-calorie sweeteners (stevia, a natural low-calorie sweetener and sugar alcohols), and noncaloric sweeteners [495].

Current intake. In Slovenia, men consume approximately 2.4 L of water daily from all sources, while women consume 2.3 L. Tap and bottled water consumption particularly averages 925 ml for men and 970 ml for women. Regarding sugar-sweetened beverages (SSBs), men consume an average of 136 ml daily, while women consume 63 ml. The average daily consumption of coffee and tea in the adult Slovenian population is 91 ml of coffee and 106 ml of tea for men, and 104 ml of coffee and 172 ml of tea for women [24].

Health effects. The human body comprises approximately 40–62% water, underscoring the vital importance of hydration due to the body's limited capacity to synthesise and conserve water [496]. Hydration is vital for overall health and crucial in various physiological processes such as digestion, circulation, and temperature regulation. Inadequate hydration can lead to dehydration, associated with the initiation and progression of chronic diseases [496–498]. However, fluids other than water and unsweetened tea can pose certain health risks.

Coffee consumption is more often associated with benefits than with harm. Intake of up to 400 mg of caffeine per day (equivalent to 2–4 cups) has been associated with a lower risk of CVD, several types of cancer, neurological and liver conditions, metabolic diseases, and all-cause mortality [499–501]. Furthermore, adding sugar or artificial sweeteners substantially attenuated the strength of the inverse relationship observed between increased coffee consumption and the risk of T2D [502]. In addition, there is conflicting evidence regarding the recommendation to consume coffee during pregnancy or pre-pregnancy. While some SRs suggest that healthy pregnant women can consume up to 300 mg of caffeine per day without any adverse reproductive and developmental effects [503], a review of 37 original observational studies and 17 meta-analyses strongly advises pregnant and pre-pregnant women to avoid caffeine consumption [504].

Drinking herbal and non-herbal tea has been a common practice across cultures for centuries due to its perceived health benefits [489]. Studies have found that green tea consumption significantly impacts liver cancer prevention. It also exerts a significantly beneficial effect on BMI, liver enzyme levels, and lipid profile, particularly by reducing LDL cholesterol, compared to no green tea intake [505–507]. Moreover, an MA of randomised controlled trials revealed that hibiscus tea has a significant effect on lowering both systolic blood pressure and diastolic blood pressure [508]. Furthermore, an MA of prospective cohort studies demonstrated that consumption of green and black tea is associated with a reduced risk of dementia, including Alzheimer's and vascular dementia [509]. An umbrella review of 96 MA of observational studies with 40 unique health outcomes suggests that tea consumption is generally more beneficial than harmful. Drinking two to three cups of tea per day has been associated with reduced all-cause mortality, CVD, stroke, and type 2 diabetes. Positive associations have also been observed for certain cancers, cognitive function, skeletal health, and maternal outcomes. However, consuming tea at very high temperatures (above 55–60 °C) may increase the risk of esophageal and gastric cancers due to thermal injury, which impairs the protective function of the esophageal epithelium [510]. Additionally, drinking **tea or coffee with meals** can **inhibit the absorption of non-heme iron**, as **polyphenols** in these beverages bind iron and form **insoluble complexes**. This inhibitory effect is most pronounced with **green, black**, and **peppermint tea**. Although **chamomile tea** also contains polyphenols, its effect on iron absorption appears to be less significant. To minimise this interaction, individuals at risk of **iron deficiency** should wait **at least one hour after eating** before consuming these teas [511–513]. Furthermore, pairing **iron-rich foods** with sources of **vitamin C** can enhance iron absorption and **counteract inhibitory effects** [514]. A limited intake of 100% fruit juices is considered somewhat healthier due to their higher vitamin and polyphenol content, usually absent in sugary beverages [515–519]. Although 100% fruit juice offers hydration and some nutrients, it has sugar levels comparable to SSBs and is low in fibre, which may contribute to overconsumption and does not provide the same satiety or nutritional benefits as whole fruits [517].

Habitual consumption of SSBs can lead to adverse health effects like body mass gain, poor oral health, and elevated risk for T2D [520], as well as all-cause mortality [515]. Moreover, consumption of SSBs was associated with a higher risk of CVD morbidity and mortality in a dose-response manner [521,522]. Energy drinks, a subgroup of SSBs, may contribute to adverse health outcomes by increasing heart rate, blood pressure, and heart contractility. It is advised to limit their consumption and to avoid mixing them with alcohol [523,524]. Energy drink consumption is linked to increased substance abuse and risk-taking behaviours and may lead to adverse cardiovascular and neurological health effects [492,493,525]. Artificially sweetened beverages contain fewer or no calories, but their risk for obesity, T2DM, hypertension, and all-cause mortality is similar to those observed due to SSB consumption [526].

Environmental impact. There are significant differences between different non-alcoholic beverages, even for the same item, depending on their packaging. Bottled water, for example, has 300 times higher emissions than tap water [527], with an overall environmental impact (including water consumption for producing mostly plastic bottles) that is potentially 3500 times higher than tap water [528]. Generally, water has lower environmental impacts compared to fruit and other processed and sweetened beverages [215,253,529]. The environmental impacts of fruit juices are considerably higher compared to consuming fruits, as more than 10 times higher emissions compared to the same weight of apples and more than twice higher water demands [215,253]. Nevertheless, many fruit juices from Slovenian farms are made of fruit that would otherwise be discarded. In this way, juice production can also, depending on the context, reduce food waste.

Risk groups. Due to frequent consumption, adolescents and young men are at the highest risk for adverse consequences of SSBs and energy drink consumption [525,530,531]. Moreover, pregnant women are more sensitive to higher caffeine intake [504]. Furthermore, consuming caffeine during pregnancy could potentially lead to adverse pregnancy outcomes [504]. Several types of tea, particularly those high in polyphenols such as tannins and oxalates, can inhibit the absorption of non-heme iron, which is predominantly found in plant-based foods. Green tea, black tea, peppermint tea, and cocoa tea (made from cocoa bean husks) are notable for their higher polyphenol content, potentially reducing iron bioavailability. In contrast, teas with minimal or negligible effects on iron absorption include chamomile, ginger, and linden tea, as they contain lower concentrations of polyphenols and are less likely to interfere with iron uptake [512,513,532]. Therefore, individuals at risk of iron deficiency or aiming to optimise iron absorption are advised to wait at least one hour after meals before consuming green or black tea, peppermint tea, or coffee. This precaution is not necessary for other herbal teas with low polyphenol content.

Science advice:

Based on health outcomes: Adults, including pregnant women, should drink around 1.5 L of water per day, while lactating women should drink 1.7 L per day. With intense sweating (during physical activity) and/or heat, hydration needs are higher [166]. The recommended beverages are water, mineral water, and unsweetened teas. Drink fruit juice occasionally, up to 200 ml per day. The total caffeine consumption from all sources should be limited to 400 mg caffeine per day (2–4 cups per day). Avoid consumption of SSBs, especially energy drinks [533,534]. Pregnant women and women planning to conceive should avoid consuming caffeine [504]. For improved iron absorption, unsweetened herbal teas may be consumed at any time. Green tea, black tea, peppermint tea, and coffee should be consumed at least one hour after meals [512,513,532].

Based on environmental impacts: It is advisable to consume as much tap water as possible. In addition, fresh, unprocessed fruit should be chosen instead of fruit juices.

Overall science advice: It is recommended to drink around 1.5 L of water (water, mineral water, or/and unsweetened tea) per day. Fruit juice intake should be limited to no more than 200 ml per day, and coffee to 2–4 cups per day (preferably avoided during pregnancy), without added sugar or artificial sweeteners [502,504]. Green tea, black tea, peppermint tea, and coffee should be consumed at least one hour after meals, while herbal teas can be consumed freely [512,513,532]. In addition, it is recommended to avoid consuming SSBs, particularly energy drinks [533,534].

2.15. Alcohol

DIETARY INTAKE

ALCOHOLIC BEVERAGES
- Beer
- Wine
- Spirits

HEALTH AND ENVIRONMENTAL EFFECTS

Beneficial health effects

No beneficial health effects. There is no safe level of alcohol consumption – any amount poses a risk to health.

Adverse health effects

There is no form of alcohol consumption that is completely risk-free. Even low levels of alcohol intake carry certain risks and can cause harm. With moderate to heavy alcohol consumption, there is an increased risk of chronic diseases (liver disease, certain cancers) and all-cause mortality.

Environmental impacts

The environmental impacts of alcohol are primarily associated with the areas utilised for cultivating crops for its production. The significant concern is that alcohol production often competes with food production for land, indicating that additional food must be imported from other places to accommodate the cultivation of crops necessary for alcohol production.

Science advice and helpful tips
No safe lower limit of alcohol consumption has been established. Complete abstinence is advised. As an alternative, alcohol-free beverages – such as non-alcoholic wine, beer, or kombucha – can be a helpful substitute, especially at social gatherings, to support lower overall alcohol intake.

Dietary sources. Alcohol (ethanol) is generally consumed as beer (about 2.5–6 vol% alcohol), wine (about 12 vol% alcohol), and spirits (about 40 vol% alcohol) [13,535].

Current intake. The average daily intake of alcoholic beverages (wine, beer and spirit) in Slovenia is 233 ml for men (33 ml of wine, 183 ml of beer and 17 ml of spirits) and 66 ml for women (18 ml of wine, 44 ml of beer and 4 ml of spirits), of which the majority is consumed as beer (183 ml in men and 44 ml in women) [24]. According to the WHO, in 2019 [536], the average annual alcohol consumption per adult (aged 15 and over) in Slovenia was 10.6 L of pure alcohol in 2020, which exceeds the EU average of approximately 9.8 L, as reported by the OECD in 2022 [537]. This places Slovenia among the countries with higher alcohol consumption in the European region.

Health effects. Moderate (4–14 drinks per week) to heavy (more than 2 drinks per day) alcohol consumption is associated with an increased risk of various cancers, such as those affecting the oral cavity, pharynx, oesophagus, stomach, larynx, colorectum, central nervous system, pancreas, liver, breast, and prostate [375,538–540]. Recognising the severity of this risk, the International Agency for Research on Cancer (IARC) classified alcohol as a Group 1 carcinogen, indicating the highest level of risk, as early as 1988 [541]. Furthermore, chronic heavy drinking is a primary risk factor for liver cirrhosis, with the risk rising sharply with each additional drink consumed. Research suggests that women might face a higher risk of alcohol-related harm than men, even at lower levels of consumption [542]. Excessive drinking can also lead to malnutrition by impairing nutrient intake and absorption [543].

The risks extend to pregnant women, where even moderate drinking is linked to adverse outcomes such as babies born small for their gestational age and preterm birth [544]. Beyond health implications, harmful alcohol consumption carries significant social and economic burdens, notably through increased sickness absence [545]. Despite the common misconception that moderate alcohol consumption provides cardiovascular benefits [546], evidence suggests that even mild to moderate alcohol intake is associated with elevated mortality risks [547,548]. Additionally, research indicates no difference in cancer risk between red and white wine, challenging the common belief that red wine is healthier. This finding is critical for public health messaging, suggesting that red wine does not offer any advantage over white wine regarding cancer risk [549]. The level of alcohol consumption that minimises harm across health outcomes is zero [550–552]. Slovenia has the highest death rate from alcohol-related mental disorders in the EU [553]. Annual health costs from alcohol are estimated at 147 million EUR, rising to 228 million EUR when including traffic accidents, crime, and domestic violence. Reduced productivity and family emotional impact are also significant factors [554].

Environmental impact. Among the main environmental impacts of alcohol consumption in Slovenia is the use of pesticides, as most alcohol is produced from fruit, grapes, or hops. Most of the pesticides in Slovenia are fungicides applied on permanent cropland, such as orchards, vineyards, and hop plantations [285]. Vineyards and hop plantations amount to 56% of Slovenia's total area of permanent crops, meaning that a large share of pesticides applied in Slovenia is used for producing beer and wine [258]. In this way, alcohol-related crop production competes with producing fruit for direct human consumption, which is particularly worrying in Slovenia, where only 30% of consumed fruit is grown in Slovenia, with the rest being imported [287,555]. Reducing alcohol consumption has been identified among the main opportunities to increase the sustainability of agriculture both in Slovenia as well as in the European Union [556], as less land used for alcohol production could be used for producing food, ecosystem restoration, or decrease the intensity of agriculture on existing permanent cropland and in other areas. Nevertheless, it is worth noting that much of alcohol in Slovenia is produced from fruit that would otherwise not reach consumers, as it would be discarded and could lead to higher fruit waste. Further, given that Slovenia has a large proportion of vineyards [557], de-alcoholisation offers an option for wine production in growing alcohol-free market. This practice may be encouraged as part of efforts to reduce overall alcohol consumption.

Risk groups. According to the WHO (2023), "there is no safe amount of alcohol that does not affect health," particularly with regard to cancer risk [552]. This is further supported by the Global Burden of Disease Study, published in The Lancet (2018), which concluded that "the level of alcohol consumption that minimises health loss is zero" [551]. Risk groups especially vulnerable to the adverse effects of alcohol intake are children, adolescents, individuals with underlying liver disease, pregnant women, and older adults. For individuals with underlying liver disease, no alcohol intake is safe [543]. Pregnant women who consume alcohol are at a heightened risk of pregnancy complications [544]. Occasional intoxication with alcohol and binge drinking may have detrimental effects, such as violence and traffic accidents [558].

Science advice.

Based on health outcomes. No amount of alcohol consumption can be considered safe for human health. For adolescents and pregnant and lactating women, complete abstinence is advised.

Based on environmental impacts. The negative environmental impacts of alcohol in Slovenia are mostly related to pesticide use and potentially reduce areas available for fruit production. This can lead to higher emissions of consumed fruit that have to be imported.

Overall science advice. There is no safe threshold for ~~regular~~ alcohol consumption. Adolescents and pregnant women are advised to abstain completely [13]. In addition, given the health and economic issues linked to alcohol consumption, and Slovenia's abundance of vineyards, prioritising de-alcoholisation is crucial. Alcohol-free alternatives such as non-alcoholic wine, beer, or kombucha can help reduce alcohol intake, especially at social events.

2.16. Ultra-Processed Foods

DIETARY INTAKE

UPFS

- Sweet and savoury packaged snacks
- Processed meats, poultry, breaded fish products (e.g., fish fingers/sticks or fish nuggets) meal replacements
- Margarine
- Instant soups
- Certain breakfast cereals
- Ice cream
- Carbonated drinks, protein shakes, etc.

HEALTH AND ENVIRONMENTAL EFFECTS

Beneficial health effects

Certain UPFs could be considered healthy from a nutritional point of view.

Adverse health effects

Regular consumption of UPFs is linked to increased risks of obesity, T2D, CVD, certain cancers, Crohn's disease, frailty, dementia and all-cause mortality.

UPFs high in refined carbohydrates, added fats, and salt are highly rewarding, appealing, and consumed compulsively, and may be addictive.

Environmental impacts

UPFs have varying environmental impacts depending on their ingredients. Animal-based products have higher impacts than plant-based ones. Palm oil products can negatively affect biodiversity.

Science advice and helpful tips

To enhance nutritional quality, whole foods should be favoured, and the consumption of UPFs, particularly those with poor nutritional profiles, should be reduced. When selecting UPFs, preference should be given to those with reduced levels of total fat, SFA, added/free sugars, artificial sweeteners, salt, additives, preservatives, flavour enhancers, and refined ingredients, and with higher levels of fibre and protein.

Dietary sources. The NOVA classification defines UPFs (**Group 4**) as ready-to-eat or ready-to-heat products that undergo extensive industrial processing and contain multiple additives, preservatives, artificial sweeteners, flavour enhancers, and refined ingredients. Common examples include sugar-sweetened beverages (SSBs), various soft drinks, both sweet and savoury packaged snacks, ice cream, potato crisps, pizza, commercial breads, cakes, biscuits, confectioneries, sweetened breakfast cereals, margarine, hamburgers, hot dogs, and other convenience foods. These foods are generally high in calories, added or free sugars, artificial sweeteners, salt, and/or **u**nhealthy fats (including SFA) while low in dietary fibre and **essential** micronutrients [467].

UPFs, often characterised by high levels of added/free sugars, unhealthy saturated/trans fats, salt, and various additives, have become a significant concern in dietary guidance, mainly because they have become a diet staple in many countries [559]. UPFs offer convenience but are typically energy-dense, higher in saturated/trans fats and added salt, but low in dietary fibre and micronutrients. They typically contain ingredients not commonly used in home cooking or traditional recipes. These ingredients are divided into two categories: those with little to no conventional culinary application and various additives designed to enhance taste, often creating intense flavours ('cosmetic additives'). Ingredients rarely used in conventional cooking and predominantly found in the production of UPFs encompass various forms of sugars (such as fructose, high-fructose corn syrup, fruit juice concentrates, inverted sugar, maltodextrin, dextrose, and lactose), artificial sweeteners, altered fats (such as hydrogenated or interesterified oils), and protein derivatives (including hydrolysed proteins, soy protein isolate, gluten, casein, whey protein, and mechanically separated meat) [467].

While UPFs are often linked to negative health effects, it is essential to distinguish between processed and UPFs. Some traditionally processed foods do not fall into the UPFs category, despite undergoing some level of processing. Additionally, not all UPFs are inherently unhealthy. The UPFs category is diverse and includes certain plant-based foods, such as burgers, vinegar, tofu, soy milk, unsweetened yoghurts and whole-grain bread. The level of processing in these foods varies. Plant-based burgers made from whole foods like legumes, vegetables, and grains tend to be more nutritious. At the same time, those containing refined ingredients – like coconut or palm oil, isolated proteins, additives, emulsifiers, and high salt content – are highly processed. Since the nutritional **quality** of these foods depends on their **ingredients and degree of processing**, it is important to assess **each product individually rather than assuming all UPFs are unhealthy.** Vinegar is **not an ultra-processed food**. It is made through **fermentation of ethanol by acetic acid bacteria** and is classified as a **processed culinary ingredient** (**NOVA Group 2**). It undergoes **simple mechanical or fermentation processes** rather than **industrial formulations**. Tofu is **also not necessarily an ultra-processed food**. Traditionally made **by coagulating soy milk and pressing curds into blocks, tofu involves minimal processing and is classified as a processed food** (**NOVA Group 3**). **However, some commercial tofu varieties contain additives or stabilisers, which may place them in the UPFs category. Despite this, minimally processed tofu made only from soybeans, water, and coagulants, remains a nutritious processed food.** Similarly, **soy milk is not automatically ultra-processed**. Plain soy milk, made **only from water and soybeans**, is classified as **processed** (**NOVA Group 3**), while **sweetened, flavoured, or modified versions** containing **preservatives, emulsifiers, and multiple additives** fall under **UPFs** (**NOVA Group 4**) [560–568]. In conclusion, the **NOVA classification** serves as a **guideline, not an absolute rule**. While some **plant-based foods** may be categorised as **UPFs** due to added ingredients and processing methods, this does **not automatically make them unhealthy**. **Vinegar, traditional tofu, and unsweetened soy milk** are **nutritious processed foods** that can be **part of a balanced diet**. The key is to **evaluate individual ingredients and processing levels** rather than **avoiding all processed foods indiscriminately**.

Current intake. The Slovenian population's intake of UPFs is currently unknown. Other countries have variable proportions of energy intake coming from UPFs, ranging from more than 50% in the United States and the United Kingdom to about 10% in Italy [569].

Health effects. Frequent consumption of common UPFs has been linked to a higher likelihood of developing obesity [570], T2DM [571], and CVDs [572]. The available evidence shows a consistent significant association between intake of UPFs and the risk of several cancers, including colorectal, breast, and pancreatic cancer. More modest associations were found for chronic lymphocytic leukaemia and central nervous system tumours [559,573]. Moreover, a high intake of UPF is associated to an increased risk of dementia in adults [574]. Additionally, increased risks of Crohn's disease [575], frailty in older adults [576], and all-cause mortality have been observed with regular UPFs intake [572]. In contrast, diets rich in unprocessed or minimally processed foods are associated with protective benefits against these health issues [577]. UPFs high in refined carbohydrates and added fats are highly rewarding, appealing, and consumed compulsively, and may be addictive [578].

Risk groups. High variability in UPF consumption among different population groups has been observed, due to factors such as price, accessibility, convenience, and possibly a lack of awareness. Children and youth are particularly vulnerable to UPF marketing and placement, while deprived populations often live in areas with limited access to healthier options. Men and individuals with overweight or obesity also tend to have higher UPF intakes [569]. Given the potential for UPFs to be addictive, the responsibility for their consumption should not be placed solely on individuals. Comprehensive systemic measures are recommended that promote healthier food choices through improved pricing and accessibility and for reduced availability of UPFs in public institutions, particularly schools and hospitals.

Environmental impact. The environmental impacts of UPFs can vary greatly depending on the ingredients used in their production. Products that contain animal-based ingredients, such as butter and milk, tend to have higher environmental impacts than those made with plant-based ingredients. Additionally, palm oil products may be associated with significant negative impacts on biodiversity.

Science advice.

Based on health outcomes. To improve dietary quality, whole foods should be chosen over UPFs, particularly those with poor nutritional profiles. When UPFs are consumed, preference should be given to products with lower levels of total fat, SFA, added sugars, and salt, and higher levels of fibre and protein. It is also advisable to promote awareness of the varied nature of UPFs, including their nutritional content and potential impact on health, for example through guidance on interpreting food labels.

Based on environmental impacts. When consuming UPFs, it is crucial to consider the ingredients. Products with a high percentage of animal-based ingredients or palm oil have a greater environmental impact. Plant-based alternatives should be chosen whenever possible.

Overall science advice. Whole foods should be prioritised over UPFs. When UPFs are consumed, preference should be given to products low in saturated and trans fats, free sugars, and salt; with few or no artificial sweeteners, additives, preservatives, flavour enhancers, or refined ingredients; and higher in fibre and protein. Integrated state-level measures are recommended to reduce the availability of UPFs in public institutions and to promote healthier food environments through improved pricing and access, in line with scientific guidance.

Chapter 3. Energy and Nutrient Intake

3.1. Energy Intake

The energy derived from different food groups is vital for meeting daily nutritional needs and supporting overall health. Energy (calories) is primarily obtained from carbohydrates and fats, and secondarily from proteins when carbohydrate intake is insufficient. Bacteria in the intestines break down some dietary fibres to provide a small amount of energy. When considering nutrition, it is essential to understand the energy density of food. Energy density is the amount of energy in a specific food, measured in calories per gram (kcal/g). The energy density of food can range from 0 to 9 kcal/g, depending on the nutrients present in the food. Fat has the highest energy density at approximately 9 kcal/g, while carbohydrates and protein have a more moderate energy density of around 4 kcal/g each [579]. This information is valuable for making informed food choices and for maintaining a healthy diet.

Consuming whole grains is beneficial for sustained energy levels as they contain complex carbohydrates and fibres. Along with these, legumes supply plant-based protein and energy, making them valuable for individuals following a planetary diet. Similarly, fruits are also a good source of energy from carbohydrates and essential vitamins, minerals, and fibre. Avocado, while calorie-dense, supplies energy primarily from healthy unsaturated fats but also contains fibres, vitamins, and minerals, recently essential parts of a balanced diet. Nuts and seeds are also energy-dense food groups, rich in essential nutrients including protein, healthy unsaturated fats, complex carbohydrates, fibre, vitamins, and minerals. Animal foods contain protein, oils contain fats, and beverages contain simple sugars as a carbohydrate nutrient, all providing energy. Balancing energy intake from these groups, avoiding UPFs, ensuring the appropriate composition of meals and portions sizes while eating ad libitum, and maintaining overall energy control are crucial for healthy body mass and well-being [474,562,565,580,581].

3.2. Macronutrients

3.2.1. PROTEIN

Dietary sources and intake. Foods 'sources of' protein are whole grains, legumes, nuts and seeds, green leafy vegetables (spinach and arugula), brassica (broccoli), fish, eggs and meat [165–168].

Main functions. Protein is essential for building and repairing body tissues, providing amino acids essential for various physiological functions like tissue repair, muscle synthesis, enzyme and hormone production, immune function, and maintaining cell and tissue structure [582]. Although animal foods are considered rich protein sources, current recommendations emphasise their moderate intake due to health and environmental concerns, aiming for a more sustainable food system [6,95,96,583,584].

Interestingly, a diet lower in total protein intake but rich in plant-based sources can benefit healthy people up to 65 years of age [585]. A balanced planetary diet should prioritise plant-based options to ensure adequate intake of essential amino acids while incorporating recommended protein sources for overall health [6,133,199,586,587]. For older adults (>65 years) with marginal or inadequate protein intake (<0.8 g/kg/day), where most protein is consumed in the evening, it is recommended to distribute protein intake more evenly throughout the day. Increasing protein consumption at breakfast and lunch can help achieve a moderately higher total protein intake and support skeletal muscle health. For individuals who already consume adequate protein (0.8–1.3 g/kg/day), having at least one high-protein meal per day may be sufficient to maintain muscle-related health [588]. **SR and MA examined whether increasing daily protein intake improves lean body mass, muscle strength, and physical performance in healthy, non-obese adults, considering resistance exercise, age, and protein intake levels. Higher protein intake enhanced lean body mass gains in resistance exercise participants** (**<65 years:** ≥1.6 g/kg/day; ≥65 years: 1.2–1.59 g/kg/day). Lower-body strength improved with protein intake of ≥1.6 g/kg/day during resistance exercise, while bench press strength showed a slight increase. No clear effects were found on handgrip strength or physical function [589].

Plant-based foods contain all essential amino acids and can serve as high-quality protein sources. Additionally, the overall protein quality and quantity of an individual's diet are crucial for optimal nutrition [199,583,590,591]. Additionally, the limitations of some plant proteins include low essential amino acids (EAAs) and leucine content, reduced protein bioavailability, and lower protein content per serving. These issues can be addressed by combining various food groups to ensure sufficient intake of all EAAs and leucine, employing preparation and cooking methods to enhance protein bioavailability, and increasing serving sizes of plant foods or isolated plant proteins, as lower protein content often correlates with lower protein density [592].

Recent evidence indicates that plant-based diets can effectively support muscle hypertrophy in untrained individuals, producing results comparable to omnivorous diets when protein intake is properly matched [593,594]. For those who are untrained, there is no need to meticulously combine different plant-based protein sources or increase portion sizes at each meal, as long as a variety of whole foods and adequate energy are consumed daily [590,595–598]. Additionally, consuming approximately 25 g of various plant-based proteins in a main meal is vital to offset the lower general anabolic properties of plant-based protein, ensuring optimal muscle protein synthesis [599]. For trained individuals and advanced athletes, evidence on plant-based proteins is limited, and more research is needed to address their specific protein requirements. Resistance-trained athletes seeking muscle hypertrophy while minimising fat gain face challenges due to the lower caloric density of plant-based proteins. Careful selection and combination of these protein sources (e.g., beans and rice), including plant-based dietary supplements (e.g., soy protein isolate), can help meet their needs [593,594]. However, many healthy adults, including endurance and strength/power athletes, do not prioritise reaching maximum muscle synthesis or mineral bone density [600,601]. Furthermore, slightly increasing protein intake and a low-energy diet can help retain muscle mass and promote fat loss when losing excess body mass is desired [602,603].

Health effects

- **Beneficial effects.** A diet high in plant protein is associated with a decreased risk of T2D, as well as all-cause and CVD mortality, especially among individuals with at least one lifestyle risk factor [604,605].
- **Adverse effects.** Research suggests that a diet high in animal protein is associated with an increased risk of CV mortality [604]. Therefore, substituting some excess animal protein currently consumed with plant protein may contribute to longer life expectancy. Plant protein intake has been associated with a reduced risk of mortality from all causes and CVDs, emphasising the importance of protein sources in a healthy diet [604–607]. In people with chronic kidney disease the protein intake should be limited to 0,8 g/kg of body mass if metabolically stable [608].
- **Dietary reference values and current intake.** The recommended daily intake of protein is 47 g for adult men and 55 g for adult women (equivalent to 0.8 g of protein per kg of body mass per day), representing about 10–15% of daily energy for

both sexes [166,167]. According to EFSA, the recommended Population Reference Intake (PRI) for protein is 0.83 g per kg of body mass to maintain neutral nitrogen balance. In adults, consuming up to twice the PRI is considered safe. Such intake levels are commonly observed in physically active individuals, including athletes and those aiming to lose body fat [609].

- Based on Slovenian data, the average protein intake is 82 g per day in adult men (equivalent to 1.2 g per kg of body mass or 19% of energy) and 114 g per day in adult women (equivalent to 1.4 g per kg of body mass or 20% of energy) [24].

3.2.2. CARBOHYDRATES

Dietary sources and intake. Carbohydrates are found in both plant-based and animal-based foods. The most abundant plant-based carbohydrate sources are cereals such as wheat, oats, buckwheat, millet, quinoa, and rice. Carbohydrates are also found in tubers (potatoes and sweet potatoes), legumes (including beans, chickpeas, lentils, and soybeans), and fruits (such as apples, berries, citruses, and grapes). While nuts, seeds, and avocados are primarily rich sources of unsaturated fats, they also contain a small amount of carbohydrates. In animal-based foods, carbohydrates are mainly found in lactose (milk sugar) and honey [610,611].

The quality of dietary carbohydrates is generally influenced by the amount of added or free sugar and dietary fibre content within the carbohydrate source. It is essential to differentiate healthy carbohydrates from unprocessed or minimally processed sources like whole-grain cereals and added sugars such as plain sugar, syrups, and white flour, including their derivative products [127]. Free sugars are defined as all monosaccharides and disaccharides added to foods and beverages by manufacturers, cooks, or consumers, plus sugars naturally present in honey, syrups, fruit juices, and fruit juice concentrates [612].

In addition, experts have proposed new criteria to assess the quality of carbohydrates in the diet. This tool is particularly useful for identifying carbohydrate-rich food products containing too much added or free sugar. The criteria recommend consuming at least 1 gram of fibre and less than 1–2 grams of free sugar for every 10 grams of carbohydrates in a diet or product to maintain a balanced diet [613].

Main functions. Carbohydrates are crucial in a balanced diet, which is necessary for overall health. They serve as the main energy source for the brain and muscles [614]. However, the quality of carbohydrates is more important for health than the quantity consumed. Substituting refined carbohydrates with those from whole foods or healthy unsaturated fats can significantly improve public health [615].

Health effects

- **Beneficial effects.** Cereals, vegetables, fruits, and pulses are recommended as the primary sources of carbohydrates in the diet [616]. Consuming high amounts of carbohydrates and dietary fibre from the above-mentioned foods and potatoes (prepared in a healthy way) has a beneficial impact on metabolic health [128,202,611,617]. Studies have shown that diets consisting of 45–60% energy from carbohydrates, especially when these carbohydrates are of high quality, are linked to lower overall mortality rates among adults [618,619].
- **Adverse effects.** The European Food Safety Authority (EFSA) found moderate evidence from RCTs that a higher intake of added and free sugars is causally linked to an increased risk of obesity and dyslipidaemia [620]. Additionally, a MA of 25 studies (6 cohorts and 19 RCTs) has shown that consuming fruit juice, which is high in calories, can lead to weight gain. Limiting fruit juice consumption is recommended to maintain a healthy weight [621]. The effect of free sugars on body mass appears to be primarily due to changes in energy intake [612,620,621]. These findings highlight the importance of monitoring and managing the intake of free sugars to mitigate health risks associated with obesity, dyslipidaemia, and dental health. In a recent prospective cohort study, consuming ≥ 2 servings of SSBs per week was linked to an increased risk of CVD, regardless of physical activity levels. This finding supports the current recommendations to reduce SSB intake, even for those who are physically active [622].
- **Dietary reference values and current intake.** The recommended intake of carbohydrates for adults is > 50% of energy [166,167]. The WHO, in its guidelines, recommended reducing the intake of free sugars to less than 10% of total energy. Moreover, a conditional recommendation advised further limiting free sugar intake to below 5% of total energy. This advice was primarily based on the impact of sugars on adult body mass and, for the stricter limit, on dental caries [612]. The SACN supports this, recommending that the average intake of free sugars across the population should not exceed 5% of total energy [177]. In Slovenia, carbohydrates account for 46% of total energy intake in adult men and 42% in adult women, with both sexes consuming 7% of their total energy as free sugars [24].

3.2.3. DIETARY FIBRE

Dietary sources and intake. The term 'dietary fibre' lacks a universal definition but is generally understood to include non-digestible carbohydrates and other components like lignin found in plant cell walls. These fibres are resistant to hydrolysis in the small intestine but may be partially fermented by bacteria in the large intestine [177]. Dietary fibres are also defined as naturally occurring plant polysaccharides and those in human milk, which human digestive enzymes cannot completely break down [623]. Natural dietary fibres include cellulose, hemicellulose lignin, pectins, β-glucans, oligosaccharides, and resistant starch [624]. Foods 'high in' fibre are cereals, legumes, fruits, vegetables, potatoes, nuts and seeds, and certain spices such as rosemary and turmeric [165–168]. Previously, dietary fibre was categorised into soluble and insoluble types. Soluble fibre, such as pectin and β-glucans (found in oats and barley), dissolves in water. In contrast, insoluble fibre, like cellulose and hemicelluloses, does not dissolve in water and has a bulking effect on stool [177]. Since this classification depends on the method of testing and solubility does not consistently predict fibre's effects on the body, it has been proposed that the distinction between soluble and insoluble fibre should be phased out [625]. Despite this proposal, the terms remain in common use.

Main functions. Dietary fibre is an essential component that helps improve digestion and absorption of nutrients in the small intestine. It also plays a vital role in enhancing satiety and reducing the time required for food to pass through the body. Soluble fibre, such as β-glucans, slows down nutrient absorption by creating a barrier that reduces the rise of blood glucose and lipid levels after eating. β-glucans also help reduce blood cholesterol levels by decreasing bile acid absorption [624]. The fact that fibre can be fermented (resistance starches are insoluble and highly fermentable, while soluble fibres are generally fermentable) is of utmost importance. It serves as food for the healthy bacteria in our gut, leading to the production of short-chain fatty acids (SCFAs). These are essential metabolites produced by the gut bacteria in the large intestine. SCFAs, which can be produced from dietary fibre, have been shown to lower the rate of cholesterol synthesis in the liver [623].

Health effects

- **Beneficial effects.** Numerous studies consistently emphasise the health benefits of increasing dietary fibre intake. The most convincing evidence associates it with lower risks of all-cause mortality, coronary heart disease, and colorectal cancer [63,64,128,584,618,623,626,627]. While the evidence supporting its protective effect against stroke and T2D is less strong, it is still significant. The effect on body mass is evident but modest. Ensuring an adequate dietary fibre intake is crucial for lowering the risk of constipation and reducing the likelihood of developing NCDs such as colorectal cancer, CVD, and T2D. Foods 'high in' fibre also support maintaining a healthy body mass, help with weight loss, and enhance insulin sensitivity. Additionally, dietary fibre supports gut health, immune function, and regular bowel movements while helping to control satiety and reducing cancer risk [63,64,128,584,618,623,626,627].
- **Adverse effects.** Foods 'high in' fibre, such as legumes and brassica vegetables, may cause flatulence. To reduce this, it is recommended to gradually introduce these foods into the diet, soak or sprout legumes, allow time after chopping before cooking, extend the cooking time for vegetables, and incorporate fermented food

into meals [628–630].

- **Dietary reference values and current intake.** The recommended daily intake of dietary fibre for adults and the elderly is 30 g [166,167]. In Slovenia, however, the average intake is only 21 g/day in adults and 22 g/day in the elderly, which is significantly below the recommended intake. Consequently, 90% of adults and 84% of the elderly fail to reach the recommended intake of at least 30 g per day [32].

3.2.4. FAT

Dietary sources and intake. 'Healthy fats', like those found in olives and flaxseeds, are rich sources of monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) [631,632]. Omega-3 PUFAs are further divided into ALA, EPA, and DHA. 'Sources of' n-3 PUFA, specifically ALA, include green leafy vegetables (such as spinach and arugula), brassica vegetables (such as broccoli), nuts and seeds (such as walnuts, flax, hemp, and chia seeds), and oils (such as flax, walnut and hemp oil). 'Sources of' n-3 LCP (EPA and DHA) are fish and seafood [165–167,200]. In contrast, linoleic acid (LA), an essential n-6 fatty acid, is commonly found in vegetable oils, nuts, seeds, cereals, meat, and processed and fried foods [633].

In contrast, 'unhealthy fats', such as SFA, are commonly found ('high in') in tropical oils/fats (coconut and palm oil), milk, cheese (except mozzarella), butter, ghee, processed meat, eggs, and lard [162,163,165–167,431,432,441,634]. Trans fatty acids (TFA), the most 'unhealthy fat', naturally occur in meat and dairy, including beef, lamb, and full-fat dairy products like butter and cheese. They are also industrially produced through hydrogenation and are found in many processed foods such as fried foods, baked goods, and packaged snacks [439,635]. In 2018, Slovenia implemented a regulation prohibiting the sale of food products containing more than 2 g of industrially produced trans fats per 100 g of fat [636]. It is crucial to prioritise healthy unsaturated fats while minimising the intake of TFA and SFA from processed and fried foods for overall health and well-being [441].

Main functions. Dietary fat is essential for overall health, supplying concentrated energy, facilitating vitamin absorption, and supporting various bodily functions such as brain health and hormone production [637]. Healthy fat sources, such as avocados, nuts, seeds, and fatty fish, offer these benefits [302,638]. Consuming PUFAs, specifically n-3 and n-6 fatty acids, is essential for a healthy diet [639–643]. Maintaining adequate intakes of both n-3 and n-6 fats is crucial for optimal health. Inadequate consumption of n-3 should be addressed by evaluating dietary intake, checking the level of n-3 in the blood, and consulting with a nutritionist or physician before using dietary supplements.

Health effects

- **Beneficial effects.** MUFAs improve cholesterol levels and reduce inflammation [644,645].
- **Adverse effects.** SFA is found in tropical oils/fats such as coconut and palm oil, milk, cheese (except mozzarella), butter, ghee, processed meat, eggs, and lard can increase the risk of heart disease [646–648]. Certain studies may manipulate results by limiting meat and egg intake while increasing fruit and vegetable consumption in the intervention group, potentially leading to confusion among individuals [649–651].
- **Dietary reference values and current intake.** The recommended daily fat intake for adults in Slovenia is 30% of total energy intake. For pregnant women after the fourth month of pregnancy and for lactating women, the recommendation is 30–35%. This intake should include at least 10% MUFA, 7–10% PUFA, and less than 10% SFA. Additionally, adults should consume 0.5% ALA and 2.5% LA. Pregnant and lactating women should also consume at least 200 mg of DHA per day [166,167]. Dietary recommendations emphasise limiting SFA and TFA intake to promote heart health. Substituting SFA and TFA (found in cakes, margarine, fried foods, butter, meat and processed meat [652]) with unsaturated fatty acids (MUFA and PUFA) found in foods such as nuts, seeds, avocados, and fatty fish benefits heart health [440]. However, consuming these fats in moderation as whole foods is crucial to avoid excessive calorie intake while enjoying their benefits. Slovenian adults consume 27% of energy from fat [24]. Furthermore, 30% of adults and 42% of the elderly exceed the upper recommended limit for TFA of 0.50% energy [652].

3.2.5. DIETARY CHOLESTEROL

Dietary sources and intake. Dietary cholesterol is primarily found in animal-based foods such as eggs, red and white meat, milk, cheese, yoghurt, and other dairy products. Dietary cholesterol differs from blood cholesterol, which the liver naturally produces for cell membranes and hormone synthesis [653].

Main functions. Cholesterol is a vital molecule that plays a crucial role in our body. Both its excess and deficiency can lead to various diseases such as CVD, mental disorders, neuropsychiatric diseases, and even mortality in the elderly. Although most clinicians understand its function in stabilising cellular plasma membranes, they overlook its numerous other functions. Additionally, cholesterol is a precursor for synthesising steroid hormones, bile acids, and vitamin D [654,655]. Since the liver synthesises all necessary cholesterol, dietary cholesterol is not essential in the human diet [655,656]. The body synthesises about 1 g of serum cholesterol for vital needs [657]. Additionally, the absorption of dietary cholesterol varies from 29% to 80%, with an average absorption rate of 60% [658].

Health effects

- **Beneficial effects.** Cholesterol is a major component of cell membranes, helping maintain their structure and fluidity, and is essential for cellular function. It serves as a precursor for synthesising hormones such as oestrogen, progesterone, testosterone, and cortisol, which regulate several physiological processes. Cholesterol is a precursor for synthesising vitamin D in the skin upon exposure to sunlight, which is essential for bone health and other functions. Cholesterol is used in the liver to produce bile acids, which aid digestion and absorption of fats and fat-soluble vitamins. Cholesterol is crucial for developing and maintaining the central nervous system, including the brain, which contributes to synapse formation and neurotransmitter function [654,655].
- **Adverse effects.** The health risks associated with high cholesterol levels are atherosclerosis, CVD, and limited catabolism and accumulation. Atherosclerosis is a condition where plaque builds up inside the arteries, leading to narrowed or blocked arteries, significantly increasing the risk of CVD (heart attacks and strokes). High levels of LDL cholesterol are linked to an increased risk of CVD, which is the leading cause of death and disability in the Western world, including in Slovenian women [27]. Humans have a limited ability to break down cholesterol, meaning that excess dietary cholesterol or cholesterol produced due to genetic factors can accumulate in the body, exacerbating the risks of CVD [378,654]. Moreover, foods high in cholesterol also tend to contain significant amounts of SFA and salt. These increase LDL cholesterol levels and blood pressure, which can further augment the risk of CVD [659,660].
- **Dietary reference values and current intake.** It is recommended to limit the intake of dietary cholesterol to no more than 300 mg per day [166,167]. Data on the dietary cholesterol intake of the Slovenian adult population is not available.

3.3. Micronutrients

3.3.1. VITAMIN B12

Dietary sources and intake. Vitamin B12 is a water-soluble vitamin and can be obtained from animal-derived foods, fortified foods or/and dietary supplements, although it is naturally synthesised by some bacteria and archaea [407,661,662]. Food 'sources of' B12 include meat, fish, eggs, and dairy products [165–168]. Ruminant animals (e.g., cows, sheep, goats) naturally produce B12 through gut bacteria, which is stored in their tissues. However, modern farming has reduced other natural B12 sources, such as soil and water. Non-ruminant animals (e.g., pigs, poultry, farmed fish) lack B12-producing bacteria, and even ruminants may have limited synthesis due to grain-based diets and antibiotics. To compensate, livestock feed is often fortified with B12 dietary supplements, meaning people consuming meat for B12 are often indirectly consuming supplemented B12 [663].

Main functions. Vitamin B12 is required for the development, myelination, and function of the central nervous system, healthy red blood cell formation, and DNA synthesis [407,664].

Health effects

- **Beneficial effects.** Vitamin B12 is enzyme cofactor. Sufficient levels of B12 help prevent megaloblastic anaemia (production of abnormally large and inefficient red blood cells) and neurological dysfunction [664]. Vitamin B12 is essential to produce red blood cells in the bone marrow. Vitamin B12 plays a crucial role in maintaining the health of the nervous system. It supports myelin production, a protective sheath around nerves, facilitating efficient nerve signalling. Some research suggests that maintaining adequate levels of B12 may support cognitive function and reduce the risk of neurodegenerative diseases, such as Alzheimer's disease. Adequate B12 intake is associated with lower levels of homocysteine, an amino acid linked to an increased risk of CVD. By helping to metabolise homocysteine, B12 may help maintain heart health [664–666].
- **Adverse effects.** Vitamin B12 deficiency can cause neurological symptoms, muscle cramps, fatigue, psychiatric symptoms, and even erectile dysfunction [667]. It is crucial not to underestimate the risk of developing a B12 deficiency in those following a plant-based diet [12] and those consuming animal-based foods a few times a week [668]. People with digestive issues, those following plant-based diets, or those over 50 may need B12 dietary supplements to prevent deficiency [407,669,670]. A nutritionist or physician should decide on the amount and frequency of dietary supplement intake based on an individual's diet and health status [671,672]. High levels of vitamin B12 have been associated with an increased risk of mortality, lung and kidney disease, and liver damage [673,674]. For those individuals consuming a plant-based diet, it is crucial to ensure adequate vitamin B12 intake by fortified food or dietary supplements to prevent deficiency [407].
- **Dietary reference values and current intake.** The recommended daily intake of vitamin B12 is 4 µg. For pregnant women the recommended intake is 4.5 µg, and for lactating women it is 5.5 µg [166,167]. Vitamin B12 intake in Slovenia is insufficient, with 43% of adults and 21% of older adults reporting inadequacies. Consequently, many older adult men and women exhibit lower serum vitamin B12 levels: 46% of older adults and 21% of adults have levels below 221 pmol/L. The

prevalence of vitamin B12 deficiency, defined by low serum vitamin B12 levels (<148 nmol/L) and high serum homocysteine levels (>15 μmol/L), is 2.3% among adults and 7.0% among older adults [34].

3.3.2. VITAMIN C

Dietary sources and intake. Vitamin C, also known as ascorbic acid, is a water-soluble vitamin. Vitamin C cannot be synthesised endogenously in humans and is therefore an essential dietary component. Foods that are a 'source of' vitamin C include fruits (especially kiwi fruit, citruses, strawberries, cantaloupe), vegetables (red and green peppers, tomatoes, broccoli, Brussels sprouts), potatoes and other tubers, and certain herbs and spices (parsley, turmeric, and rosemary) [165–168]. Heat and air exposure can reduce vitamin C content in foods. Boiling causes significant loss while steaming and microwaving preserve it better. Chopping fruits and vegetables may lead to minor vitamin C degradation [675–677].

Main functions. Vitamin C is an antioxidant that protects cells from damage caused by free radicals while boosting the immune system. It is also a cofactor for several enzymes involved in the biosynthesis of collagen, carnitine, and neurotransmitters. It helps absorb iron and supports healthy skin, blood vessels, and bones [678].

Health effects

- **Beneficial effects.** Increasing vitamin C intake can reduce the risk of all-cause mortality, CVD, and several cancers, including gastric, pancreatic, breast, prostate, renal, and lung cancer. Vitamin C intake also benefits respiratory, neurological, ophthalmologic, musculoskeletal, renal, and dental outcomes [679,680].
- **Adverse effects.** At very high intakes, adverse effects of vitamin C include diarrhoea and gastrointestinal disturbances, as well as oxalate formation and kidney stone formation in susceptible individuals [681]. Its toxicity level has no known upper limit; however, the authorities suggest an upper tolerable level of 1–2 g per day [681]. Smokers may have increased requirements for vitamin C and are at risk of inadequate intake. Prolonged deficiency of vitamin C causes scurvy. A risk factor is low intake of fruits, fruit juices and vegetables [681].
- **Dietary reference values and current intake.** The recommended vitamin C intake is 95 mg daily for women and 110 mg for men [166,167]. Data on the vitamin C intake of the Slovenian adult population is not available. To ensure adequate vitamin C intake, aim to consume at least five servings of fruits and vegetables daily [129,356]. These can be fresh, frozen, canned, or cooked using various methods.

3.3.3. VITAMIN D

Dietary sources and intake. Vitamin D is a fat-soluble vitamin obtained through sun exposure, certain foods, and/or dietary supplements [167]. Vitamin D3 (cholecalciferol) is a steroid-like compound synthesised in human skin from 7-dehydrocholesterol through exposure to ultraviolet B (UVB) light from the sun within the 290–315 nm wavelength range [682,683]. Slovenia is situated at a latitude of 46°N, where the sun radiation for a part of the year is insufficient for vitamin D3 production in the skin. Obtaining enough vitamin D through diet alone is challenging since very few foods contain enough. Fatty fish are food 'sources of' vitamin D [165–168]. In lesser amounts, it can also be found in beef liver, egg yolk, and cheese, which are high in SFA, cholesterol, potential contaminants, and certain UV-exposed mushrooms [25,684].

Main functions. Vitamin D is an essential nutrient and a pro-hormone. It is first hydroxylated to 25-hydroxyvitamin D [25(OH)D] in the liver. Thereafter, it is further hydroxylated to the active form of vitamin D, 1,25-dihydroxy vitamin D (calcitriol), predominantly in the kidneys and other tissues [682,683]. Vitamin D is essential for the immune system. It reduces inflammation, while many genes encoding proteins that regulate cell proliferation, differentiation, and apoptosis are also modulated in part by vitamin D [683]. Vitamin D facilitates calcium absorption in the intestines and maintains optimal serum calcium and phosphate levels, which are vital for normal bone mineralisation and maintaining a healthy skeleton. Vitamin D supports bone growth and remodelling. Sufficient vitamin D intake prevents rickets in children and osteomalacia in adults. Furthermore, when combined with calcium and physical activity (strength training), vitamin D protects against osteoporosis [685–688].

Health effects

- **Beneficial effects.** Adequate vitamin D is associated with a lower risk of chronic diseases, including COVID-19 infection, depression, increased BMI, cancer mortality, and total mortality [682,689–692].
- **Adverse effects.** Adverse effects of excessive vitamin D intake, which enhances calcium absorption from food, include hypercalcaemia. Vitamin D deficiency is widespread, especially during winter, due to less sun exposure and a predominantly indoor lifestyle [166,693,694]. Vitamin D deficiency leads to impaired mineralisation of bone due to an inefficient absorption of dietary calcium and phosphorus. It is associated with increased serum parathyroid hormone (PTH) concentration. Frail older adults, people with low sun exposure (due to institutionalisation) and people with dark skin pigmentation are at risk of vitamin D deficiency [25,682]. Supplementation is recommended during

autumn and winter, while sun exposure is sufficient during spring and summer [684,695]. A daily dietary supplement of 2000 IU of vitamin D3 can help prevent and treat vitamin D deficiency in adults, improving health outcomes [696]. The tolerable upper intake level is 4000 IU (100 mcg) per day [697]. Personalised recommendations based on dietary patterns, lifestyle, health status, and body composition should be sought from a nutritionist or physician [698,699].

- **Dietary reference values and current intake.** The recommended daily intake of vitamin D is 20 µg (equivalent to 800 IU) per day [700]. More recent Slovenian recommendations advise 1500–2000 IU per day throughout pregnancy and 1000–2000 IU per day (or 14,000 IU per week) year-round for adults over 70 years of age [701]. A Slovenian survey conducted on a representative sample of healthy Slovenians aged 18 to 74 found exceptionally low vitamin D intakes. Many did not even meet the threshold for exceptionally low vitamin D intake (2.5 µg per day). Mean daily vitamin D intake (not including dietary supplements) was 2.7, 2.9, and 2.5 µg in adolescents, adults, and the elderly, respectively. In the autumn-winter period, approximately 80% of Slovenian adults had insufficient blood levels of vitamin D (25(OH)D <50 nmol/L), and nearly 40% of healthy adult Slovenians had severe vitamin D deficiency (25(OH)D <30 nmol/L [25]. The widespread deficiency of vitamin D is a serious issue that deserves separate consideration beyond the scope of this document.

3.3.4. FOLATE (VITAMIN B9)

Dietary sources and intake. Foods that are a 'source of' folate include whole grains, legumes/pulses, nuts and seeds [165–168]. Dietary folate is sensitive to light and oxidation and is partly degraded by cooking. Synthetic folate (known as folic acid) is mainly found in dietary supplements [702].

Main functions. Folate, or vitamin B9, is an essential micronutrient soluble in water. It is vital for forming red blood cells, supporting healthy cell growth and function, and foetal development. It also has metabolic function and acts as a cofactor for enzymes in one-carbon metabolism, thus important for the biosynthesis of nucleotides (RNA and DNA). Additionally, folates are important for converting homocysteine into methionine. Taking folic acid dietary supplements before conception, alongside regular dietary intake of folate, is key in preventing neural tube defects such as spina bifida and anencephaly in infants [702,703].

Health effects

- **Beneficial effects.** Adequate intake of folate protects against folate deficiency anaemia. Sufficient folate levels decrease the all-cause mortality rate and the risk of certain cancers, CVD, and neurological conditions. For pregnant women, adequate status lowers the risk of neural tube defects in offspring [704].

- **Adverse effects.** Low folate intake can lead to anaemia and CVD [703]. The deficiency is mainly caused by insufficient consumption of dark green leafy vegetables, cereals, nuts, and legumes [705,706]. Excessive folate intake, usually as a dietary supplement (folic acid), may increase the risk of prostate cancer, colorectal adenomatous lesions, asthma or wheezing, and depression [704]. Moreover, folic acid at high intakes can hide vitamin B12 deficiency symptoms, leading to delayed diagnosis and potential anaemia and neurological damage [707].
- **Dietary reference values and current intake.** The recommended daily intake of folate for adults is 300 µg, while pregnant and lactating women should increase the intake to 550 µg and 450 µg, respectively [166,167]. However, studies have shown that most adults (58%) and older people (68%) in Slovenia do not meet this dietary requirement [708].

3.3.5. IRON

Dietary sources and intake. Food 'sources of' iron include cereals, vegetables such as spinach and carrots, nuts and seeds, spices and herbs, and red meats such as beef, blood sausage, and salami [165–168]. Dietary iron has two main forms: haem (Fe^{2+}; from animal tissues) and non-haem (Fe^{3+}; from plants and iron-fortified foods) iron. Plants and iron-fortified foods contain non-haem iron only, whereas meat, seafood, and poultry contain both haem and non-haem iron [709,710]. Plant-based (non-haem) iron is not absorbed as efficiently as (haem) iron from animal-based foods [711–714]. The absorption of non-haem iron is enhanced by vitamin-C-rich foods such as fruits, bell peppers, broccoli, and vinegar [715–717], while it is inhibited by milk, coffee (due to polyphenols in both regular and decaffeinated coffee), tea (especially non-herbal teas such as black and green tea, due to tannins), red wine, egg yolks, and cocoa, as well as phytate and polyphenols [716,718]. To optimise non-haem iron absorption, it is advisable to avoid consuming these beverages and foods within one hour of a meal. Herbal teas, which are low in tannins, have little to no effect on iron absorption [513,532,714,716,717,719]. Iron absorption is homeostatically regulated, i.e., upregulated when iron stores are low and downregulated when iron stores are high. Iron is recycled in the body, and humans have no pathway to excrete surplus iron [709,720].

Main functions. Iron is necessary for the functioning of haemoglobin and myoglobin, which are responsible for transferring oxygen throughout the body. It is also essential for healthy connective tissue, physical growth, cellular functioning, neurological development, many enzymes involved in energy metabolism, the synthesis of certain hormones and other functions in different tissues, including the brain [709,721,722]

Health effects

- **Beneficial effects**. Adequate iron levels ensure efficient oxygen delivery, supporting overall energy levels and preventing fatigue. Sufficient iron levels are necessary for optimal brain health, including memory, concentration, and overall cognitive performance [721,722].
- **Adverse effects.** Ensuring sufficient iron intake through dietary sources or supplementation is crucial for maintaining overall health and well-being. Both iron deficiency and iron overload can have adverse effects on health. Iron deficiency can cause fatigue, reduced concentration, dizziness, tinnitus, pallor, headache, restless leg syndrome, alopecia, dry hair or skin, koilonychia, and atrophic glossitis [721–723]. High-dose iron dietary supplements can cause mucosal erosion in the stomach and intestine, leading to nausea, abdominal pain, vomiting and diarrhoea. Even higher doses may lead to systemic iron overload and can result in gastrointestinal bleeding, shock, metabolic acidosis and acute liver failure [709].
- **Dietary reference values and current intake**. The recommended daily intake of iron is 10–15 mg for adult men and 10 mg for adult women. For pregnant women the recommended intake is 30 mg, and for lactating women it is 20 mg [165,166]. Inadequate iron intake has been reported in 33% of Slovenian adults (including 76% of women aged 18–50 years) and in 14% of older adults [33].

3.3.6. MAGNESIUM

Dietary sources and intake. Food 'sources of' magnesium include cereals, legumes/pulses, green leafy vegetables, nuts and seeds, and spices and herbs (onion, parsley, ginger, cinnamon, turmeric, rosemary). Generally, foods containing dietary fibre provide magnesium [165–168].

Main functions. Magnesium is an abundant mineral in the body and is naturally present in many foods. *It* is a cofactor of many enzymes and necessary in a large number of biochemical and physiological processes such as energy metabolism, neurological and muscular function, muscle contraction, function of cells and membranes, glucose transport, electrical potential in nerves and cell membranes, transmission of neuromuscular impulses, blood pressure regulation, normal heart rhythm, blood glucose control, and healthy bones [724–726].

Health effects

- **Beneficial effects**. Adequate magnesium intake reduces the risk of metabolic syndrome and cancer mortality rates. It may be associated with a lower risk of T2D and stroke [726–729].
- **Adverse effects.** The adverse effect of high magnesium intake is diarrhoea [730].

Magnesium deficiency is uncommon due to its regulated excretion. Prolonged low intakes or certain health conditions can lead to magnesium deficiency, which can cause nausea, loss of appetite, vomiting, and weakness. Long-term deficiency may be associated with migraine headaches, Alzheimer's disease, stroke, high blood pressure, heart disease, and T2D [724,725].

- **Dietary reference values and current intake.** The recommended daily magnesium intake is 300–310 mg for men and 350–400 mg for women. For pregnant women the recommended intake is 310 mg, and for lactating women it is 390 mg [166,167]. Data on magnesium intake in the adult Slovenian population are not available.

3.3.7. POTASSIUM

Dietary sources and intake. Potassium is an essential nutrient that is naturally present in many foods. 'Sources of' potassium-rich foods include potatoes and other tubers, legumes/pulses, nuts and seeds, and spices and herbs (turmeric) [165–168]. Among starchy foods, whole-wheat flour and brown rice are much higher in potassium than their refined counterparts, white wheat flour and white rice [165].

Main functions. *Potassium is present in all body tissues and is required for normal cell function, fluid balance, and acid-base balance.* It is particularly important for supporting bone health and healthy blood pressure [731,732].

Health effects

- **Beneficial effects**. A potassium-rich diet can lower blood pressure in individuals with hypertension and reduce the risk of CVD, stroke and premature death [733,734]. Therefore, increased potassium intake can be an important intervention to reduce CVD events. This is especially beneficial for people with low potassium and high sodium intake (> 4 g per day, equivalent to > 10 g of salt per day) since low potassium-to-sodium intake ratios are more strongly related to CVD risk than either nutrient alone [732,735,736].
- **Adverse effects**. There are no identified adverse effects of potassium in healthy individuals [737]. People with kidney dysfunction may have a risk of hyperkalemia, which may be lethal if untreated [732]. Insufficient potassium intake can increase blood pressure, kidney stone risk, bone turnover, and urinary calcium excretion. However, extreme potassium deficiency is rare due to its widespread presence in food [732]. Prolonged diarrhoea, vomiting, and use of laxatives or diuretics can cause potassium deficiency, leading to weakness, fatigue, constipation, and arrhythmias that can negatively impact the heart's ability to pump blood [732,736]. Elevated potassium intake is managed through either renal excretion or cellular uptake and release [737]. Notably, hyperkalemia, which is elevated potassium levels

in the blood, can be caused by heparin, potassium-sparing diuretics, and poor kidney function [738,739].

- **Dietary reference values and current intake.** The recommended potassium intake for men and women is 4000 mg daily, while lactating women should increase the intake to 4400 mg daily [166,167]. A recent national study conducted in 2022 indicated insufficient potassium intake, with the average daily intake of 2.9 g, 3.1 g in men and 2.7 g in women [740], well below the recommended levels.

3.3.8. CALCIUM

Dietary sources and intake. Food 'sources of' calcium include milk and dairy products (except cream), cereals (amaranth), pulses (dry soy), vegetables (cabbage), fruits (dry figs), and nuts and seeds (hazelnuts, almonds, flaxseed, chia seeds, and sesame seeds) [165–168]. Dairy products are the most common sources of calcium. People with lactose intolerance or following poorly designed plant-based diets may face difficulties getting enough calcium [67,741]. Broccoli, kale, and kiwi are other important plant sources of calcium, while spinach has a higher content of oxalates, which reduce calcium absorption [742–744].

Main functions. Calcium is the most abundant mineral in the body. Over 99% is stored in bones and teeth [745]. It is essential for healthy bones and teeth, muscle contractions, blood clotting, vasodilation, nerve transmission, and hormonal secretion [746].

Health effects

- **Beneficial effects**. Adequate calcium intake mitigates hypertensive disorders, decreases blood pressure, especially in young individuals, prevents osteoporosis and colorectal adenomas, and reduces cholesterol levels. Furthermore, the offspring of mothers who maintain adequate calcium intake during pregnancy may also experience lower blood pressure [747]. Adequate calcium intake, together with regular physical activity, especially resistance training, is an important preventive measure for bone health [688,748–752]. Calcium sufficiency prevents rickets, osteomalacia and fractures [745]. Calcium intake from foods is safe, while calcium dietary supplements may cause constipation. Combining calcium dietary supplements with vitamin D supplements may increase the incidence of kidney stones [745].
- **Adverse effects**. No qualified adverse effect can be identified. Excessive calcium intake may adversely affect mineral metabolism in combination with high vitamin D intake [682,745]. Inadequate calcium intake may adversely affect adult bone health [753]. Additionally, high dairy calcium intakes were found to be associated with a higher risk of prostate cancer, while dietary supplemental and non-dairy

calcium showed no significant association with this risk [383].

- **Dietary reference values and current intake.** The recommended daily calcium intake for men and women is 1000 mg [166,167]. This recommendation is based on very short-term studies rather than fracture risk [348]. Data on calcium intake for adult Slovenians are not available.

3.3.9. SODIUM

Dietary sources and intake. The dietary intake of sodium (sodium chloride (NaCl)) encompasses the modest quantities naturally occurring in foods, higher levels incorporated during kitchen and table food preparation, and even larger amounts added during the industrial processing of many food products. One gram of salt corresponds to about 0.4 g of sodium, and 1 g of sodium is equivalent to 2.5 g of salt. Foods 'high in' sodium (NaCl, dietary salt) include pickled vegetables, canned fish, cheese, processed meats and snacks (bakery foods, crisps, and salted nuts) [165–168].

Main functions. *Sodium* is a crucial mineral that helps regulate the body's fluid balance, nerve function, and muscle contractions [754].

Health effects

- **Beneficial effects**. Sodium enables the functioning of cells, membranes, muscles, and nerves [755].
- **Adverse effects**. High intake of sodium increases the risk of CVD and stroke by elevating blood pressure. The risk of elevated blood pressure due to high sodium intake increases with ageing [756]. It also contributes to the development of chronic kidney disease, gastric cancer, calcium nephrolithiasis, and osteoporosis. Sodium intake is associated with mortality [754]. Acute toxicity with fatal outcomes has been reported with single doses of about 7 g. Lower amounts may be detrimental for subjects with heart failure, renal failure or decompensated liver cirrhosis [755]. Limiting sodium intake by avoiding processed foods, foods in restaurants, and non-iodised salt is essential for maintaining a healthy lifestyle [756–760]. Sodium deficiency due to low dietary intake is rare due to added salt in a wide range of commonly used food products.
-
- **Dietary reference values and current intake.** The recommended sodium intake for men and women is 1500 mg per day [166,167]. The WHO, SR/MA and National Institute of Public Health of Slovenia recommend that adults consume less than 2000 mg of sodium daily, equivalent to less than 5 g of salt per day [759,761,762]. However, studies have shown that salt consumption in Slovenia significantly exceeds these recommendations. A 2010 study reported an average daily salt intake of 11.3 g among Slovenian adults, 13.0 g in men and 9.9 g in women [763],

which is more than double the WHO allowance of daily salt intake [759,761]. A more recent national study conducted in 2022 showed some improvement, with the average daily salt intake decreasing to 10.3 g, 11.7 g in men and 8.7 g in women [740], but remaining more than twice the WHO recommended limit [759,761].

3.3.10. ZINC

Dietary sources and intake. Foods that are a 'source of' zinc include meat (red, white and processed), fish and seafood, dairy (cheese), eggs, whole grains, legumes/pulses, nuts and seeds, spices and herbs (onion, parsley and ginger) [165–168]. Phytate and calcium negatively impact the amount of absorbable zinc. Zinc intake can reduce the absorption of copper, iron, and calcium. The bioavailability of zinc from plant foods is lower than that from animal foods due to phytate content [764]. Zinc absorption is enhanced by vitamin-C-rich foods such as fruits, bell peppers, broccoli, and vinegar [165,166,765]. Adding garlic and onion to whole grains or legumes/pulses can increase zinc bioavailability. Proper preparation methods (soaking, fermenting, and sprouting of pulses and grains) can also increase zinc bioavailability from plant-based foods [220,766,767]. Reducing phytate content can improve mineral status. However, phytates also have beneficial effects, such as preventing cancer, CVDs, diabetes mellitus, and kidney stones [221].

Main functions. *Zinc* is an essential element as a stable divalent cation (Zn^{2+}). It has a wide range of vital physiological functions and is present in every cell of the body. It has a structural and catalytic role in each of the seven classes of enzymes. It is involved in synthesising, metabolising, and turnover of proteins, carbohydrates, lipids, nucleic acids, and some vitamins [768]. Zinc acts as a cofactor for key enzymes that reduce oxidative stress. Strong homeostatic mechanisms keep the zinc content of tissues and fluids constant over a wide range of intakes through changes in excretion and absorption [768]. Zinc also supports healthy growth and development during pregnancy, infancy, childhood, and adolescence and is involved in the sense of taste [764].

Health effects

- **Beneficial effects**. Adequate zinc intake has many health benefits, such as reducing cancer risk, depression, and T2D. It can improve sperm quality, concentration, and pregnancy rate. Zinc can lower the chances of diarrhoea and pneumonia. It has antiviral, antioxidant, and anti-inflammatory properties that improve respiratory tract infections, including COVID-19. Additionally, it positively affects bone formation, blood lipids, and IGF-1 metabolism [764].
- **Adverse effects**. Zinc is not toxic, even in high doses, though it may induce vomiting. Excess zinc in the diet is not stored in the body, and no known

disorder is associated with zinc accumulation. Severe zinc deficiency increases susceptibility to infections, poor growth, poor wound healing, hair loss, anorexia, altered taste, skin lesions, and eczema in low- and middle-income countries [768].

- **Dietary reference values and current intake.** The recommended daily intake of zinc is 7–10 mg for men and 11–16 mg for women, depending on the amount of phytate consumed. A more plant-based diet with a higher content of chelating substances (such as phytic acid and tannins) increases zinc requirements. Data on population intake of phytate are limited; according to the EFSA, intake ranges from 300 to 1400 mg per day [764]. For pregnant women the recommended daily zinc intake is 7–13 mg, and for lactating women it is 11–14 mg [166,167]. Data on zinc intake in the adult Slovenian population are not available.

3.3.11. IODINE

Dietary sources and intake. Foods that are 'sources of' iodine include fish (salmon and tuna), seaweed (nori, awake and kelp), and processed meat (if iodised salt is used) [165–168].

Main functions. *Iodine* is an essential trace element that helps produce thyroid hormones, which regulate metabolism and overall health [769].

Health effects

- **Beneficial effects**. Iodine intake is crucial for thyroid functioning, brain development, metabolism regulation, immune function, and reproductive health [770].
- **Adverse effects**. Inadequate (insufficient or excessive) iodine intake is associated with thyroid dysfunction and disease [771]. Meeting the recommended iodine intake can be challenging for adults without exceeding the daily salt intake limit [763,772], with excessive salt intake yielding high blood pressure, CVD, and premature death [773–775]. Including seaweed varieties such as nori and kelp in the diet may be beneficial. However, overeating kombu seaweed can lead to excessive iodine intake [776,777]. In contrast, excessive intakes (in populations with excessive seaweed use) can also cause hyperthyroidism, autoimmune thyroid disease, and thyroid cancer [770,771]. Adults should not consume more than 600 µg of iodine per day [778].
- **Dietary reference values and current intake.** The recommended daily intake of iodine is 180–200 µg for men and women. For pregnant women the recommended intake is 230 µg per day, and for lactating women it is 260 µg per day [166,167]. Iodine deficiency is a significant global concern affecting all people [779,780]. A SR of 11 studies found that no dietary group had an adequate median urinary iodine

concentration. People following a plant-based diet had the lowest iodine intake [781]. Data on iodine intake in the adult Slovenian population are not available.

3.3.12. SELENIUM

Dietary sources and intake. Foods that are 'sources of' selenium include nuts and seeds (Brazil nuts, flaxseed, and sesame seeds), dairy (cheese), processed meat (blood sausage), and spices and herbs (garlic and ginger) [165–168] with Brazil nuts being the richest sources [782,783]. One Brazil nut a day can provide the recommended daily selenium intake [166,167,784]. Quantifying and identifying selenium in foods is complex, and its content varies widely. As a result, food composition tables are often inaccurate, leading to imprecise estimates of selenium intake [785].

Main functions. *Selenium* is an essential mineral with various bodily functions, such as cognitive improvement, antioxidant protection, and thyroid hormone metabolism [786,787].

Health effects

- **Beneficial effects**. Selenium intake can lower the risk of CVD and some cancers in populations with low selenium status [788]. Extra selenium dietary supplements are not recommended if an individual's selenium-deficient status has been corrected [789].
- **Adverse effects**. Overconsumption of selenium can cause adverse effects such as fatigue, nausea, skin lesions, and, in rare cases, fatal health events [783].
- **Dietary reference values and current intake.** The recommended selenium intake for men and women is 60 and 70 mg daily [166,167]. Studies in Europe show that selenium intake is often below optimal levels [790].

Appendix A. Shaping a Healthier Future

A.1. The Role of SNG2025 in Health Promotion

Adhering to SNG2025 is essential for maintaining high dietary quality, preventing NCDs, and promoting overall health. Conversely, the principle of eating in moderation is widely endorsed as a practical approach for maintaining weight, preventing weight gain, and enhancing health. However, general recommendations such as ‘eat everything in moderation’, ‘diversify your diet’, ‘anyone can lose weight with sufficient willpower’, or ‘eat less, exercise more’ frequently do not result in improved dietary quality or long-term health benefits. Such broad advice often lacks the specificity required to achieve sustained dietary improvements and favourable health outcomes [791–795]. Therefore, it is critical to implement comprehensive dietary guidance that addresses key lifestyle factors for overall well-being. Prioritising preventive strategies through dietary education is essential. Additionally, to combat preventable NCDs effectively, it is necessary to make healthy foods affordable and available. These diseases are increasingly prevalent, reaching epidemic proportions and imposing significant economic burdens [44]. Ultimately, this leads to both a diminished quality of life and inefficient allocation of public resources [796–798].

To influence public health positively, health workers and dietitians require enhanced education in nutrition [799–808]. With unhealthy eating habits recognised globally as the leading cause of NCDs [760,809,810], it is essential to include healthy eating guidelines as a standard component of modern medical practice. Considering this, nutrition can no longer be ignored. As unhealthy dietary practices are the primary cause of NCDs, it is imperative to emphasise the significance of maintaining a nutritious diet. Also, medical practitioners must regularly and appropriately advise their patients on healthy eating [803,804,808,811–813]. Therefore, there is a need to redefine the food and healthcare system from disease care to healthcare, to promote education on healthy eating habits, and to use new food-based dietary guidance as a starting point.

Until recently, health and environmental goals have not been aligned properly either with national or global goals [814]. In this regard, the planetary diet promotes both, health and sustainability. It aims to tackle the three challenges facing the food system: feeding a growing world population, improving public health, and reducing the environmental impact of our food choices. This diet emphasises the need for a balanced, affordable, and nutritious diet that meets dietary requirements while respecting the planet's limits [6]. Many studies support obtaining adequate nutrition in all stages of life through well-designed plant-based diets without animal-source foods [815,816]. However, the planetary diet allows some animal-source foods, making it simple to accommodate various dietary requirements [6,662]. Careful planning is necessary to meet dietary recommendations for all dietary patterns [67,817,818]. Studies on the omnivorous diet highlighted nutritional gaps that the planetary diet can solve. By incorporating more vegetables and fruits, the diet promotes the adequate intake of fibre, ALA, vitamins D and E, folate, calcium, and magnesium. It also encourages a lower intake of meat and processed meat, free sugars, unhealthy saturated and trans fats, and added salt [6], nowadays often consumed excessively [24,67,817].

The dynamic nature of nutrition science continually reshapes our FBDG, necessitating collaboration among stakeholders (policymakers, farmers, consumers, educators, and the media) to develop and implement a strategic plan for health promotion. This plan should articulate clear objectives and the means to achieve them. Society-wide structural changes, influenced by politicians, professionals, business leaders, and the media, are essential to modify the food environment effectively. A collaborative framework is crucial for creating recommendations that educate and motivate, fostering a sustainable shift towards healthier lifestyles. To enhance public health, it is imperative to implement measures such as targeted subsidies, health-oriented tax policies, insurance adjustments for unhealthy lifestyle repercussions, and reduced marketing pressures from unhealthy food industries. These interventions are necessary to counteract the trend towards detrimental dietary habits and to build a healthier, economically stable, and environmentally sustainable society [27]. The planetary diet promotes human health and environmental sustainability. It offers flexibility in dietary composition, allowing people to tailor their food choices according to personal preferences, reducing unhealthy dietary habits and minimising ecological impact [819]. The state should ensure that nutritionally essential foods are broadly available for all [662].

Meal planning is linked with a healthier diet and better weight management [820]. For effective meal planning, it is helpful to plan shopping, organise time for cooking meals from basic whole foods, and prepare parts of meals in advance. This can make mealtime more convenient and enjoyable while freeing time for other pursuits. When dining out, meals primarily consisting of whole, unprocessed foods should be chosen. When planning main meals, a planetary health plate should be composed of approximately half vegetables and fruits by volume. The other half, based on calorie contribution, should primarily consist of whole grains, plant-based protein sources, unsaturated plant oils, and, if desired, modest amounts of animal protein. This approach ensures an adequate intake of essential nutrients and promotes overall health and well-being [821]. The easiest way to follow meal planning is to implement delicious meals for breakfast, lunch, dinner, and snacks. Individual meals should be tailored, based on dietary preferences, available ingredients, time constraints, health status, nutritional needs, and personal goals. This customisation ensures that each meal aligns with specific dietary requirements and objectives. When it comes to reading food labels, it is best to disregard marketing buzzwords such as 'excellent source of', 'free from', and 'natural'. Focus on the list of ingredients. Choose foods that contain recognisable ingredients, have few total ingredients, and do not include artificial colours, flavourings, preservatives, stabilisers, thickeners, sweeteners, sugars, and/or unfamiliar names [822]. However, the most optimal is to prepare meals from whole foods.

Learning to cook can contribute to better health. Developing cooking skills empowers individuals to take greater responsibility for their diet and overall well-being. For lasting impact, cooking should be promoted as an enjoyable activity, with an emphasis on preparing tasty, convenient and healthy meals. Frequent cooking at home may require more effort, energy, and cleaning, but it is associated with improved diet quality, health, and longevity [823–825]. There are various methods of preparing food. Healthy options include moist-heat techniques such as poaching, simmering, boiling, or steaming. Other beneficial methods include braising, stewing, and pressure cooking, while no-heat techniques such as curing, culturing, fermenting, acidifying, sprouting, soaking, high-speed blending, pureeing, vacuum sealing, juicing (in rare cases only), and dehydrating may be used. It is essential to consider dry heat cooking methods such as air drying/dehydrating, sweating, searing, stir-frying, griddle cooking, baking, roasting, grilling, broiling, and sautéing, but minimise air and deep frying [327,826,827]. When utilising these methods, it is essential to ensure the food is cooked to the appropriate temperature to guarantee its safety [828,829]. Some recommended methods also effectively reduce the alpha-oligosaccharides and other anti-nutritional factors, or can save preparation time, especially in the case of legumes [220]. In addition, boiling, pressure cooking, steaming, and roasting all cause the loss of iodine [776]. Avoiding excessive iodine loss by adjusting cooking methods is recommended [776,777]. For example, adding salt at the end of the cooking process can help minimise iodine loss. When cooking plant foods, some methods may reduce their nutritional value. Prolonged boiling and high-temperature cooking are particularly detrimental. In contrast, steaming and microwave cooking help retain nutrients, especially those that are water-soluble. Using cooking liquids in dishes can save some nutrients that usually disappear [827].

A.2. Dietary Patterns

The SNG2025 promote the consumption of whole foods, with higher intake of plant-based foods over animal-based ones. Some individuals may not consume certain food groups despite their nutritional importance and potential health benefits. Therefore, the present guidelines encourage a dietary pattern with the best possible approximation of the planetary diet, ensuring nutritional sufficiency and optimal health.

For predicting disease risk, it is more important to consider overall dietary patterns than just individual foods or nutrients [830]. Implementing the recommended planetary diet will aid in increasing the intake of fibre folate and potassium, which are frequently deficient in the Western diet. Consuming more whole foods also means consuming less processed foods and hidden salt. Using iodised salt can improve iodine intake. While the planetary diet may not be perfect, it addresses many current nutritional gaps and considers cultural eating habits [6,67].

Sections A.2.1. to A.2.4. present background information on various dietary patterns that have one important thing in common: a well-balanced diet should predominantly consist of unprocessed or minimally processed foods.

A.2.1. MEDITERRANEAN DIET

Among the various commonly promoted dietary patterns labelled as 'healthy', the Mediterranean diet appears to be one of the most suitable for broad implementation. The diet emphasises the consumption of large amounts of fruits, vegetables, whole grains, nuts, and olive oil, while also including fish, chicken, and a little low-fat dairy or red meat [68,831]. The food in this diet contains antioxidants, healthy fats, and fibre that can help lower inflammation and improve plasma cholesterol levels [68]. In addition, the Mediterranean diet is not limited to a dietary pattern in the strict sense but also encompasses sociability and regular physical activity, which together contribute to a healthy lifestyle. Additionally, a national analysis in the US indicated that reducing the consumption of red and processed meat by substituting these with other protein sources such as poultry, seafood, eggs, and plant proteins, may lead to financial savings for households, particularly those with low incomes [832].

Mediterranean diet adherence has been consistently associated with a reduced risk of CVD, improved metabolic outcomes, age-related cognitive disorders, and lower overall mortality in diverse populations [833–836]. Adding more plant-based options and whole foods can further improve the health benefits of the Mediterranean diet and potentially reduce GHG emissions [68–70,837–843]. Adopting a Mediterranean lifestyle can be healthy for many individuals, even if they are not from the Mediterranean region [837,844]. For some individuals, the cost and availability of Mediterranean foods may pose a challenge, making it difficult to adhere to the diet and reap its benefits. However, there are many other affordable, healthy and sustainable plant-based foods that are more traditional to Slovenia. These include potatoes, buckwheat, beans, cabbage, oats, turnips, garlic, onions, apples, pears, and fermented foods such as sauerkraut and pickled turnip.

A.2.2. DASH DIET

The DASH diet focuses on and targets the general improvement of cardiovascular health [73]. As with the Mediterranean diet, the DASH diet primarily comprises fruits, vegetables, whole grains, low-fat dairy products, lean meats, and fish. It was designed to be low in SFA and cholesterol, with moderate protein content, and high in minerals and fibre. An important emphasis of DASH is on foods rich in potassium and magnesium [73]. A diet prepared according to this pattern is tasty, flexible enough, and relatively simple to implement consistently [72].

The primary goal of the DASH diet is to prevent or control high blood pressure [72]. A landmark study conducted by Sacks and Kass in 1988 [845] showed that people on a plant-based diet have lower blood pressure than those who consume animal products. However, later on, the 'final' DASH diet was designed to have enough benefits of a plant-based diet to lower blood pressure while still containing enough animal products to make it acceptable and palatable to omnivorous individuals with high blood pressure [72]. The standard DASH diet recommends (allows) up to 2.3 g of sodium per day, and the version with an even greater restriction – up to 1.5 g per day – provides for an even more significant reduction in blood pressure [846,847]. Although DASH was originally a dietary pattern tailored explicitly to people with arterial hypertension, it has been shown to provide a broader range of health benefits. Research has shown that eating according to DASH principles in adults reduces mortality from all causes and causes related to CVDs. In observational studies, the DASH dietary pattern was also associated with a lower incidence of diabetes and heart failure [73,848]. Additionally, the DASH diet may improve the lipid profile in individuals with overweight or obesity by lowering total cholesterol, LDL cholesterol, and VLDL cholesterol levels. However, it does not significantly impact HDL lipoprotein cholesterol or triglyceride levels [849].

It is worth noting that two recent randomised trials compared the DASH diet. One compared it with the Mediterranean diet in adults with high normal blood pressure, while the other compared it with a WFPB diet in individuals with insulin-treated

T2D. The first of the cited studies found that the Mediterranean diet was superior in lowering office systolic blood pressure. However, both diets reduced blood pressure to an extent higher than salt restriction alone [850]. The study that compared the DASH diet with the WFPB diet found that adopting either can result in significant, rapid changes in insulin requirements, insulin sensitivity, and related markers among individuals with insulin-treated T2D. Systolic and diastolic blood pressure did not significantly change after the DASH or WFPB diets compared to baseline; however, systolic blood pressure was lower after the DASH diet. More significant dietary changes towards a plant-based diet produced larger benefits [851].

Two important conclusions can be drawn from the research of the DASH diet: first, it helps regulate hypertension and therefore represents another dietary tool for hypertensive individuals, and second, consuming more dairy increases blood pressure among lacto-vegetarians [845]. However, recent systematic reviews indicate that consuming higher amounts of dairy products may be linked to a reduced risk of hypertension [852,853], and there is no conclusive evidence showing that replacing cow's milk with plant-based drinks affects blood pressure [854].

A.2.3. VEGETARIAN DIETS

A vegetarian diet excludes meat, poultry, and fish, with allowed variations that may include dairy and eggs, while a vegan diet does not. These diets centre around plant-based foods such as fruits, vegetables, legumes, whole grains, nuts, and seeds. Vegetarian diets are associated with a reduction in body mass and body fat and contribute to a lower risk of several NCDs, including obesity, CVD, hypertension, both type 1 and T2D, non-alcoholic liver disease, and rheumatoid arthritis. Additionally, these diets are associated with decreased risk of certain types of cancer, although the data are limited [68,75,76,89,855–867]. Additionally, the results of the highest-quality studies indicate a consistent protective link between meat-free diets and depression [868].

The term 'plant-based diet' varies in meaning and is often used interchangeably with 'vegan' or 'vegetarian' diets. It is crucial to accompany the use of this term with a dietary description that specifies the included and excluded food groups [77]. Vegetarian diets are low in SFA and dietary cholesterol while high in fibre, vitamins, minerals, and antioxidants. However, not all plant-based foods are equally healthy. Unhealthy vegetarian diets, poor in specific nutrients and rich in highly processed and refined foods, can increase morbidity and mortality [861]. The adequate intake of vitamin B12, calcium, iodine, zinc, and n-3 LCP (i.e., EPA and DHA) should be ensured [67].

A vegan diet may be the most environmentally sustainable option [95,97,869]. These diets are also associated with reductions in body mass and body fat [68,76,870–872]. A vegan diet improves aerobic performance and promotes lower body mass without compromising strength [600,873]. However, athletes following a vegan diet may need proper planning to ensure adequate intake of essential nutrients. It is critical to tailor a vegan diet to individual goals, training demands, and ethical considerations, considering personal preferences, seasonal variations, and cultural backgrounds. Effective planning and evaluation are vital to optimise vegan or vegetarian sports nutrition [67,600,874,875]. Contrary to the common belief that a vegetarian diet is more expensive than an omnivorous diet, studies from the US and Europe indicate the opposite [134–138].

A.2.4. LOW-CARBOHYDRATE, HIGH-FAT DIETS

Adopting an LCHF or ketogenic diet involves significantly reducing carbohydrate intake (LCHF) or almost eliminating it (ketogenic) while increasing fat and moderate protein intake. The primary objective of the ketogenic diet is to induce ketosis, by which fats become the main energy source instead of carbohydrates [80,81]. The ketogenic diet may be beneficial for overweight or obese adults, with or without T2D, leading to rapid weight loss, muscle loss, improved blood sugar control, reduced seizure frequency in those with drug-resistant epilepsy, and enhanced cardiometabolic health, including lower triglyceride and HbA1c levels and higher HDL cholesterol levels [876–881]. However, both LCHF and the ketogenic diet have been linked to significant increases in LDL cholesterol and mortality risks [882–885]. The ketogenic diet significantly affects the adaptive immune system, enhancing specific pathways and cell types, whereas a vegan diet primarily boosts the innate immune system, particularly in antiviral immunity pathways [886].

Several studies have revealed multiple adverse effects associated with the ketogenic diet, ranging from the mild ‘keto flu’, characterised by fatigue, weakness, and gastrointestinal disturbances, to severe complications such as cardiac arrhythmias due to selenium deficiency [887]. The restrictive nature of these diets makes long-term adherence difficult, potentially leading to nutrient deficiencies and difficulties with meeting daily fibre, vitamin, and mineral requirements [888]. For many individuals, the risks of ketogenic diets may exceed the benefits due to its temporary improvements, adverse dietary impacts, and insufficient data on long-term safety [81,889–892]. Although popular for managing obesity, T2D, and other NCDs, the evidence supporting the effectiveness of the ketogenic diet is limited, and the potential risks are significant [81,887]. Modifying the diet to include plant-based sources of LCHF and ketogenic plans with higher unsaturated fat intake might mitigate some of the concerns with animal-based versions of the LCHF and ketogenic diet [884,893–896]. Additionally, the diet has negative implications for muscle mass in strength training [897], motor skills in sports like cross-fit [891], and bone health and performance in endurance sports [898,899]. Despite its potential for body fat loss, the ketogenic diet is less effective than a conventional 'high' carbohydrate omnivorous diet [82] or a low-fat, whole-food vegan diet [883,900]. Therefore, consulting a healthcare professional or registered dietitian is crucial before starting a classic LCHF or ketogenic diet to ensure it aligns with individual expected health goals and risk acceptance [80,887].

A.2.5. ABO BLOOD-TYPE DIET

Dr. J. D'Adamo proposed a diet based on blood type. According to his theory, each blood type has specific antigens that influence food choices, impacting digestion, the immune system, and overall health [901]. However, individual differences are significant in how our bodies respond to different diets and lifestyle choices regardless of blood type group [902,903]. Despite the observation that people with different blood types may have varying levels of cardiovascular risk, research has not supported that diets based on the ABO blood group improve health or reduce disease risk. Studies have shown no effects on body mass, body fat, or cardiovascular health for individuals following these blood type-specific diets compared to control diets [83–85].

A.3. Nutritional and Environmental Benefits of Organic Foods

Ensuring food safety, nutritional quality and security are fundamental issues for the immediate future. Industrialised production methods have clearly demonstrated serious limitations, including widespread contamination of the food chain and water due to persistent pesticide residues and reduced nutrient and flavour profiles resulting from inexpensive, intensive food production and processing [904]. When evaluating organic or non-organic (conventional) foods, the question arises whether organic foods overall offer greater nutritional value, safety and health benefits. One of the most important reasons for the increasing demand for organic foods is their perceived health benefits [905–909]. However, the long-term health benefits of consuming organic food remain to be established. Consumption of organic food is associated with healthier eating practices and lower levels of overweight and obesity, which may influence the results of observational studies. Therefore, the methodology of studies on health benefits in people consuming organic or conventional foods should eliminate lifestyle factors that, in parallel with the agricultural origin of the food, affect people's health (mainly physical activity, type and composition of daily diet and overweight/obesity).

For the most part, the literature often does not show that organic plant foods show a significant nutritional advantage over conventional counterparts in terms of protein, fibre, carbohydrates or fats, including packaged and processed varieties [278,910]. However, data on carbohydrate, protein, and vitamin level comparisons are insufficiently documented [904]. Furthermore, when comparing staple plant foods such as maize, wheat, rice, and potatoes with fast food compositions high in meat, refined carbohydrates, and fats, the nutritional differences between conventionally and organically grown crops appear relatively small [911]. It is important to emphasise that the essential nutrients inherent in foods of plant and animal origin remain constant despite changes in production systems [912]. However, selected studies show that organic foods of plant origin contain more dry matter and minerals such as iron and magnesium [904,913]. According to an extensive and thorough analysis by Hunter et al. 2011, based on 33 independent screening studies and 908 comparisons of micronutrients, significantly more minerals (5.7% more) and all micronutrients including vitamins (5.5% more) were found in organic plant foods compared to conventional foods. The differences mainly concern sodium, copper, boron, zinc and phosphorus, and of the vitamins, β-carotene and vitamin C. Significant differences in the described respect were shown for legumes and vegetables and all plant raw materials combined [913]. The largest MA to date based on 343 carefully selected publications showed that there are significantly more reducing sugars as well as total carbohydrates in organic raw materials compared to conventional ones [910]. More recent studies also generally confirm this and showed significantly more total sugars and reducing sugars in organically fertilised onions compared to those fertilised conventionally [914]. Also, Reche et al. (2019) showed higher sugar content (sucrose, glucose, and fructose) in organic jujube fruit than in conventional fruit [915]. Also, a recent review paper indicates that the majority (although not 100%) of studies from different countries prove a higher sugar content in organically grown fruit [916]. Furthermore, studies have shown that organic vegetables contain higher amounts of certain sugars, bioactive compounds, and antioxidants than their conventionally cultivated crops [904,917]. Very importantly, organically grown fruits, vegetables, and cereals contain significantly more polyphenolic compounds than their conventionally grown counterparts [904,910].

So far, the most comprehensive is the previously mentioned meta-analysis by Baranski et al. (2014), who showed from 19% more for phenolic acids through 50% for flavonols and anthocyanins to up to 69% more for flavanones in plant materials from organic production than conventional production [910]. Polyphenols protect us from many diseases as they increase our immunity; they also have anti-bacterial and anti-cancer effects and inhibit the ageing process [918].

Studies have also proven that there is significantly less cadmium in organic raw materials than in conventionally produced raw materials [910]. This is due to the lower cadmium content in manure used in organic farming than in phosphate fertilisers used in conventional farming. In addition, the better structure of organically farmed soils inhibits the uptake of cadmium by plants. Cadmium is a heavy metal that causes kidney and bone disease and cancer with long-term exposure. The aforementioned MA [908,910] covering fruit, vegetables and processed foods of plant origin showed that pesticide residues were four times more frequent in conventional crops than in organic ones, with the largest differences detected for fruit, slightly smaller for vegetables and the smallest for cereals. EFSA (2018) [919] were very similar to those of 2014 [908,910]. Pesticide residues were found in organic raw materials at a level of 6.5% of the samples tested, compared to 44.5% of the samples tested in conventional raw materials. The difference was thus seven times, which is higher than what was found a few years earlier. Further results are shown in the 2023 EFSA report [920]. The 2021 data continue to show that organic food shows lower pesticide exceedance and quantification rates compared to non-organic counterparts. Of the 6,530 organic samples tested, 17% showed measurable pesticide residues, compared to 44% for conventional samples. Thus, an unfavourable trend for organic samples can be seen, as residue levels in organic samples increased by about 2.5 times compared to 2017. In organic samples, 2% exceeded the corresponding MRLs, and in conventional samples, 4% [920]. Pesticide concentrations in whole-grain and wholemeal products are higher than in polished grains, such as white-flour products, because the outer bran layers of grains have a higher pesticide load than the endosperm [921]. Fruit and vegetables are the main sources of dietary pesticide exposure. Switching to an organic diet can help reduce levels of glyphosate and aminomethylphosphonic acid in the body, which are considered to be potentially carcinogenic [922,923]. In general, organic produce tends to contain fewer pesticide residues than its conventionally grown counterparts, reducing exposure to pesticides [904,911,924].

This is very important because, according to many studies, pesticides have negative effects on human health, reducing the function of selected systems and organs and, in the case of excessive accumulation and lack of appropriate treatment, leading to death [915]. Chronic exposure to pesticides and their accumulation can lead to a number of dysfunctions in the body, causing memory and concentration disorders, confusion, depressive states, irritability, disorientation or increased reaction time. According to studies, dietary exposure to pesticides can, among other things, disrupt the endocrine system and affect inflammation, oxidative stress and lipid metabolism [925–929]. For adults, the link between pesticide exposure and the development of a dangerous cancer of the lymphatic system, namely non-Hodgkin's lymphoma, is best proven [930].

For years, there has been controversy over the occurrence of mycotoxins in organic foods. There is a widespread opinion among scientists that organic raw materials are more vulnerable because the use of fungicides that kill mould fungi in crops is prohibited. There is a view that organic crops remain susceptible to contamination by fungi that can produce aflatoxins and fumonisins, which are associated with liver and oesophageal cancer [922,923,931]. However, a recent systematic literature review and MA of the data indicate otherwise [932]. The results of an analysis based on long-term data in organic and conventional cereal grains/products showed significantly higher contents of the Fusarium mycotoxins DON (deoxynivalenol), ZEA (zearalenone) and HT-2/T-2 (trichothecenes)-in conventional than in organic products. The same is true for aflatoxins, which are the mould mycotoxins produced by Aspergillus and Penicillium. In contrast, the opposite results were obtained for OTA, or ochratoxins, in addition to enniatins and bowercins – which are significantly more abundant in organic than conventional products. Overall, the authors suggest that contamination levels are similar in organic and conventional cereals. Besides, Fusarium mycotoxin contamination decreased between the 1990s and 2020. Finally, the authors conclude that keeping ochratoxin (OTA) concentrations below the maximum contamination levels (3.0 μm/kg) set by the EU remains a major challenge.

When writing about the quality of organic food, it is impossible to ignore the issue of nitrites and nitrates, which, according to a MA, are 87% lower in organic crops for nitrites and 30% lower for nitrates, compared with conventional crops [910]. The reason for this is the different way in which the crops are fertilised – in the organic system, no readily available mineral fertilisers are used, the excess of which the plants convert into nitrates and nitrites. These compounds, taken in for a long time and in higher concentrations with food and drinking water, cause the formation of carcinogenic nitrosamines, which are linked to gastrointestinal cancers and leukaemia in adults [933]. These problems mostly affect middle-aged and elderly people.

Animal raw materials from organic production, compared to conventional raw materials, contain significantly more health-beneficial unsaturated fatty acids of the n-3 group [924,934]. This applies to meat, milk, eggs and derived products. This is due to the fact that animals in an organic system are fed differently – they spend much more time in open meadows and pastures. The consumption of large quantities of fresh plants – grasses and forbs – ensures that the unsaturated fatty acids, which largely contain CLA, are intensively synthesised in the rumen of the cow. There are no synthetic additives in their feed, and the proportion of cereals and concentrate feeds is lower. Unsaturated fatty acids, especially CLA (rumenic acid), of which there is on average 50% more in organic milk than conventional milk, are of health-promoting importance – with anti-atherosclerotic, anti-allergic, and anti-carcinogenic effects [924,934,935].

There are fewer antibiotic residues in organic animal raw materials compared to conventional raw materials. This is due to the fact that organic farmers very rarely use antibiotics, as the withdrawal period is twice as long as in conventional farming. This means that products cannot be sold for a long time, and this generates losses for the producer. Therefore, in addition to ethical motives, organic producers avoid using antibiotics in their animals. The administration of antibiotics to animals in feed or drinking water, which is widely used in industrial farming, is considered to be the main reason for the development of antibiotic resistance. Overuse of antibiotics in veterinary medicine is well correlated with an increasing number of resistant bacterial isolates and rising levels of antibiotic residues in food [936]. In 2019 it was reported that approximately 5 million people died worldwide from infections associated with multiresistant strains, including 1.27 million from infections caused by bacteria resistant to available antibiotics [937,938]. Organic animal husbandry creates greater safety for the consumer in this respect.

It is worth mentioning that organic processing aims to preserve as much as possible of the nutritional value of the products obtained, which is why, in accordance with current legal regulations, no synthetic food additives are used, but only 82 natural substances used to improve the appearance, taste and shelf life of the products. In comparison, more than 600 different synthetic additives are used in conventional processing, many of which have a negative impact on consumer health. The most glaring example is the azo dyes – yellow, orange, red dyes, used to colour confectionery products (jellies, sweets, jelly beans). Excessive amounts of these dyes in children's diets result in motor hyperactivity, which has been scientifically proven [939,940]. Taking all the above facts into account, it can be concluded that organic food may offer greater consumer safety and higher nutritional value than conventional food, as it contains fewer contaminants and more beneficial nutrients.

Organic farming practices appear to promote optimal health and reduce the risk of chronic diseases in adults. Scientific evidence supports the effect of organic food consumption on lower rates of obesity in childhood and adulthood [941]. Metabolic syndrome has also been shown to be significantly less frequent in regular consumers of organic food compared to consumers of conventional food [942]. Another French study showed that, compared to conventional consumers, regular consumers of organic food had a lower risk of T2D, hypertension, and CVD. However, this relationship was only significant for men [943]. In contrast, in California, US, it was shown that patients following an organic diet or intermittent fasting had a significantly lower prevalence of erectile dysfunction [944]. Also important in the context of reproduction is a Norwegian study, which found that women who consume a lot of organic vegetables during pregnancy are less likely to suffer from severe pre-eclampsia than women who consume mainly conventional vegetables [945].

Finally, 3 large cohort studies have shown that regular consumption of organic food reduces cancer risk. A UK study [946] involving 623,080 middle-aged British women showed that regular consumption of organic food reduced the incidence of non-Hodgkin's lymphoma by 21%, while it had no effect on other cancers. In France, on the other hand [947], a study of 68,946 people found that cancer risk was 25% lower for regular organic food consumers compared to conventional consumers. For postmenopausal breast cancer, the reduction was 34%, for non-Hodgkin's lymphoma as much as 86% for non-Hodgkin's lymphoma and 76% for all lymphomas combined. In Denmark, 44,872 women and men aged 50–65 years who answered questions on organic food consumption were included [948]. The results showed no association between frequency of organic food consumption and overall cancer incidence, while a lower incidence of gastric cancer and a higher incidence of non-Hodgkin's lymphoma were shown. The latter result is inconsistent with previous studies, but the authors did not specify its possible causes. This confirms the need for further similar studies in different countries in Europe and around the world, so that more insight can be gained into this important issue.

While as described, the consumption of organic food may be associated with positive health and environmental effects, the adoption of a diet based on organic food should be combined with a shift toward plant-based eating patterns to optimise both planetary and human health [949]. Organic plant-based foods produced in Slovenia, with no or minimal processing, are preferred. It is important to note that this does not need to be an all-or-nothing approach; even partial steps in this direction can have a significant impact.

A.4. Time Restricted Eating, Water-Only Fasting and Fasting-Mimicking Diet

Time-restricted eating (TRE) limits the daily eating window to 8–12 hours with fasting during the remaining hours [857]. It does not require changes in food quality or quantity [858] and is recognised for potential benefits in weight management and metabolic health. Despite its simplicity, TRE requires lifestyle adjustments to maintain a consistent eating schedule, which can be challenging due to social events and psychological factors [859,860]. Adherence to TRE in clinical trials ranges from 47% to 95% [859]. Weight loss through TRE is often due to reduced energy intake rather than meal timing alone, emphasising the importance of regular physical activity and balanced diets to prevent muscle loss and an increased appetite [861–865]. Early TRE, particularly approaches that include breakfast, may be more effective for weight management, including muscle mass preservation [866–868]. Although TRE can reduce the risk of NCDs such as obesity and CVDs, its long-term sustainability compared to traditional calorie restriction remains in question

[869–873]. The success of TRE is influenced by various factors, including physical activity, dietary intake, and individual health conditions [874]. Ongoing research is necessary to determine its long-term benefits for individuals with healthy BMI and those already adhering to healthy eating patterns [875].

Medically supervised water-only fasting and fasting-mimicking diets (FMD) are gaining attention for their health benefits, including weight loss and metabolic improvements [950–952]. FMD mimics fasting effects with low in protein and calories [527]. Water-only fasting induces ketosis within 24–48 hours, utilising fat for energy while preserving muscle mass, which supports metabolic health and may enhance specific cancer therapies [844,953–959]. However, water-only fasting should be done under medical supervision due to potential risks including metabolic acidosis, headaches, insomnia, and hunger [877]. FMD, when monitored by professionals, is generally safer, and associated with fewer side effects, such as muscle mass loss [752,876,884]. Both fasting strategies show promise for improving cardiometabolic health and promoting healthy ageing, but medical supervision is essential, especially for prolonged fasting periods. Future research should focus on understanding the mechanisms behind these benefits and establishing guidelines for safe and effective fasting interventions [960].

A.5. Dietary Supplements: A Targeted Role within SNG2025 Approach

As emphasised in the Planetary Health Diet and other FBDGs, a nutritionally adequate diet based on whole, minimally processed foods is the foundation of optimal health. While dietary supplements cannot replace a balanced and varied diet, they may play a targeted role in situations where nutritional needs cannot be fully met through food alone. The need for dietary supplements should ideally be evaluated individually, considering factors such as age, dietary habits and preferences, physiological status (e.g., pregnancy, ageing), lifestyle factors, and overall health. Supplementation should be guided by qualified healthcare professionals and based on validated biomarkers and/or a documented risk of deficiency. When individual biomarker-based supplementation is not available, some general recommendations can be used as described in the following paragraphs. The role of dietary supplements is to complement – not replace – a nutrient-rich, food-first approach to eating.

Vitamin D frequently warrants supplementation across all dietary patterns. Endogenous synthesis of vitamin D via sunlight exposure is often insufficient during the autumn and winter. Individuals with minimal sun exposure, such as institutionalised persons or those with predominantly indoor lifestyles, are at particularly high risk for deficiency. A daily dietary supplementation of 2000 IU (50 µg) of vitamin D_3 is considered a simple, effective, and safe dosage to prevent and treat vitamin D deficiency in the adult general population [961]. According to recent Slovenian recommendations, a daily intake of 1500–2000 IU is advised throughout pregnancy, while individuals aged over 70 years are recommended to consume 1000–2000 IU per day or 14,000 IU weekly year-round [701].

Folate (vitamin B9) is another critical nutrient, particularly during pregnancy. The recommended daily intake for adults is 300 µg. For pregnant women the recommended intake is 550 µg, and for lactating women it is 450 µg, reflecting the increased physiological demands of gestation and lactation [166,167].

Other micronutrients of concern, depending on dietary habits and population-specific risk factors, include vitamin B12, iodine, and the long-chain polyunsaturated fatty acids (LC-PUFAs) EPA and DHA.:

- Vitamin B12 is an essential nutrient found almost exclusively in animal-derived foods. The recommended daily intake is 4 µg, increasing to 4.5 µg during pregnancy and 5.5 µg during lactation [166,167]. Individuals following a vegetarian diet are at risk of deficiency and should take vitamin B12 dietary supplements to ensure adequate intake. For vegans in particular, dietary supplementation is essential, as plant-based diets provide virtually no active B12. For vegetarians, including vegans, a dietary supplement of 50–100 µg is generally effective for both prevention and treatment of deficiency [962]. Supplementation may also be indicated for those with limited intake of animal products and older adults, as vitamin B12 absorption decreases with age due to gastric atrophy. Because only a small percentage of orally ingested B12 is absorbed via passive diffusion, particularly in the absence of intrinsic factor, supplement doses often need to be substantially higher than the recommended daily intake to ensure sufficient uptake. For individuals who do not consume adequate amounts of B12-rich foods, a common recommendation is 25–100 µg daily or 1,000 µg twice per week [963]. For at-risk populations, regular monitoring of vitamin B12 status, through both dietary assessment and biomarkers such as serum B12 and methylmalonic acid, is advisable [407].
- Iodine is essential for the synthesis of thyroid hormones and for proper neurodevelopment. Supplementation may be necessary for individuals who avoid dairy, seafood, and iodised salt. The recommended daily intake for adults is 180–200 µg, increasing to 230 µg during pregnancy and 260 µg during lactation [166,167].
- LC-PUFAs, specifically EPA and DHA, are important for cardiovascular and cognitive health. During pregnancy and lactation, they play a critical role in supporting foetal brain and retinal development. Adequate intake of these fatty acids has also been linked to a reduced risk of pre-eclampsia, low birth

weight, preterm delivery, and postpartum depression. Furthermore, they may promote improved infant growth, immune function, and visual acuity, while also benefiting cardiometabolic health in pregnant women [964]. Plant-based diets often lack direct sources of EPA and DHA unless algae-based dietary supplements are included. Even individuals who consume animal products may fall short of recommended intakes without regular consumption of fatty fish. For pregnant and lactating women, a minimum of 200 mg DHA per day is recommended [166,167].

In conclusion, while dietary supplements can be helpful or necessary in certain situations, they are meant to support, not replace, evidence-based FBDGs.

A.6. Diet and Lifestyle

Healthy eating is an essential component of a healthy lifestyle. According to Lifestyle Medicine, seven pillars are crucial for preventing NCDs and improving overall health, well-being, and quality of life. These pillars include a plant-based diet, physical activity, adequate sleep, abstaining from risky substances, stress management, social connection, and positive psychology [965]. The most significant potential to improve public health lies in the ability of individuals to adopt healthful behaviours [149].

In recent decades, eating habits globally have shifted towards less healthy patterns. Most regions worldwide report consuming insufficient amounts of fruits, legumes, nuts and both resistant and non-starchy vegetables, all of which are recommended for optimal health [966]. Chronic degenerative diseases are common in Western countries due to inappropriate shifts in energy, macronutrients, and food consumption patterns. This is likely because the modern diet and lifestyle differ from what our human genome adapted to over millions of years [967]. Factors other than genetics, such as unhealthy diet and lifestyle in general, are mainly responsible for causing NCDs [110,968].

The epidemic of obesity and NCDs, such as CVDs, T2D, cancer, autoimmune and neurodegenerative disorders, as well as depression, can all be traced back to unhealthy lifestyle choices [969–971]. These are also evident in Slovenia's high rates of obesity, T2D, CVD risk, and prevalent other chronic illnesses [23,25,28,29,142,972–975]. Slovenia experiences a significant mental health burden, with surveys indicating that depression affects approximately 8% of Slovenian adults, corresponding to 135,000 individuals [976]. In addition, one in six individuals will experience depression at some point in their lives, and currently, one in twenty Slovenians is affected. Many individuals remain undiagnosed or fail to receive appropriate professional care. An SR and an MA that thoroughly examined the impact of dietary patterns on depression found that higher intakes of fruits, vegetables, n-3 fatty acids, and whole grains were linked to a lower risk of depression [977]. The recent systematic reviews consistently show a protective association between meat-free diets and depression [383]. While plant-based diets provide anti-inflammatory and antioxidant benefits, their neurological implications depend on nutrient adequacy [978]. However, two MAs funded by the meat industry did not support these findings [979,980]. In addition, about 25% of adults experience daily stress, and suicide rates are among the EU's highest (≈19.8/100,000), especially in men. Socioeconomic challenges and high alcohol use worsen these issues, further amplified by COVID-19 [976,981,982].

A summary of population data for Slovenia indicates that less than 10% follow a healthy diet [25,32–34,708], while less than 5% of adults follow a more or less completely healthy lifestyle [109].

Among the top 25 leading global risk factors for the most common NCDs in the 1990 and 2010 Global Burden of Disease study, 18 are associated with an unhealthy diet, while physical inactivity is ranked 10th [983]. When combined with prolonged sitting, physical inactivity takes on additional negative dimensions that increase the risk of common diseases and premature death [984–986]. The adoption and maintenance of an overall healthy lifestyle, being associated with a longer life expectancy and reduced risk of developing NCDs, includes eating a balanced and nutritionally sufficient diet, engaging in regular and adequate physical activity comprising aerobic and strength exercise, avoiding smoking, limiting alcohol intake, improving sleep quality, stress control, maintaining a healthy body mass, and controlling exposure to environmental pollutants, sun exposure, and infections [45,46,51,987].

Stress affects both physical and mental health. Long-term exposure to stress has been linked to worse outcomes in many major health conditions. However, not all stress is harmful. While chronic, excessive stress can lead to negative health effects, moderate or acute stress – often called 'eustress' – can be beneficial. Eustress helps improve performance, increases alertness, and promotes adaptation to challenges. It is the prolonged, unrelenting stress that tends to cause adverse outcomes [631,988]. Social stress (psychosocial discrimination, financial difficulties in different social circles, life traumas, loneliness, etc.) can cause premature ageing of the immune system and increase the risk of NCDs, a weakened response to infections, and overall bodily ageing [989,990]. Ongoing low-intensity stress, such as that experienced in the workplace, can also lead to burnout, causing exhaustion, difficulty with motivation and productivity, and irritability due to a lack of energy [991]. Stress can also affect health by developing unhealthy eating habits, such as skipping meals, overeating, or making poor food choices. These habits can increase feelings of stress and contribute to unfavourable health outcomes, including obesity and mood disorders

[992,993]. Getting sufficient quality sleep (at least seven hours of sleep each night, with a consistent sleep schedule) is essential for general, physical and cognitive health, as well as overall well-being [994–999]. Inadequate sleep leads to chronic inflammation and can contribute to certain diseases, especially when combined with an unhealthy diet [1000]. Bedtime eating, as well as consumption of certain foods, can affect the quality of sleep and sleep patterns [1001–1004]. Insufficient sleep can lead to severe consequences, such as developing dementia [995].

A.7. Integrating Physical Activity, Time Spent in Nature and Healthy Eating for Disease Prevention

Physical activity transcends physical fitness, offering extensive benefits crucial for holistic health and well-being. It fosters cardiovascular health, muscle and bone strength, as well as weight management, significantly enhances mental health, mitigates stress, and boosts cognitive functions [1005–1011]. Consistent physical activity also plays a pivotal role in improving insulin sensitivity, which is particularly important for individuals dealing with insulin resistance and related conditions such as T2D. Regular exercise not only helps in managing weight but also enhances the body's ability to metabolise carbohydrates effectively, thereby reducing insulin resistance almost immediately. This improvement allows for better metabolic tolerance of carbohydrate intake, creating a key interaction between physical activity and diet [1012]. The beneficial impact of consistent physical activity extends to reducing the risk of numerous NCDs and increasing life expectancy, establishing it as a foundational pillar of a healthy lifestyle [1005–1011].

Integrating regular physical activity into daily life halves the risk of over 25 prevalent chronic conditions and premature death [1013,1014]. When paired with a healthy diet, the synergy of diet and exercise emerges as the most effective strategy for controlling body mass and composition, addressing over 50 diseases associated with obesity [603,1015–1019]. The traditional ideas of masculinity and their association with meat consumption are changing, even among athletes [1020], primarily due to their greater awareness of the importance of a healthy diet for well-being and the environment. Notably, even minimal physical activity has been linked to a significant decrease in the risk of more than ten types of cancer [1010,1021]. Moreover, strength training for about 60 minutes per week has been associated with a 10–17% reduction in the risk of common NCDs and all-cause mortality among adults, independent of aerobic activities [1022]. A balanced regimen that includes aerobic activities (such as walking, cycling, or swimming) and strength training is associated with up to a 40% reduction in the risk of premature death [1023].

SR and MA emphasise the health benefits of nature exposure, linking it to enhanced cognitive function, mental health, physical activity, sleep, and lower cardiovascular risks. Experimental studies demonstrate protective effects on mental well-being, while observational studies suggest long-term advantages for chronic disease prevention [1024–1027].

This combination, along with mindfulness practices, enhances mental health and well-being [1028] and plays a vital role in effective energy intake control [1029]. For weight management, a holistic approach that combines physical activity with a balanced diet is proven more efficient than either strategy alone [603,1015,1030]. Interestingly, protein dietary supplements offer no significant additional benefits for muscle mass, strength, or body composition when a protein-rich diet is already in place [1031–1033].

Recent research reveals that protein supplements, before or after strength training sessions, do not markedly enhance muscle mass, strength, or overall body composition in healthy non-athletic individuals who already adhere to a balanced, adequate protein diet spread across multiple meals. This finding underscores the sufficiency of a well-structured dietary regimen in meeting the nutritional demands for muscle development and strength gains, diminishing the presumed necessity of additional protein dietary supplementation for those already achieving optimal protein intake through their daily diet [1031–1033].

Enhanced physical activity demands additional energy and nutrients to be provided through diet. Low intensity physical activities (up to 70% of VO_2max) preferably depend on fat metabolism, and activities above 80% VO_2max almost exclusively on carbohydrate metabolism [1034]. For substantial increases in physical activities, especially in sports and work, specific nutritional strategies to provide energy and nutrients were developed [1035]. For prolonged moderate-to-intensive physical activities (more than 60 minutes), nutrition during activity to maintain intensity and after activity to restore energy storage are important. Physical activity, especially in humid and hot conditions, may impose dehydration. Proper hydration is therefore important for physical activity since moderate-to-severe dehydration may reduce physical performance and induce symptoms of illness [1036]. However, excessive drinking during physical activity may lead to overhydration. In many marathon runners running more than four hours, overhydration was observed, which may have severe negative health outcomes including death [1037,1038]. A simple method to control hydration levels related to physical activity is to measure body mass before, during and after physical activity [1039]. Drinking during exercise should prevent excessive dehydration (more than 2% body mass loss from water deficit) and maintain electrolyte balance.

Regular engagement in moderate-to-vigorous physical activities, even in shorter bouts, significantly mitigates the risk associated with a sedentary lifestyle, underscoring the vital role of physical activity in extending life expectancy [1040]. The core health benefits are predominantly derived from aerobic exercises (such as walking, cycling, or swimming) and strength training, including gym equipment or weights [1023,1041]. Specifically, strength training not only aids in effective weight management but also plays a crucial role in reducing the risk of CVDs [1042]. Integrating mindfulness with physical activity amplifies its positive effects on mental health and well-being [1028], while regular, adequate exercise is instrumental in maintaining controlled energy intake [1029]. A holistic approach, combining aerobic and strength training with a healthy diet implemented with moderate caloric restriction of around 12–18%, without nutritional insufficient or compromising quality of life, offers the most substantial benefits for weight management and overall health, proving more effective than either component alone [573,603,1015,1030].

In contemporary lifestyles characterised by intermittent weight gain, particularly from holiday indulgences (such as excessive consumption of energy-dense foods), the importance of incorporating regular physical activity becomes particularly pronounced [1043]. This lifestyle approach not only facilitates weight management but also provides significant support in managing severe depression [1044–1048]. Given the comprehensive evidence, it is clear that regular physical activity and exercise represent essential, medicine-like interventions for maintaining and enhancing health across various dimensions [1009].

Appendix B. Search Strategy with Keywords

Table B: Search strategy with keywords

SEARCH STRATEGY

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1 CEREALS

(((("Edible Grain"[tiab] OR "Cereal"[tiab]) OR ("Triticum"[Mesh] OR "Triticum"[tiab] OR "Wheat"[tiab]) OR ("Avena"[Mesh] OR "Avena"[tiab] OR "Oat"[tiab]) OR ("Oryza"[Mesh] OR "Oryza"[tiab] OR "Rice"[tiab]) OR ("Secale"[Mesh] OR "0Secale"[TiAB] OR "Rye"[tiab]) OR ("Hordeum"[Mesh] OR "Hordeum"[tiab] OR "Barley"[tiab]) OR ("Whole Grains"[Mesh] OR "Whole Grain*"[Tiab]) OR ("Glutens"[Mesh] OR "Gluten*"[tiab] OR "Hordein*"[tiab] OR "Secalin"[tiab] OR "Glutelin*"[tiab]))) AND (((systematic review[ti] OR systematic literature review[ti] OR Cochrane Database Syst Rev[ta] OR systematic review[pt] OR placebo[tiab] OR meta-analysis[pt] OR (randomised controlled trial[pt]) OR (controlled clinical trial[pt])) OR ((randomised[tiab] OR randomised[tiab]) OR (placebo[tiab]) OR (drug therapy[sh]) OR (randomly[tiab]) OR (trial[tiab]) OR (groups[tiab]))))) NOT (animals[mh] NOT humans[mh])

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2 POTATOES

(((("Solanum tuberosum"[Mesh] OR "Solanum tuberosum*"[tiab] OR "Potato"[tiab]) OR ("Ipomoea batatas"[Mesh] OR "Ipomoea batatas*"[tiab] OR "Sweet Potato*"[tiab]) OR ("Helianthus"[Mesh] OR "Helianthus"[tiab] OR "Jerusalem Artichoke*"[tiab] OR "Helianthus tuberosus"[tiab] OR "Sunflower"[tiab] OR "Helianthus Annuus"[tiab]) OR ("Dioscorea"[Mesh] OR "Dioscorea*"[tiab] OR "Shan Yao"[tiab] OR "Yam"[tiab]) OR ("Manihot"[Mesh] OR "Manihot*"[tiab] OR "Kasaba*"[tiab] OR "Cassava*"[tiab] OR "Tapioca*"[tiab] OR "Manioc*"[tiab]))) AND (((((systematic review[ti] OR systematic literature review[ti] OR Cochrane Database Syst Rev[ta] OR systematic review[pt] OR placebo[tiab] OR meta-analysis[pt] NOT (animals[mh] NOT humans[mh])) OR (randomised controlled trial[pt]) OR (controlled clinical trial[pt])) OR ((randomised[tiab] OR randomised[tiab]) OR (placebo[tiab]) OR (drug therapy[sh]) OR (randomly[tiab]) OR (trial[tiab]) OR (groups[tiab])))) NOT (animals[mh] NOT humans[mh])))

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3 PULSES / LEGUMES

(((((("Arachis"[Mesh] OR "Arachis"[tiab] OR "Peanut*"[tiab]) OR ("Vigna"[Mesh] OR "Vigna"[tiab] OR "Cowpea"[tiab] OR "Bean"[tiab] OR "Pea"[tiab] OR "Mungo"[tiab] OR "Black Gram"[tiab])) OR ("Pisum sativum"[Mesh] OR "Pisum"[tiab] OR "Pea"[tiab])) OR ("Glycine max"[Mesh] OR "Glycine max"[tiab] OR "Soy Bean*"[tiab] OR "Soybean*"[tiab])) OR (("Cicer"[Mesh] OR "Cicer"[tiab] OR "Chickpea*"[tiab] OR "Garbanzo*"[tiab]) OR ("Lens Plant"[Mesh] OR "Lens"[tiab] OR "Lentil*"[tiab]))) AND ((((randomised controlled trial[pt]) OR (controlled clinical trial[pt]) OR (randomised[tiab] OR randomised[tiab]) OR (placebo[tiab]) OR (drug therapy[sh]) OR (randomly[tiab]) OR (trial[tiab]) OR (groups[tiab])) NOT (animals[mh] NOT humans[mh])) OR (systematic review[ti] OR systematic literature review[ti] OR Cochrane Database Syst Rev[ta] OR systematic review[pt] OR placebo[tiab] OR meta-analysis[pt] NOT (animals[mh] NOT humans[mh]))))

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4 FRUITS

((("Fruit"[Mesh] OR "Fruit*"[tiab] OR "Legume Pod*"[tiab) OR ("Rubus"[Mesh] OR "Rubus"[tiab] OR "Blackberry"[tiab] OR "Blackberries"[tiab] OR "Raspberries"[tiab] OR "Raspberry"[tiab]) OR ("Vaccinium macrocarpon"[Mesh] OR "Vaccinium macrocarpon*"[tiab] OR "Cranberry"[tiab] OR "Cranberries"[tiab]) OR ("Lycium"[Mesh] OR "Lycium"[tiab] OR "Goji Berry"[tiab] OR "Goji Berries"[tiab] OR "Wolfberry"[tiab] OR "Wolfberries"[tiab] OR "Goji Berry"[tiab]) OR ("Fragaria"[Mesh] OR "Fragaria*"[tiab] OR "Strawberry"[tiab] OR "Strawberries"[tiab]) OR ("Actinidia"[Mesh] OR "Actinidia*"[tiab] OR "Kiwi"[tiab]) OR ("Passiflora"[Mesh] OR "Passiflora"[tiab] OR "Passion*"[tiab] OR "Granadilla*"[tiab] OR "Passiflora"[tiab]) OR ("Citrus"[Mesh] OR "Citrus"[tiab] OR "Pomelo"[tiab] OR "Citron"[tiab] OR "Orange"[tiab] OR "Mandarin"[tiab] OR "Tangerine"[tiab] OR "Lemon"[tiab] OR "Kaffir Lime*"[tiab]) OR ("Citrus paradisi"[Mesh] OR "Citrus"[tiab] OR "Grapefruit*"[tiab] OR "Toronja*"[tiab]) OR ("Cucurbitaceae"[Mesh] OR "Cucurbitaceae"[tiab] OR "Coccinia*"[tiab] OR "Ivy Gourd*"[tiab] OR "Fevillea*"[tiab] OR "Melothria*"[tiab] OR "Melon*"[tiab]) OR ("Citrullus"[Mesh] OR "Citrullus"[tiab] OR "Watermelon"[tiab]) OR ("Malus"[Mesh] OR "Malus"[tiab] OR "Apple*"[tiab] OR "Apple*"[tiab]) OR ("Benomyl"[Mesh] OR "Benomyl"[tiab] OR "Fundazol"[tiab] OR "Fundasol"[tiab] OR "Benlate"[tiab]) OR ("Prunus armeniaca"[Mesh] OR "Prunus armeniaca"[tiab] OR "Apricot*"[tiab]) OR ("Prunus avium"[Mesh] OR "Prunus avium"[tiab] OR "Cherry"[tiab] OR "Cherries"[tiab] OR "Prunus"[tiab]) OR ("Litchi"[Mesh] OR "Litchi"[tiab] OR "Lychee*"[tiab]) OR ("Mangifera"[Mesh] OR "Mangifera*"[tiab] OR "Mango*"[tiab]) OR ("Prunus persica"[Mesh] OR "Prunus persica"[tiab] OR "Nectarine*"[tiab] OR "Peach*"[tiab]) OR ("Prunus domestica"[Mesh] OR "Prunus"[tiab] OR "Plum*"[tiab] OR "Plum*"[tiab]) OR ("Tephritidae"[Mesh] OR "Tephritidae"[tiab] OR "Trypetidae"[tiab] OR "Anastrepha"[tiab] OR "Bactrocera"[tiab] OR "Rhagoletis"[tiab] OR "Bactrocera tryoni"[tiab] OR "Anastrepha ludens"[tiab] OR "Anastrepha suspensa"[tiab]) OR ("Musa"[Mesh] OR "Musa*"[tiab] OR "Banana*"[tiab]) ("Fruit"[Mesh] OR "Fruit*"[tiab] OR "Berries"[tiab] OR "Berry"[tiab] OR "Plant Capsule*"[tiab] OR "Legume Pod*"[tiab])) AND (((((systematic review[ti] OR systematic literature review[ti] OR Cochrane Database Syst

Rev[ta] OR systematic review[pt] OR placebo[tiab] OR meta-analysis[pt] NOT (animals[mh] NOT humans[mh])) OR (randomized controlled trial[pt]) OR (controlled clinical trial[pt])) OR ((randomised[tiab] OR randomised[tiab]) OR (placebo[tiab]) OR (drug therapy[sh]) OR (randomly[tiab]) OR (trial[tiab]) OR (groups[tiab])))) NOT (animals[mh] NOT humans[mh])))

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5 VEGETABLES

((("Onions"[Mesh] OR "Onion*"[tiab] OR "Allium cepa*"[tiab] OR "Leek*"[tiab] OR "Allium porrum"[tiab]) OR ("Garlic"[Mesh] OR "Garlic*"[tiab] OR "Allium sativum"[tiab]) OR ("Beta vulgaris"[Mesh] OR "Beta vulgari*"[tiab] OR "Beet*"[tiab] OR "Chard*"[tiab]) OR ("Daucus carota"[Mesh] OR "Daucus carota"[tiab] OR "Carrot*"[tiab]) OR ("Lactuca"[Mesh] OR "Lactuca"[tiab] OR "Lettuce*"[tiab] OR "Lactuca Sativa*"[tiab]) OR ("Pastinaca"[Mesh] OR "Pastinaca*"[tiab] OR "Parsnip*"[tiab]) OR ("Brassica napus"[Mesh] OR "Brassica napus"[tiab] OR "Turnip*"[tiab] OR "Rapeseed*"[tiab] OR "Rutabaga"[tiab]) OR ("Brassica"[Mesh] OR "Brassica"[tiab] OR "Collard Green*"[tiab] OR "Kale"[tiab] OR "Cauliflower"[tiab] OR "Broccoli"[tiab] OR "Cabbage"[tiab]) OR ("Mustard Plant"[Mesh] OR "Mustard Plant*"[Mesh] OR "Brassica nigra"[tiab] OR "Mustard*"[tiab]) OR ("Armoracia"[Mesh] OR "Armoracia"[tiab] OR "Horseradish*"[tiab] OR "Armoracia"[tiab]) OR ("Raphanus"[Mesh] OR "Raphanus"[tiab] OR "Radish*"[tiab]) OR ("Nasturtium"[Mesh] OR "Nasturtium"[tiab] OR "Watercress"[tiab] OR "Nasturtium"[tiab]) OR ("Spinacia oleracea"[Mesh] OR "Spinacia oleracea"[tiab] OR "Spinach"[tiab])) AND (((((systematic review[ti] OR systematic literature review[ti] OR Cochrane Database Syst Rev[ta] OR systematic review[pt] OR placebo[tiab] OR meta-analysis[pt] NOT (animals[mh] NOT humans[mh])) OR (randomised controlled trial[pt]) OR (controlled clinical trial[pt])) OR ((randomised[tiab] OR randomised[tiab]) OR (placebo[tiab]) OR (drug therapy[sh]) OR (randomly[tiab]) OR (trial[tiab]) OR (groups[tiab])))) NOT (animals[mh] NOT humans[mh])))

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6 NUTS AND SEEDS

((((((((((((("Prunus dulcis"[Mesh] OR "Prunus dulcis"[tiab] OR "Almond*"[tiab] OR "Prunus*"[tiab]) OR ("Bertholletia"[Mesh] OR "Bertholletia"[tiab] OR "Brazil Nuts"[tiab] OR "Brazil Nut"[tiab] OR "Bertholletia excelsa"[tiab])) OR ("Anacardium"[Mesh] OR "Anacardium*"[tiab] OR "Cashew*"[tiab])) OR ("Corylus"[Mesh] OR "Corylus"[tiab] OR "Filbert"[tiab] OR "Hazelnut*"[tiab])) OR ("Carya"[Mesh] OR "Carya"[tiab] OR "Hickory"[tiab] OR "Pecan*"[tiab] OR "Pecan*"[tiab])) OR ("Pinus"[Mesh] OR "Pinus*"[tiab] OR "PIne*"[tiab])) OR ("Pistacia"[Mesh] OR "Pistacia"[tiab] OR "Pistachio*"[tiab])) OR ("Macadamia"[Mesh] OR "Macadamia"[tiab])) OR ("Juglans"[Mesh] OR "Juglans"[tiab] OR "Walnut*"[tiab] OR "Juglans nigra*"[tiab])) OR ("Arachis"[Mesh] OR "Arachis"[tiab] OR "Peanut*"[tiab])) OR (((("Salvia hispanica"[Mesh] OR "Salvia hispanica"[tiab] OR "Chia"[tiab] OR "Salvia columbariae"[tiab]) OR ("Flax"[Mesh] OR "Flax*"[tiab] OR "Linum*"[tiab] OR "Linseed*"[tiab]

OR "Linseed*"[tiab])) OR ("Cucurbita"[Mesh] OR "Cucurbita"[tiab] OR "Pumpkin*"[tiab] OR "Squash Plant*"[tiab] OR "Squashe*"[tiab])) OR ("Helianthus"[Mesh] OR "Helianthus"[tiab] OR "Jerusalem Artichoke*"[tiab] OR "Helianthus tuberosus*"[tiab] OR "Sunflower*"[tiab] OR "Helianthus annuus"[tiab])))) AND (((((systematic review[ti] OR systematic literature review[ti] OR Cochrane Database Syst Rev[ta] OR systematic review[pt] OR placebo[tiab] OR meta-analysis[pt] NOT (animals[mh] NOT humans[mh])) OR (randomised controlled trial[pt]) OR (controlled clinical trial[pt])) OR ((randomised[tiab] OR randomised[tiab]) OR (placebo[tiab]) OR (drug therapy[sh]) OR (randomly[tiab]) OR (trial[tiab]) OR (groups[tiab])))) NOT (animals[mh] NOT humans[mh])))

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7 FISH AND SEAFOOD

(((((("Fishes"[Mesh] OR "Fish*"[tiab]) OR ("Fish Oils"[Mesh] OR "Fish Oil*"[tiab] OR "Fish Liver Oil*"[tiab])) OR ("Salmonidae"[Mesh] OR "Salmonidae*"[tiab] OR "Salmonid*"[tiab] OR "Grayling*"[tiab] OR "Thymallus*"[tiab] OR "Whitefish*"[tiab])) OR ("Crustacea"[Mesh] OR "Crustacea*"[tiab] OR "Ostracod*"[tiab])) OR ("Mollusca"[Mesh] OR "Mollusca*"[tiab] OR "Mollusk*"[tiab] OR "Mollusc*"[tiab])) OR ("Seafood"[Mesh] OR "Seafood*"[tiab] OR "Sea-Food*"[tiab] OR "Sea Food*"[tiab])) AND ((((((randomised controlled trial[pt]) OR (controlled clinical trial[pt]) OR (randomised[tiab] OR randomised[tiab]) OR (placebo[tiab]) OR (drug therapy[sh]) OR (randomly[tiab]) OR (trial[tiab])) AND (systematic review[ti] OR systematic literature review[ti] OR Cochrane Database Syst Rev[ta] OR systematic review[pt] OR placebo[tiab] OR meta-analysis[pt]))) NOT (animals[mh] NOT humans[mh])))

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8 MILK AND DAIRY PRODUCTS

(((((("Cheese"[Mesh] OR "Cheese*"[tiab]) OR ("Butter"[Mesh] OR "Butter*"[tiab])) OR ("Yogurt"[Mesh] OR "Yogurt"[tiab])))) AND (((systematic review[ti] OR systematic literature review[ti] OR Cochrane Database Syst Rev[ta] OR systematic review[pt] OR placebo[tiab] OR meta-analysis[pt] OR (randomised controlled trial[pt]) OR (controlled clinical trial[pt])) OR ((randomised[tiab] OR randomised[tiab]) OR (placebo[tiab]) OR (drug therapy[sh]) OR (randomly[tiab]) OR (trial[tiab]) OR (groups[tiab]))))) NOT (animals[mh] NOT humans[mh])

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9 PROCESSED MEAT

(("Meat"[Mesh] OR "Meat*"[tiab]) OR ("Red Meat"[Mesh] OR "Beef"[tiab] OR "Lamb Meat*"[tiab] OR "Veal*"[tiab] OR"Beef*"[tiab]) OR ("Pork Meat"[Mesh] OR "Pork"[tiab] OR "Pig"[tiab] OR "Bacon"[tiab] OR "Cured Ham"[tiab]) OR ("Goats"[Mesh] OR "Goat*"[tiab] OR "Capra*"[tiab]) OR ("Poultry"[Mesh] OR "Poultry"[tiab] OR "Poultries"[tiab] OR "Domestic

Fowl*"[tiab]) OR ("Chickens"[Mesh] OR "Chicken*"[tiab] OR "Gallus"[tiab]) OR ("Ducks"[Mesh] OR "Duck*"[tiab]) OR ("Turkey"[Mesh] OR "Turkey"[tiab] OR "Turkiye"[tiab]) OR ("Rabbits"[Mesh] OR "Rabbit*"[tiab] OR "Hare*"[tiab] OR "Oryctolagus cuniculus"[tiab]) OR ("Meat Products"[Mesh] OR "Meat Product*"[tiab] OR "Processed Meat"[tiab] OR "Smoking Meat"[tiab] OR "Salted meat"[tiab] OR "Curing Meat"[tiab] OR "Preserving Meat"[tiab])) AND ((((systematic review[ti] OR systematic literature review[ti] OR Cochrane Database Syst Rev[ta] OR systematic review[pt] OR placebo[tiab] OR meta-analysis[pt] NOT (animals[mh] NOT humans[mh])) OR (randomised controlled trial[pt]) OR (controlled clinical trial[pt])) OR ((randomised[tiab] OR randomised[tiab]) OR (placebo[tiab]) OR (drug therapy[sh]) OR (randomly[tiab]) OR (trial[tiab]) OR (groups[tiab]))) NOT (animals[mh] NOT humans[mh]))

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10 EGGS

(((("Solanum tuberosum"[Mesh] OR "Solanum tuberosum*"[tiab] OR "Potato"[tiab]) OR ("Ipomoea batatas"[Mesh] OR "Ipomoea batatas*"[tiab] OR "Sweet Potato*"[tiab]) OR ("Helianthus"[Mesh] OR "Helianthus"[tiab] OR "Jerusalem Artichoke*"[tiab] OR "Helianthus tuberosus"[tiab] OR "Sunflower"[tiab] OR "Helianthus Annuus"[tiab]) OR ("Dioscorea"[Mesh] OR "Dioscorea*"[tiab] OR "Shan Yao"[tiab] OR "Yam"[tiab]) OR ("Manihot"[Mesh] OR "Manihot*"[tiab] OR "Kasaba*"[tiab] OR "Cassava*"[tiab] OR "Tapioca*"[tiab] OR "Manioc*"[tiab])) AND (("Eggs"[Mesh] OR "Egg"[tiab]) OR ("Egg White"[Mesh]) OR ("Egg Yolk"[Mesh]))) AND ((((systematic review[ti] OR systematic literature review[ti] OR Cochrane Database Syst Rev[ta] OR systematic review[pt] OR placebo[tiab] OR meta-analysis[pt] NOT (animals[mh] NOT humans[mh])) OR (randomised controlled trial[pt]) OR (controlled clinical trial[pt])) OR ((randomised[tiab] OR randomised[tiab]) OR (placebo[tiab]) OR (drug therapy[sh]) OR (randomly[tiab]) OR (trial[tiab]) OR (groups[tiab]))))) NOT ((animals[mh] NOT humans[mh]))

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11 FATS AND OILS

(((("Plant Oils"[Mesh] OR "Plant Oil*"[tiab] OR "Vegetable Oil*"[tiab]) OR ("Margarine"[Mesh] OR "Margarine"[tiab]) OR ("Butter"[Mesh] OR "Butter*"[tiab]) OR ("Ice Cream"[Mesh] OR "Cream"[tiab]) OR ("Dietary Fats"[Mesh] OR "Dietary Fat*"[tiab] OR "Lard*"[tiab])) AND ((((randomised controlled trial[pt]) OR (controlled clinical trial[pt]) OR (randomised[tiab] OR randomised[tiab]) OR (placebo[tiab]) OR (drug therapy[sh]) OR (randomly[tiab]) OR (trial[tiab]) OR (groups[tiab])) NOT (animals[mh] NOT humans[mh])) OR (systematic review[ti] OR systematic literature review[ti] OR Cochrane Database Syst Rev[ta] OR systematic review[pt] OR placebo[tiab] OR meta-analysis[pt]))) NOT ((animals[mesh] NOT humans[mesh])))

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12 HERBS AND SPICES

(((((((((((((((((((("Petroselinum"[Mesh] OR "Petroselinum*"[tiab] OR "Parsley"[tiab]) OR ("Apium"[Mesh] OR "Apium*"[tiab] OR "Celery*"[tiab] OR "Celeries*"[tiab] OR "Celeriac*"[tiab])) OR ("Garlic"[Mesh] OR "Garlic"[tiab] OR "Allium sativum"[tiab])) OR ("Rosmarinus"[Mesh] OR "Rosmarinus"[tiab] OR "Rosmary"[tiab])) OR ("Thymus Plant"[Mesh] OR "Thymus Plant*"[tiab] OR "Thyme*"[tiab])) OR ("Ocimum basilicum"[Mesh] OR "Ocimum basilicum"[tiab] OR "Basil"[tiab])) OR ("Anethum graveolens"[Mesh] OR "Anethum graveolen*"[tiab] OR "Dill*"[tiab])) OR ("Origanum"[Mesh] OR "Origanum*"[tiab] OR "Paprika"[tiab] OR "Oregano*"[tiab] OR "Marjoram*"[tiab])) OR ("Capsicum"[Mesh] OR "Capsicum"[tiab] OR "Bell Pepper"[tiab] OR "Sweet Pepper"[tiab] OR "Red Pepper"[tiab] OR "Green Pepper"[tiab] OR "Cayenne"[tiab] OR "Paprika"[tiab] OR "Hot Pepper"[tiab] OR "Jalapeno Pepper"[tiab] OR "Pimiento"[tiab] OR "Capsicum annuum"[tiab] OR "Chilli Pepper*"[tiab] OR "Chile Pepper*"[tiab])) OR ("Cinnamomum zeylanicum"[Mesh] OR "Cinnamomum zeylanicum"[tiab] OR "Cinnamon"[tiab])) OR ("Zingiber officinale"[Mesh] OR "Zingiber officinale*"[tiab] OR "Ginger*"[tiab])) OR ("Curcuma"[Mesh] OR "Curcuma*"[tiab] OR "Tumeric*"[tiab] OR "Tumeric*"[tiab])) OR ("Origanum"[Mesh] OR "Origanum"[tiab] OR "Oregano*"[tiab] OR "Marjoram*"[tiab])) OR ("Crocus"[Mesh] OR "Crocus"[tiab] OR "Saffron"[tiab])) OR ("Carum"[Mesh] OR "Carum*"[tiab] OR "Caraway*"[tiab] OR "Ajowan*"[tiab])) OR ("Cuminum"[Mesh] OR "Cuminum"[tiab])) OR ("Foeniculum"[Mesh] OR "Foeniculum*"[tiab] OR "Fennel*"[tiab])) OR ("Piper nigrum"[Mesh] OR "Piper nigrum*"[tiab] OR "Black Pepper*"[tiab]))) AND (((((systematic review[ti] OR systematic literature review[ti] OR Cochrane Database Syst Rev[ta] OR systematic review[pt] OR placebo[tiab] OR meta-analysis[pt] NOT (animals[mh] NOT humans[mh])) OR (randomised controlled trial[pt]) OR (controlled clinical trial[pt])) OR ((randomised[tiab] OR randomised[tiab]) OR (placebo[tiab]) OR (drug therapy[sh]) OR (randomly[tiab]) OR (trial[tiab]) OR (groups[tiab])))) NOT (animals[mh] NOT humans[mh])))

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13 SWEETS AND SNACKS [MESH MAJOR TOPIC DOES NOT EXIST]

((("Sugar-Sweetened Beverages"[Mesh] OR "Sugar-Sweetened Beverage*"[tiab] OR "Sugar-Added Beverage*"[tiab] OR "Sweetened Beverage*"[tiab]) OR ("Snacks"[Mesh] OR "Snack*"[tiab]) OR ("Candy"[Mesh] OR "Candy"[tiab]) OR ("Candies"[tiab] OR "Confection*"[tiab]) OR ("Chocolate"[Mesh] OR "Chocolate*"[tiab] OR "Cocoa Powder*"[tiab]) OR ("Dessert"[tiab] OR "Cake*"[tiab] OR "Doughnut*"[tiab] OR "Pie"[tiab] OR "Brownies"[tiab] OR "Biscuit*"[tiab] OR "Pudding"[tiab]) OR ("Ice Cream"[Mesh] OR "Ice Cream*"[tiab]) OR ("Crisp*"[tiab] OR "Cracker"[tiab] OR "Pretzel"[tiab])) AND (((((systematic review[ti] OR systematic literature review[ti] OR Cochrane Database Syst Rev[ta] OR systematic review[pt] OR placebo[tiab] OR meta-analysis[pt] NOT (animals[mh] NOT humans[mh])) OR (randomised controlled trial[pt]) OR (controlled clinical trial[pt])) OR ((randomised[tiab] OR randomised[tiab]) OR (placebo[tiab]) OR (drug therapy[sh]) OR (randomly[tiab]) OR (trial[tiab]) OR (groups[tiab])))) NOT (animals[mh] NOT humans[mh])))

14 WATER AND NON-ALCOHOLIC BEVERAGES [MESH MAJOR TOPIC DOES NOT EXIST]

(((("Water"[Mesh] OR "Water"[tiab]) OR ("Mineral Waters"[Mesh] OR "Mineral Water*"[tiab]) OR ("Tea"[Mesh] OR "Tea"[tiab]) OR ("Coffea"[Mesh] OR "Coffea"[tiab]) OR ("Fruit and Vegetable Juices"[Mesh] OR "Fruit Juice*"[tiab]) OR ("Beverages"[Mesh] OR "Beverage*"[tiab]))) AND (((((systematic review[ti] OR systematic literature review[ti] OR Cochrane Database Syst Rev[ta] OR systematic review[pt] OR placebo[tiab] OR meta-analysis[pt] NOT (animals[mh] NOT humans[mh])) OR (randomised controlled trial[pt]) OR (controlled clinical trial[pt])) OR ((randomised[tiab] OR randomised[tiab]) OR (placebo[tiab]) OR (drug therapy[sh]) OR (randomly[tiab]) OR (trial[tiab]) OR (groups[tiab])))) NOT (animals[mh] NOT humans[mh])))

15 ALCOHOL

(((("Alcohol Drinking"[Mesh] OR "Alcohol"[tiab]) OR ("Beer"[Mesh] OR "Beer*"[tiab]) OR ("Wine"[Mesh] OR "Wine"[tiab] OR Vino[tiab]) OR ("Spirits"[tiab] OR "Snops"[tiab]))) AND (((((systematic review[ti] OR systematic literature review[ti] OR Cochrane Database Syst Rev[ta] OR systematic review[pt] OR placebo[tiab] OR meta-analysis[pt] NOT (animals[mh] NOT humans[mh])) OR (randomised controlled trial[pt]) OR (controlled clinical trial[pt])) OR ((randomised[tiab] OR randomised[tiab]) OR (placebo[tiab]) OR (drug therapy[sh]) OR (randomly[tiab]) OR (trial[tiab]) OR (groups[tiab])))) NOT (animals[mh] NOT humans[mh])))

16 ULTRA-PROCESSED FOODS

((((("Food, Processed"[Mesh] OR "Processed Food*"[tiab] OR "Ultra-Processed Food*"[tiab]) OR ("Satureja"[Mesh] OR "Satureja"[tiab] OR Savory[tiab] OR Savories[tiab]) OR "Processed Meat"[tiab] OR ("Poultry"[Mesh] OR "Poultry"[tiab] OR "Poultries"[tiab] OR "Domestic Fowl*"[tiab]) OR "fish nugget*"[tiab] OR ("Fish Products"[Mesh] OR "Fish Product*"[tiab]) OR "Meal Replacement*"[tiab] OR ("Margarine"[Mesh] OR "Margarine"[tiab]) OR "Instant soup*"[tiab] OR "Breakfast Cereals"[tiab] OR ("Ice Cream"[Mesh] OR "Ice Cream*"[tiab]) OR ("Carbonated Beverages"[Mesh] OR "Carbonated Beverage*"[tiab] OR "Carbonated Drink*"[tiab] OR "Soft Drink*"[tiab] OR "Soda Pop*"[tiab]))) AND ((((((systematic review[ti] OR systematic literature review[ti] OR Cochrane Database Syst Rev[ta] OR systematic review[pt] OR placebo[tiab] OR meta-analysis[pt]) OR (randomised controlled trial[pt]) OR (controlled clinical trial[pt])) OR ((randomised[tiab] OR randomised[tiab]) OR (placebo[tiab]) OR (drug therapy[sh]) OR (randomly[tiab]) OR (trial[tiab]) OR (groups[tiab]))))))) NOT ((animals[mh] NOT humans[mh])))

#1 TO #16 HEALTH/NCDS

((((((((((((((((("Edible Grain"[tiab] OR "Cereal"[tiab]) OR ("Triticum"[Mesh] OR "Triticum"[tiab] OR "Wheat"[tiab]) OR ("Avena"[Mesh] OR "Avena"[tiab] OR "Oat"[tiab]) OR ("Oryza"[Mesh] OR "Oryza"[tiab] OR "Rice"[tiab]) OR ("Secale"[Mesh] OR "Secale"[TiAB] OR "Rye"[tiab]) OR ("Hordeum"[Mesh] OR "Hordeum"[tiab] OR "Barley"[tiab]) OR ("Whole Grains"[Mesh] OR "Whole Grain*"[Tiab]) OR ("Glutens"[Mesh] OR "Gluten*"[tiab] OR "Hordein*"[tiab] OR "Secalin"[tiab] OR "Glutelin*"[tiab])) OR (((("Solanum tuberosum"[Mesh] OR "Solanum tuberosum*"[tiab] OR "Potato"[tiab]) OR ("Ipomoea batatas"[Mesh] OR "Ipomoea batatas*"[tiab] OR "Sweet Potato*"[tiab]) OR ("Helianthus"[Mesh] OR "Helianthus"[tiab] OR "Jerusalem Artichoke*"[tiab] OR "Helianthus tuberosus"[tiab] OR "Sunflower"[tiab] OR "Helianthus Annuus"[tiab]) OR ("Dioscorea"[Mesh] OR "Dioscorea*"[tiab] OR "Shan Yao"[tiab] OR "Yam"[tiab]) OR ("Manihot"[Mesh] OR "Manihot*"[tiab] OR "Kasaba*"[tiab] OR "Cassava*"[tiab] OR "Tapioca*"[tiab] OR "Manioc*"[tiab]))))) OR ((((("Arachis"[Mesh] OR "Arachis"[tiab] OR "Peanut*"[tiab]) OR ("Vigna"[Mesh] OR "Vigna"[tiab] OR "Cowpea"[tiab] OR "Bean"[tiab] OR "Pea"[tiab] OR "Mungo"[tiab] OR "Black Gram"[tiab])) OR ("Pisum sativum"[Mesh] OR "Pisum"[tiab] OR "Pea"[tiab])) OR ("Glycine max"[Mesh] OR "Glycine max"[tiab] OR "Soy Bean*"[tiab] OR "Soybean*"[tiab])) OR (("Cicer"[Mesh] OR "Cicer"[tiab] OR "Chickpea*"[tiab] OR "Garbanzo*"[tiab]) OR ("Lens Plant"[Mesh] OR "Lens"[tiab] OR "Lentil*"[tiab])))) OR ((("Fruit"[Mesh] OR "Fruit*"[tiab] OR "Legume Pod*"[tiab) OR ("Rubus"[Mesh] OR "Rubus"[tiab] OR "Blackberry"[tiab] OR "Blackberries"[tiab] OR "Raspberries"[tiab] OR "Raspberry"[tiab]) OR ("Vaccinium macrocarpon"[Mesh] OR "Vaccinium macrocarpon*"[tiab] OR "Cranberry"[tiab] OR "Cranberries"[tiab]) OR ("Lycium"[Mesh] OR "Lycium"[tiab] OR "Goji Berry"[tiab] OR "Goji Berries"[tiab] OR "Wolfberry"[tiab] OR "Wolfberries"[tiab] OR "Goji Berry"[tiab]) OR ("Fragaria"[Mesh] OR "Fragaria*"[tiab] OR "Strawberry"[tiab] OR "Strawberries"[tiab]) OR ("Actinidia"[Mesh] OR "Actinidia*"[tiab] OR "Kiwi"[tiab]) OR ("Passiflora"[Mesh] OR "Passiflora"[tiab] OR "Passion*"[tiab] OR "Granadilla*"[tiab] OR "Passiflora"[tiab]) OR ("Citrus"[Mesh] OR "Citrus"[tiab] OR "Pomelo"[tiab] OR "Citron"[tiab] OR "Orange"[tiab] OR "Mandarin"[tiab] OR "Tangerine"[tiab] OR "Lemon"[tiab] OR "Kaffir Lime*"[tiab]) OR ("Citrus paradisi"[Mesh] OR "Citrus"[tiab] OR "Grapefruit*"[tiab] OR "Toronja*"[tiab]) OR ("Cucurbitaceae"[Mesh] OR "Cucurbitaceae"[tiab] OR "Coccinia*"[tiab] OR "Ivy Gourd*"[tiab] OR "Fevillea*"[tiab] OR "Melothria*"[tiab] OR "Melon*"[tiab]) OR ("Citrullus"[Mesh] OR "Citrullus"[tiab] OR "Watermelon"[tiab]) OR ("Malus"[Mesh] OR "Malus"[tiab] OR "Apple*"[tiab] OR "Apple*"[tiab]) OR ("Benomyl"[Mesh] OR "Benomyl"[tiab] OR "Fundazol"[tiab] OR "Fundasol"[tiab] OR "Benlate"[tiab]) OR ("Prunus armeniaca"[Mesh] OR "Prunus armeniaca"[tiab] OR "Apricot*"[tiab]) OR ("Prunus avium"[Mesh] OR "Prunus avium"[tiab] OR "Cherry"[tiab] OR "Cherries"[tiab] OR "Prunus"[tiab]) OR ("Litchi"[Mesh] OR "Litchi"[tiab] OR "Lychee*"[tiab]) OR ("Mangifera"[Mesh] OR "Mangifera*"[tiab] OR "Mango*"[tiab]) OR ("Prunus persica"[Mesh] OR "Prunus persica"[tiab] OR "Nectarine*"[tiab] OR "Peach*"[tiab]) OR ("Prunus domestica"[Mesh] OR "Prunus"[tiab] OR "Plum*"[tiab] OR "Plum*"[tiab]) OR ("Tephritidae"[Mesh] OR "Tephritidae"[tiab] OR "Trypetidae"[tiab] OR "Anastrepha"[tiab] OR "Bactrocera"[tiab] OR "Rhagoletis"[tiab] OR "Bactrocera tryoni"[tiab] OR "Anastrepha ludens"[tiab] OR "Anastrepha suspensa"[tiab]) OR ("Musa"[Mesh] OR "Musa*"[tiab] OR "Banana*"[tiab]) ("Fruit"[Mesh] OR "Fruit*"[tiab] OR "Berries"[tiab] OR "Berry"[tiab] OR "Plant

Capsule*"[tiab] OR "Legume Pod*"[tiab])))) OR ((("Onions"[Mesh] OR "Onion*"[tiab] OR "Allium cepa*"[tiab] OR "Leek*"[tiab] OR "Allium porrum"[tiab]) OR ("Garlic"[Mesh] OR "Garlic*"[tiab] OR "Allium sativum"[tiab]) OR ("Beta vulgaris"[Mesh] OR "Beta vulgari*"[tiab] OR "Beet*"[tiab] OR "Chard*"[tiab]) OR ("Daucus carota"[Mesh] OR "Daucus carota"[tiab] OR "Carrot*"[tiab]) OR ("Lactuca"[Mesh] OR "Lactuca"[tiab] OR "Lettuce*"[tiab] OR "Lactuca Sativa*"[tiab]) OR ("Pastinaca"[Mesh] OR "Pastinaca*"[tiab] OR "Parsnip*"[tiab]) OR ("Brassica napus"[Mesh] OR "Brassica napus"[tiab] OR "Turnip*"[tiab] OR "Rapeseed*"[tiab] OR "Rutabaga"[tiab]) OR ("Brassica"[Mesh] OR "Brassica"[tiab] OR "Collard Green*"[tiab] OR "Kale"[tiab] OR "Cauliflower"[tiab] OR "Broccoli"[tiab] OR "Cabbage"[tiab]) OR ("Mustard Plant"[Mesh] OR "Mustard Plant*"[Mesh] OR "Brassica nigra"[tiab] OR "Mustard*"[tiab]) OR ("Armoracia"[Mesh] OR "Armoracia"[tiab] OR "Horseradish*"[tiab] OR "Armoracia"[tiab]) OR ("Raphanus"[Mesh] OR "Raphanus"[tiab] OR "Radish*"[tiab]) OR ("Nasturtium"[Mesh] OR "Nasturtium"[tiab] OR "Watercress"[tiab] OR "Nasturtium"[tiab]) OR ("Spinacia oleracea"[Mesh] OR "Spinacia oleracea"[tiab] OR "Spinach"[tiab])))) OR ((((((((((("Prunus dulcis"[Mesh] OR "Prunus dulcis"[tiab] OR "Almond*"[tiab] OR "Prunus*"[tiab]) OR ("Bertholletia"[Mesh] OR "Bertholletia"[tiab] OR "Brazil Nuts"[tiab] OR "Brazil Nut"[tiab] OR "Bertholletia excelsa"[tiab])) OR ("Anacardium"[Mesh] OR "Anacardium*"[tiab] OR "Cashew*"[tiab])) OR ("Corylus"[Mesh] OR "Corylus"[tiab] OR "Filbert"[tiab] OR "Hazelnut*"[tiab])) OR ("Carya"[Mesh] OR "Carya"[tiab] OR "Hickory"[tiab] OR "Pecan*"[tiab] OR "Pecan*"[tiab])) OR ("Pinus"[Mesh] OR "Pinus*"[tiab] OR "PIne*"[tiab])) OR ("Pistacia"[Mesh] OR "Pistacia"[tiab] OR "Pistachio*"[tiab])) OR ("Macadamia"[Mesh] OR "Macadamia"[tiab])) OR ("Juglans"[Mesh] OR "Juglans"[tiab] OR "Walnut*"[tiab] OR "Juglans nigra*"[tiab])) OR ("Arachis"[Mesh] OR "Arachis"[tiab] OR "Peanut*"[tiab])) OR (((("Salvia hispanica"[Mesh] OR "Salvia hispanica"[tiab] OR "Chia"[tiab] OR "Salvia columbariae"[tiab]) OR ("Flax"[Mesh] OR "Flax*"[tiab] OR "Linum*"[tiab] OR "Linseed*"[tiab] OR "Linseed*"[tiab])) OR ("Cucurbita"[Mesh] OR "Cucurbita"[tiab] OR "Pumpkin*"[tiab] OR "Squash Plant*"[tiab] OR "Squashe*"[tiab])) OR ("Helianthus"[Mesh] OR "Helianthus"[tiab] OR "Jerusalem Artichoke*"[tiab] OR "Helianthus tuberosus*"[tiab] OR "Sunflower*"[tiab] OR "Helianthus annuus"[tiab]))))) OR (((((("Fishes"[Mesh] OR "Fish*"[tiab]) OR ("Fish Oils"[Mesh] OR "Fish Oil*"[tiab] OR "Fish Liver Oil*"[tiab])) OR ("Salmonidae"[Mesh] OR "Salmonidae*"[tiab] OR "Salmonid*"[tiab] OR "Grayling*"[tiab] OR "Thymallus*"[tiab] OR "Whitefish*"[tiab])) OR ("Crustacea"[Mesh] OR "Crustacea*"[tiab] OR "Ostracod*"[tiab])) OR ("Mollusca"[Mesh] OR "Mollusca*"[tiab] OR "Mollusk*"[tiab] OR "Mollusc*"[tiab])) OR ("Seafood"[Mesh] OR "Seafood*"[tiab] OR "Sea-Food*"[tiab] OR "Sea Food*"[tiab]))) OR (((((("Cheese"[Mesh] OR "Cheese*"[tiab]) OR ("Butter"[Mesh] OR "Butter*"[tiab])) OR ("Yogurt"[Mesh] OR "Yogurt"[tiab])))))) OR ((("Meat"[Mesh] OR "Meat*"[tiab]) OR ("Red Meat"[Mesh] OR "Beef"[tiab] OR "Lamb Meat*"[tiab] OR "Veal*"[tiab] OR"Beef*"[tiab]) OR ("Pork Meat"[Mesh] OR "Pork"[tiab] OR "Pig"[tiab] OR "Bacon"[tiab] OR "Cured Ham"[tiab]) OR ("Goats"[Mesh] OR "Goat*"[tiab] OR "Capra*"[tiab]) OR ("Poultry"[Mesh] OR "Poultry"[tiab] OR "Poultries"[tiab] OR "Domestic Fowl*"[tiab]) OR ("Chickens"[Mesh] OR "Chicken*"[tiab] OR "Gallus"[tiab]) OR ("Ducks"[Mesh] OR "Duck*"[tiab]) OR ("Turkey"[Mesh] OR "Turkey"[tiab] OR "Turkiye"[tiab]) OR ("Rabbits"[Mesh] OR "Rabbit*"[tiab] OR "Hare*"[tiab] OR "Oryctolagus cuniculus"[tiab]) OR ("Meat Products"[Mesh] OR "Meat Product*"[tiab] OR "Processed Meat"[tiab] OR "Smoking Meat"[tiab] OR "Salted meat"[tiab] OR "Curing Meat"[tiab] OR "Preserving Meat"[tiab])))) OR (((("Solanum tuberosum"[Mesh] OR "Solanum tuberosum*"[tiab] OR "Potato"[tiab])

OR ("Ipomoea batatas"[Mesh] OR "Ipomoea batatas*"[tiab] OR "Sweet Potato*"[tiab]) OR ("Helianthus"[Mesh] OR "Helianthus"[tiab] OR "Jerusalem Artichoke*"[tiab] OR "Helianthus tuberosus"[tiab] OR "Sunflower"[tiab] OR "Helianthus Annuus"[tiab]) OR ("Dioscorea"[Mesh] OR "Dioscorea*"[tiab] OR "Shan Yao"[tiab] OR "Yam"[tiab]) OR ("Manihot"[Mesh] OR "Manihot*"[tiab] OR "Kasaba*"[tiab] OR "Cassava*"[tiab] OR "Tapioca*"[tiab] OR "Manioc*"[tiab])) AND (("Eggs"[Mesh] OR "Egg"[tiab]) OR ("Egg White"[Mesh]) OR ("Egg Yolk"[Mesh]))))) OR ((("Plant Oils"[Mesh] OR "Plant Oil*"[tiab] OR "Vegetable Oil*"[tiab]) OR ("Margarine"[Mesh] OR "Margarine"[tiab]) OR ("Butter"[Mesh] OR "Butter*"[tiab]) OR ("Ice Cream"[Mesh] OR "Cream"[tiab]) OR ("Dietary Fats"[Mesh] OR "Dietary Fat*"[tiab] OR "Lard*"[tiab])))) OR ((((((((((((((((((("Petroselinum"[Mesh] OR "Petroselinum*"[tiab] OR "Parsley"[tiab]) OR ("Apium"[Mesh] OR "Apium*"[tiab] OR "Celery*"[tiab] OR "Celeries*"[tiab] OR "Celeriac*"[tiab])) OR ("Garlic"[Mesh] OR "Garlic"[tiab] OR "Allium sativum"[tiab])) OR ("Rosmarinus"[Mesh] OR "Rosmarinus"[tiab] OR "Rosmary"[tiab])) OR ("Thymus Plant"[Mesh] OR "Thymus Plant*"[tiab] OR "Thyme*"[tiab])) OR ("Ocimum basilicum"[Mesh] OR "Ocimum basilicum"[tiab] OR "Basil"[tiab])) OR ("Anethum graveolens"[Mesh] OR "Anethum graveolen*"[tiab] OR "Dill*"[tiab])) OR ("Origanum"[Mesh] OR "Origanum*"[tiab] OR "Paprika"[tiab] OR "Oregano*"[tiab] OR "Marjoram*"[tiab])) OR ("Capsicum"[Mesh] OR "Capsicum"[tiab] OR "Bell Pepper"[tiab] OR "Sweet Pepper"[tiab] OR "Red Pepper"[tiab] OR "Green Pepper"[tiab] OR "Cayenne"[tiab] OR "Paprika"[tiab] OR "Hot Pepper"[tiab] OR "Jalapeno Pepper"[tiab] OR "Pimiento"[tiab] OR "Capsicum annuum"[tiab] OR "Chilli Pepper*"[tiab] OR "Chile Pepper*"[tiab])) OR ("Cinnamomum zeylanicum"[Mesh] OR "Cinnamomum zeylanicum"[tiab] OR "Cinnamon"[tiab])) OR ("Zingiber officinale"[Mesh] OR "Zingiber officinale*"[tiab] OR "Ginger*"[tiab])) OR ("Curcuma"[Mesh] OR "Curcuma*"[tiab] OR "Tumeric*"[tiab] OR "Tumeric*"[tiab])) OR ("Origanum"[Mesh] OR "Origanum"[tiab] OR "Oregano*"[tiab] OR "Marjoram*"[tiab])) OR ("Crocus"[Mesh] OR "Crocus"[tiab] OR "Saffron"[tiab])) OR ("Carum"[Mesh] OR "Carum*"[tiab] OR "Caraway*"[tiab] OR "Ajowan*"[tiab])) OR ("Cuminum"[Mesh] OR "Cuminum"[tiab])) OR ("Foeniculum"[Mesh] OR "Foeniculum*"[tiab] OR "Fennel*"[tiab])) OR ("Piper nigrum"[Mesh] OR "Piper nigrum*"[tiab] OR "Black Pepper*"[tiab]))))) OR (("Sugar-Sweetened Beverages"[Mesh] OR "Sugar-Sweetened Beverage*"[tiab] OR "Sugar-Added Beverage*"[tiab] OR "Sweetened Beverage*"[tiab]) OR ("Snacks"[Mesh] OR "Snack*"[tiab]) OR ("Candy"[Mesh] OR "Candy"[tiab]) OR ("Candies"[tiab] OR "Confection*"[tiab]) OR ("Chocolate"[Mesh] OR "Chocolate*"[tiab] OR "Cocoa Powder*"[tiab]) OR ("Dessert"[tiab] OR "Cake*"[tiab] OR "Doughnut*"[tiab] OR "Pie"[tiab] OR "Brownies"[tiab] OR "Biscuit*"[tiab] OR "Pudding"[tiab]) OR ("Ice Cream"[Mesh] OR "Ice Cream*"[tiab]) OR ("Crisp*"[tiab] OR "Cracker"[tiab] OR "Pretzel"[tiab]))) OR (((("Water"[Mesh] OR "Water"[tiab]) OR ("Mineral Waters"[Mesh] OR "Mineral Water*"[tiab]) OR ("Tea"[Mesh] OR "Tea"[tiab]) OR ("Coffea"[Mesh] OR "Coffea"[tiab]) OR ("Fruit and Vegetable Juices"[Mesh] OR "Fruit Juice*"[tiab]) OR ("Beverages"[Mesh] OR "Beverage*"[tiab])))) OR ((("Alcohol Drinking"[Mesh] OR "Alcohol"[tiab]) OR ("Beer"[Mesh] OR "Beer*"[tiab]) OR ("Wine"[Mesh] OR "Wine"[tiab] OR Vino[tiab]) OR ("Spirits"[tiab] OR "Snops"[tiab])))) OR ((("Food, Processed"[Mesh] OR "Processed Food*"[tiab] OR "Ultra-Processed Food*"[tiab]) OR ("Satureja"[Mesh] OR "Satureja"[tiab] OR Savory[tiab] OR Savories[tiab]) OR "Processed Meat"[tiab] OR ("Poultry"[Mesh] OR "Poultry"[tiab] OR "Poultries"[tiab] OR "Domestic Fowl*"[tiab]) OR "fish nugget*"[tiab] OR ("Fish Products"[Mesh] OR "Fish Product*"[tiab]) OR "Meal Replacement*"[tiab] OR ("Margarine"[Mesh] OR "Margarine"[tiab]

) OR "Instant soup*"[tiab] OR "Breakfast Cereals"[tiab] OR ("Ice Cream"[Mesh] OR "Ice Cream*"[tiab]) OR ("Carbonated Beverages"[Mesh] OR "Carbonated Beverage*"[tiab] OR "Carbonated Drink*"[tiab] OR "Soft Drink*"[tiab] OR "Soda Pop*"[tiab])))) AND (((((randomised controlled trial[pt]) OR (controlled clinical trial[pt]) OR (randomised[tiab] OR randomised[tiab]) OR (placebo[tiab]) OR (drug therapy[sh]) OR (randomly[tiab]) OR (trial[tiab]) OR (groups[tiab])) NOT (animals[mh] NOT humans[mh]))) OR ((systematic review[ti] OR systematic literature review[ti] OR Cochrane Database Syst Rev[ta] OR systematic review[pt] OR placebo[tiab] OR meta-analysis[pt])))) NOT (animals[mesh] NOT humans[mesh])) AND ((((((((((((((((((("Non-alcoholic Fatty Liver Disease"[Mesh] OR "Non-alcoholic Fatty Liver Disease*"[tiab] OR "Non alcoholic Liver Disease*"[tiab] OR "Non-alcoholic Liver Disease*"[tiab] OR "Nonalcoholic Fatty Liver"[tiab] OR "Nonalcoholic Steatohepatitis"[tiab]) OR ("Kidney Diseases"[Mesh] OR "Kidney Disease*"[tiab])) OR ("Migraine Disorders"[Mesh] OR "Migraine"[tiab] OR "Status Migrainosus"[tiab] OR "Headache*"[tiab])) OR ("Neoplasms"[Mesh] OR "Neoplasm*"[tiab] OR "Tumor*"[tiab] OR "Neoplasia*"[tiab] OR "Cancer*"[tiab] OR "Malignancy"[tiab] OR "Malignancies"[tiab] OR "Carcinoma*"[tiab])) OR ("Mortality"[Mesh] OR "Mortality"[tiab] OR "Mortalities"[tiab] OR "Death Rate*"[tiab] OR "Case Fatality Rate*"[tiab])) OR ("Cause of Death"[Mesh] OR "Cause of Death"[tiab] OR "Death Cause*"[tiab] OR "All-cause Mortality"[tiab] OR "All Cause Mortality"[tiab])) OR ("Malnutrition"[Mesh] OR "Malnutrition*"[tiab] OR "Malnourishment*"[tiab] OR "Undernutrition*"[tiab] OR "Nutritional Deficiency"[tiab] OR "Nutritional Deficiencies"[tiab])) OR ("Sports"[Mesh] OR "Sport*"[tiab] OR "Exercise*"[tiab])) OR ("Exercise"[Mesh] OR "Exercise*"[tiab] OR "Physical Activity"[tiab] OR "Physical Activities"[tiab])) OR ("Food/economics"[Mesh] OR "Food Cost*"[tiab] OR "Food Price*"[tiab])) OR (Cholesterol, LDL[Mesh] OR "LDL Cholesterol"[tiab] OR "beta-Lipoprotein Cholesterol"[tiab] OR "beta Lipoprotein Cholesterol"[tiab] OR "Low Density Lipoprotein Cholesterol"[tiab] OR "LDL Cholesteryl Linoleate"[tiab])) OR ("Diabetes Mellitus, Type 2"[Mesh] OR "Type 2 Diabetes Mellitus"[tiab] OR "Adult-Onset Diabetes Mellitus"[tiab] OR "Ketosis-Resistant Diabetes Mellitus"[tiab] OR "NIDDM"[tiab] OR "Maturity-Onset Diabetes Mellitus"[tiab] OR "Maturity Onset Diabetes Mellitus"[tiab] OR "MODY"[tiab] OR "Type 2 Diabetes Mellitus"[tiab] OR "Noninsulin-Dependent Diabetes Mellitus"[tiab] OR "Noninsulin Dependent Diabetes Mellitus"[tiab] OR "Maturity-Onset Diabetes"[tiab] OR "Maturity Onset Diabetes"[tiab] OR "Type 2 Diabetes"[tiab])) OR ("Blood Pressure"[Mesh] OR "Blood Pressure"[tiab] OR "Pulse Pressure"[tiab] OR "Diastolic Pressure"[tiab] OR "Systolic Pressure"[tiab] OR "Hypertension"[tiab] OR "Hypotension"[tiab])) OR ("Blood Glucose"[Mesh] OR "Blood Glucose"[tiab] OR "Blood Sugar"[tiab] OR "Hyperglycemia"[tiab] OR "Hypoglycemia"[tiab])) OR ("Cardiovascular Diseases"[Mesh] OR "Cardiovascular Disease*"[tiab] OR "Cardiac Event*"[tiab] OR "Cardiac Event*"[tiab])) OR ("Coronary Disease"[Mesh] OR "Coronary Disease*"[tiab] OR "Coronary Heart Disease*"[tiab] OR "Coronary Heart Disease*"[tiab])) OR ("Myocardial Ischemia"[Mesh] OR "Myocardial Ischemia"[tiab] OR "Ischemic Heart Disease*"[tiab] OR "Ischemic Heart Disease*"[tiab]))) AND (((((systematic review[ti] OR systematic literature review[ti] OR Cochrane Database Syst Rev[ta] OR systematic review[pt] OR placebo[tiab] OR meta-analysis[pt] NOT (animals[mh] NOT humans[mh])) OR (randomised controlled trial[pt]) OR (controlled clinical trial[pt])) OR ((randomised[tiab] OR randomised[tiab]) OR (placebo[tiab]) OR (drug therapy[sh]) OR (randomly[tiab]) OR (trial[tiab]) OR (groups[tiab])))))) NOT (animals[mh] NOT humans[mh]))

1 TO # 4 DIETS(MEDITERRANEAN, DASH, VEGETARIAN/ VEGAN AND ABO TYPE)

((((("Diet, Mediterranean"[Mesh] OR "Mediterranean Diet*"[tiab]) OR (Dietary Approaches To Stop Hypertension[Mesh] OR "Dietary Approaches To Stop Hypertension"[tiab] OR "DASH Diet*"[tiab]) OR ("Diet, Vegan"[Mesh] OR "Vegan Diet*"[tiab] OR "Veganism*"[tiab] OR "Vegetarian Diet*"[tiab] OR "Plant-based diet*"[tiab] OR "Vegetarian Eating*"[tiab] OR "Vegetarianism*"[tiab])) OR ("ABO Blood-Group System"[Mesh] AND "Diet"[Mesh] OR "Blood Type Diet*"[tiab])) AND ((((((((((((((((("Non-alcoholic Fatty Liver Disease"[Mesh] OR "Non-alcoholic Fatty Liver Disease*"[tiab] OR "Non alcoholic Liver Disease*"[tiab] OR "Non-alcoholic Liver Disease*"[tiab] OR "Nonalcoholic Fatty Liver"[tiab] OR "Nonalcoholic Steatohepatitis"[tiab]) OR ("Kidney Diseases"[Mesh] OR "Kidney Disease*"[tiab])) OR ("Migraine Disorders"[Mesh] OR "Migraine"[tiab] OR "Status Migrainosus"[tiab] OR "Headache*"[tiab])) OR ("Neoplasms"[Mesh] OR "Neoplasm*"[tiab] OR "Tumor*"[tiab] OR "Neoplasia*"[tiab] OR "Cancer*"[tiab] OR "Malignancy"[tiab] OR "Malignancies"[tiab] OR "Carcinoma*"[tiab])) OR ("Mortality"[Mesh] OR "Mortality"[tiab] OR "Mortalities"[tiab] OR "Death Rate*"[tiab] OR "Case Fatality Rate*"[tiab])) OR ("Cause of Death"[Mesh] OR "Cause of Death"[tiab] OR "Death Cause*"[tiab] OR "All-cause Mortality"[tiab] OR "All Cause Mortality"[tiab])) OR ("Malnutrition"[Mesh] OR "Malnutrition*"[tiab] OR "Malnourishment*"[tiab] OR "Undernutrition*"[tiab] OR "Nutritional Deficiency"[tiab] OR "Nutritional Deficiencies"[tiab])) OR ("Sports"[Mesh] OR "Sport*"[tiab] OR "Exercise*"[tiab])) OR ("Exercise"[Mesh] OR "Exercise*"[tiab] OR "Physical Activity"[tiab] OR "Physical Activities"[tiab])) OR ("Food/economics"[Mesh] OR "Food Cost*"[tiab] OR "Food Price*"[tiab])) OR (Cholesterol, LDL[Mesh] OR "LDL Cholesterol"[tiab] OR "beta-Lipoprotein Cholesterol"[tiab] OR "beta Lipoprotein Cholesterol"[tiab] OR "Low Density Lipoprotein Cholesterol"[tiab] OR "LDL Cholesteryl Linoleate"[tiab])) OR ("Diabetes Mellitus, Type 2"[Mesh] OR "Type 2 Diabetes Mellitus"[tiab] OR "Adult-Onset Diabetes Mellitus"[tiab] OR "Ketosis-Resistant Diabetes Mellitus"[tiab] OR "NIDDM"[tiab] OR "Maturity-Onset Diabetes Mellitus"[tiab] OR "Maturity Onset Diabetes Mellitus"[tiab] OR "MODY"[tiab] OR "Type 2 Diabetes Mellitus"[tiab] OR "Noninsulin-Dependent Diabetes Mellitus"[tiab] OR "Noninsulin Dependent Diabetes Mellitus"[tiab] OR "Maturity-Onset Diabetes"[tiab] OR "Maturity Onset Diabetes"[tiab] OR "Type 2 Diabetes"[tiab])) OR ("Blood Pressure"[Mesh] OR "Blood Pressure"[tiab] OR "Pulse Pressure"[tiab] OR "Diastolic Pressure"[tiab] OR "Systolic Pressure"[tiab] OR "Hypertension"[tiab] OR "Hypotension"[tiab])) OR ("Blood Glucose"[Mesh] OR "Blood Glucose"[tiab] OR "Blood Sugar"[tiab] OR "Hyperglycemia"[tiab] OR "Hypoglycemia"[tiab])) OR ("Cardiovascular Diseases"[Mesh] OR "Cardiovascular Disease*"[tiab] OR "Cardiac Event*"[tiab] OR "Cardiac Event*"[tiab])) OR ("Coronary Disease"[Mesh] OR "Coronary Disease*"[tiab] OR "Coronary Heart Disease*"[tiab] OR "Coronary Heart Disease*"[tiab])) OR ("Myocardial Ischemia"[Mesh] OR "Myocardial Ischemia"[tiab] OR "Ischemic Heart Disease*"[tiab] OR "Ischemic Heart Disease*"[tiab]))) AND (((((systematic review[ti] OR systematic literature review[ti] OR Cochrane Database Syst Rev[ta] OR systematic review[pt] OR placebo[tiab] OR meta-analysis[pt] NOT (animals[mh] NOT humans[mh])) OR (randomised controlled trial[pt]) OR (controlled clinical trial[pt])) OR ((randomised[tiab] OR randomised[tiab]) OR (placebo[tiab]) OR (drug therapy[sh]) OR (randomly[tiab]) OR (trial[tiab]) OR (groups[tiab])))))) NOT (animals[mh] NOT humans[mh])

Appendix C. References Added after Revision of the SNG2025

A) REVIEWER-INITIATED REFERENCES

References added based on suggestions from international reviewers and Slovenian experts during the May–June 2024 review process.
Alcohol in Slovenia:
https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20231010-1, https://nijz.si/wp-content/uploads/2022/07/alcohol_policy_in_slovenia_final.pdf, https://health.ec.europa.eu/system/files/2022-12/2022_healthatglance_rep_en_0.pdf, https://www.who.int/europe/news/item/04-01-2023-no-level-of-alcohol-consumption-is-safe-for-our-health and https://www.who.int/data/gho/data/themes/global-information-system-on-alcohol-and-health
Alcohol:
https://www.thelancet.com/journals/lanpub/article/PIIS2468-2667(22)00317-6/fulltext, https://pubmed.ncbi.nlm.nih.gov/30146330/ and https://pmc.ncbi.nlm.nih.gov/articles/PMC10989238/
Ammonia in animal farming: https://www.sciencedirect.com/science/article/pii/S0301479722018588
Antinutrients:
https://pubmed.ncbi.nlm.nih.gov/32987890/
Aquaculture surpasses traditional fishing:
https://www.fao.org/newsroom/detail/fao-report-global-fisheries-and-aquaculture-production-reaches-a-new-record-high/en
Ca-fortified plant-based alternatives:
https://pmc.ncbi.nlm.nih.gov/articles/PMC10504201/ and https://pmc.ncbi.nlm.nih.gov/articles/PMC10421432/
CDC 'One Health':
https://www.cdc.gov/one-health/about/index.html
Cocoa:
https://pubmed.ncbi.nlm.nih.gov/34578786/
Dairy products and CRC and prostate cancer: SR/MA: https://pubmed.ncbi.nlm.nih.gov/31089733/ and https://pubmed.ncbi.nlm.nih.gov/25527754/
Dairy products and SFA:
https://pmc.ncbi.nlm.nih.gov/articles/PMC10255899/pdf/nutrients-15-02603.pdf, https://pubmed.ncbi.nlm.nih.gov/33985895/ and https://pubmed.ncbi.nlm.nih.gov/34550320/

Depression – prevalence:
https://pubmed.ncbi.nlm.nih.gov/37024144/
Depression and diet:
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Appendix D. Scoring System Model for Foods Classification as ‘High in’ and ‘Source of’

To objectively quantify the nutrient content of various foods, a scoring system was devised based on existing literature (Table 1). This model classifies foods as either ‘high in’ sodium, SFA, and dietary fibre, or as a ‘source of’ protein, n-3 polyunsaturated fatty acids (n-3 PUFA), and micronutrients. The scoring system was applied in Sections 3 and 4 of the SNG2025. Additionally, the food groups charts in this chapter provide a summary of the topic, with written content that is properly cited.

Table C. Criteria for scoring system model for foods classification as ‘high in’ sodium, SFA and fibre, and ‘source of’ proteins, n-3 polyunsaturated fatty acids (n-3 PUFAs) and micronutrients according to the European Food Safety Authority [200] and Voedings centrum of Netherland (Netherlands Nutrition Center) [163], cited by the European Food Safety Authority (EFSA) [162], European Commission [168], and D-A-CH recommended values [166] adopted in Slovenia [167], calculated based on data from the Slovenian food database [165].

	'High in'			'Source of'		
Food Groups	**SODIUM** modified [165–168] ≥ 0.12 g/100 g or ml	SFA [162,163,165–167] > 1 g/100 g (milk) > 5 g/100 g (meat, fish, eggs) > 6 g/100 g (nuts/seeds) > 18 g/100 g (cream, cheese) > 24 g/100 g (oils)	**DIETARY FIBRE** [165–168] ≥ 6 g/100 g or ≥ 3 g/100 kcal	**PROTEINS** [165–168] ≥ 12% E	**N-3 PUFA** [165–167,200] 0.3 g ALA/100 g and 0.3 g ALA/100 kcal or 40 mg EPA + DHA/100 g and 40 mg EPA + DHA/100 kcal	**MICRONUTRIENTS** [165–168] ≥ 15% of recommended value/100 g or ml
Cereals		NO	YES	YES	NO	Vitamins: B1(thiamine), B2 (riboflavin), B3 (niacin), B5 (pantothenic acid), B6 (pyridoxine), B7 (biotin) and B9 (folate)) Minerals: calcium (amaranth), iron, zinc, magnesium and phosphorus
Potatoes and Other Starchy Tubers		NO	YES	NO	NO	Vitamin: C Mineral: potassium
Legumes and Pulses		NO	YES	YES	NO	Vitamins: B3 (niacin), B5 (pantothenic acid), B6 (pyridoxine), B9 (folate) and K Minerals: calcium, iron, magnesium, phosphorous, potassium and zinc

Fruits		NO	YES	NO	NO	Vitamins: C, B7 (biotin) and K (blueberries) Minerals: calcium (dry figs)
Vegetables	YES (pickled vegetables)	NO	YES	YES (green leafy vegetables: spinach and arugula, brassica vegetables: broccoli)	YES (green leafy vegetables: spinach and arugula, brassica vegetables: broccoli)	Vitamins: β-carotene*, C and K Mineral: calcium (cabbage), iron (spinach, carrot)
Mushrooms**	YES (pickled vegetables)	NO	YES (porcini and real bolete)	NO	NO	Vitamins: D (porcini), B3 (niacin: shiitake and button mushroom), B5 (pantothenic acid: porcini, shitake and button mushrooms) Minerals: iodine (button mushrooms), selenium (porcini and real bolete)
Nuts and Seeds		NO	YES	YES	YES (walnuts (oil), flaxseed, hemp seeds, chia seeds)	Vitamins: B2 (riboflavin; sesame seeds, hazelnut), B3 (niacin), B6 (pyridoxine), B7 (biotin), B9 (folate), vitamin E (hazelnuts, peanuts, pumpkin seeds) Minerals: potassium, magnesium, phosphorus, iron, zinc, calcium (hazelnuts, almonds, flaxseed, sesame seeds and chia seeds), selenium (Brazil nuts, flaxseed and sesame seeds)

Fish and Seafood	YES (canned fish)	NO	NO	YES	YES	Vitamins: B12 (cobalamin), D and K (squid) Minerals: phosphorus (all listed), iodine (salmon, tuna)
Milk and Dairy	YES (cheese)	YES (milk and cheese, except mozzarella)	NO	YES	NO	Vitamins: B2 (riboflavin), B12 (cobalamin; cheese) Minerals: calcium (all except cream), phosphorus, selenium and zinc (both two in cheese)
Meat and Processed Meat	YES (processed meats)	YES (processed meat)	NO	YES	NO	Vitamins: B2 (riboflavin, red/white meat), B6 (pyridoxine, red/white meat) and B12 (cobalamin; red meat and karst pancetta)) Minerals: iron (beef, blood sausage and salami , iodine (processed meat, if iodised salt used), phosphorus (red/white/processed meat), selenium (blood sausage) and zinc (red/white/processed meat)

Eggs	NO	YES	NO	YES	NO	Vitamins: A, B2 (riboflavin), B5 (pantothenic acid), B7 (biotin) and B12 (cobalamin) Minerals: iron, phosphorus, selenium and zinc
Fats and Oils	NO	YES (butter, lard, ghee and tropical oils)	NO	NO	YES (flax oil, hemp oil, rapeseed oil and soybean oil)	Vitamins: K (all listed), A (ghee, butter), E (vegetable oils and butter; not lard and tropical oils/fats)
Sweets and Snacks	YES (Crisps, salted nuts, salty crackers)	NO (Many industrial baked goods such as biscuits, cakes, pastries, and brownies are 'high in' SFA)	NO	NO	NO	Vitamins: / Minerals: /
Water and Non-Alcoholic Beverages (non-fortified)	NO	NO	NO	NO	NO	Vitamins: / Minerals: /
Alcohol	NO	NO	NO	NO	NO	Vitamins: / Minerals: /

Herbs and Spices*** (/50 g)	NO	NO (turmeric)	YES (rosemary, turmeric)	YES (parsley)	NO	Vitamins: β-carotene (parsley), B9 (folate; parsley and rosemary), C (parsley, turmeric and rosemary); E and K (both in parsley and ginger) Minerals: calcium (onion, parsley, cinnamon and rosemary), iron (all listed), magnesium (onion, parsley, ginger, cinnamon, turmeric and rosemary), potassium (turmeric), selenium (garlic and ginger) and zinc (onion, parsley and ginger)
Vinegar**** (/50 g)	NO	NO	NO	NO	NO	Vitamins: / Minerals: /

* The vitamin A content of foods is expressed as retinol equivalents (RE). Conversion factors are as follows: 1 mg RE = 1 mg of retinol = 6 mg of total-trans-β-carotene = 12 mg of other provitamin A carotenoids = 1.15 mg of total-trans-retinyl acetate = 1.83 mg of total-trans-β-retinyl palmitate; 1 IU = 0.3 µg retinol [166,167]. Food composition of chosen foods within groups checked in Open Platform for Clinical Nutrition (OPEN) [165]: cereals: oatmeal, wholegrain pasta, buckwheat porridge, millet porridge, quinoa, amaranth; potatoes and other starchy tubers: white, sweet, yam, pulses: beans, lentils, chickpeas, peas, soy (tofu); fruits: apple, banana, orange, strawberries, blueberries, dry figs, vegetables: tomatoes and carrots (colourful vegetables), broccoli, cabbage and Brussels sprouts (brassica), spinach and arugula (dark green vegetables), lettuce (leafy), nuts and seeds: walnuts (oil), hazelnuts, almonds, peanuts, flax seeds, sesame, chia and pumpkin seeds; fish and seafood: trout, canned tuna (in olive oil), wild salmon, grilled sardines, grilled squid; milk and dairy: milk (3.5% fat), plain yoghurt, cheese (mozzarella and Emmentaler), cottage cheese (20% fat); meat and processed meat: beef, chicken thighs, pork loin and hot dog, salamis karst pancetta, blood sausage; eggs (not-enriched): chicken egg; fats and oils: olive oil, sunflower oil, butter, coconut fat, palm fat, ghee, lard, hemp oil, rapeseed oil, soy oil; sweets and snacks: crisps, pretzels, salted peanuts, salty crackers, biscuits, chocolate, pudding; water and non-alcoholic beverages: water, apple juice, orange juice, tea, coffee, energy drink, carbonated beverage; alcohol: beer, wine, plum brandy. ** Mushrooms (fresh): porcini mushrooms, shiitake, button mushrooms, real bolete, umbrella mushrooms (are fungi, not vegetables, although they are commonly treated as vegetables in cooking). *** Herbs and spices (parsley (leaves), basil, oregano, garlic, onion powder, rosemary, turmeric, cinnamon, ginger); are consumed in small amounts, so they do not qualify as a primary source of nutrients under the uniform Scoring System model for classifying foods as ‘high in’ or a ‘source of’ specific nutrients. **** Vinegar: balsamic, apple cider and wine vinegar (as a condiment, is included in the group of herbs and spices). If a nutrient is found only in specific foods within a group, those foods are indicated in brackets. For example, in cereals: Minerals – calcium (amaranth).

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PART II.

Improving the Sustainability of the Slovenian Nutrition Guidelines 2025

Environmental Impacts of Slovenia's Food System

– SCIENTIFIC EVIDENCE BASE

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EATING FOR HEALTH AND THE PLANET
Part II. Improving the Sustainability of the Slovenian Nutrition Guidelines 2025 - Environmental Impacts of Slovenia's Food System

Section 1. Unsustainability of the Current Slovenian, European, and Global Food Systems

KEY MESSAGES

- The current food system is unsustainable, inefficient, and unhealthy for people and the planet
- Slovenia is highly dependent on European and global food systems
- Animal-based products are less sustainable in terms of water and land use and greenhouse gas and eutrophying emissions

1.1 Why Is a More Sustainable Food System Needed?

The current Slovenian lifestyle carries a substantial environmental footprint. Every aspect of daily life impacts the environment more than it should, given that more efficient and sustainable alternatives are already available. This applies to commuting and transport, home heating, waste generation, and electricity production and consumption. In recent years, gradual shifts towards more sustainable options have been seen, such as improvements in public transport, electrification of households, transport and industry, greater emphasis on reducing, reusing and recycling waste, and an increasing the share of low-carbon sources of energy. Nevertheless, there is one sector – crucial to human existence – where it will be most difficult to increase sustainability: the food system.

Globally, the food system – part of the agriculture, forestry, and other land use sector – has profound impacts on the environment. It is the second largest source of greenhouse gas emissions, contributing 25–37% of total emissions (IPCC, 2019). The food system is by far the largest consumer of freshwater, using 70% of all freshwater withdrawals (UN Water, 2020). It is also the biggest direct driver of biodiversity loss (Pilling & Bélanger, 2019), wetland degradation (Fluet-Chouinard et al., 2023), land degradation (IPCC, 2019), and water pollution (EEA, 2021). The food system is the main reason Earth looks the way it does today: over thousands of years, most habitable areas have been converted to agriculture (Ellis et al., 2021). Nearly half of the habitable surface (excluding glaciers and barren land) is now used for agriculture, more than all the world's forests combined (Ramankutty et al., 2008). Most of these areas were converted from forests, natural grasslands and wetlands, affecting not only biodiversity but also the water cycle and crucial soil functions. The majority of agricultural land (80%) is used for livestock production, both for grazing and for producing feed (FAO, 2023b; Ritchie & Roser, 2019). Only a minor share of global agricultural areas is used to produce crops for direct human consumption, such as cereals, potatoes, vegetables, and fruit.

Despite the major impacts of agriculture on water and soil resources, greenhouse gas emissions and biodiversity, a common argument for maintaining the current food system is that, while these impacts are unfortunate, food is indispensable. It is therefore argued that priority should be given to the energy, transport, and industry sectors. Such reasoning, however, has several flaws. First, as noted above, the current food system, which prioritises high-input commercial agriculture, is the biggest direct driver of biodiversity loss, land degradation, and declines in water quality and quantity. Second, the system is highly inefficient. Although 80% of the global agricultural land is used for livestock production, it provides only 17% of global calorie supply and 38% of protein supply (Alexander et al., 2016; Ritchie & Roser, 2019). This indicates that more food could be produced on existing agricultural land, thereby contributing more effectively to global food security, especially given that 700 million people continue to live with malnutrition (FAO, 2023b). Finally, agriculture is also the sector most affected by climate change and geopolitical shocks, influencing the costs and availability of agricultural inputs. A system that requires more land, water, and agricultural inputs is less resilient than one that can feed the same number of people on a smaller area, using less water and inputs.

1.2 Why Is a Planetary Focus Needed When Talking About Slovenian Diets?

Slovenia is deeply embedded in the European and global food systems and imports many food items and agricultural inputs. In 2022, 27% of cereals consumed in Slovenia were imported (most used for livestock feed), along with 63% of potatoes, 61% of vegetables, 70% of fruit, and 59% of pork (Zagorc et al., 2023). While Slovenia was statistically self-sufficient in beef and poultry, it nevertheless imported significant quantities of both, while also exporting specific meat items. Most of the fruit, vegetables, and meat are imported from neighbouring EU member states, as well as from countries from the Western Balkans and the wider Mediterranean region (e.g., potatoes from Egypt). Slovenia also imports water-demanding food items, such as fruit and rice, from countries with semi-arid conditions, where a large share of crops that are irrigated.

Slovenia is also highly dependent on imports of agricultural inputs from abroad, often from distant regions. For example, the livestock sector, particularly poultry and pork production, relies on imports of soya (mostly in the form of soya oil-cake) from South America, thereby potentially contributing to ecosystem degradation there (MMC RTV, 2022; Zagorc et al., 2023). When considering the environmental impacts of the food system, this indicates that the focus must be extended beyond Slovenian boundaries rather than remaining solely on domestic agriculture. Reducing environmental impacts abroad is both fair and necessary, just as Slovenia seeks to avoid environmental degradation resulting from the consumption patterns of others. Moreover, reliance on other regions for food increases susceptibility to geopolitical shocks, price volatility, and climate extremes such as droughts, heatwaves, and floods. Transitioning to a more sustainable food system with greater transparency and control would also bring more stability for farmers and consumers.

Finally, compared to other European and global averages, Slovenia consumes large quantities of animal-based food products, which have the highest environmental impacts among all food items (Table 1). Reducing consumption of such products therefore presents an opportunity for the food system of Slovenia to decrease its environmental impacts at the national, European, and global levels. This shift would also yield important health co-benefits, as health issues related to overconsumption of meat are among the leading causes of premature deaths in Slovenia (EUROSTAT, 2024).

Item	Slovenia	EU	World
Beef	20.6	10.3	9,0
Pork	32.8	33.1	14,5
Poultry	30.9	23.4	16,2

Table 1. Average consumption of beef, pork and poultry in kg/capita for Slovenia (Zagorc et al., 2023), the EU and globally (FAO, 2023a). Numbers for Slovenia and the EU are for 2021, global values for 2020.

1.3 Why Is Examining the Environmental Impacts of Food Throughout Its Life Cycle Needed?

Identifying the environmental impacts of food items is not straightforward. The entire supply chain must be considered, including feed production, the application of fertilisers and pesticides, harvesting and storage, as well as the stages after products leave farms, such as transport, processing, packaging, retail, and waste. For animal-based foods in particular, a substantial share of environmental impacts occurs beyond the farm stage (Figure 1).

Greenhouse gas emissions illustrate why examining the whole life cycle of food items is essential, using the largest database of life cycle environmental impacts (Poore & Nemecek, 2018).

On average, greenhouse gas emissions beyond farm gates are 50% higher for beef, twice as high for dairy, 3.5 times higher for eggs, 5 times higher for pork and 10 times higher for poultry. Feed production contributes to a large share of emissions for eggs (47%), pork (35%), and poultry (25%). Processing, transport, retail, packaging, waste and losses are particularly significant for poultry (30%), milk (28%), and pork (23%). Food waste and losses, frequently emphasised in strategies to reduce the environmental impacts of diets, contribute 9% of emissions for dairy, and 15% for poultry.

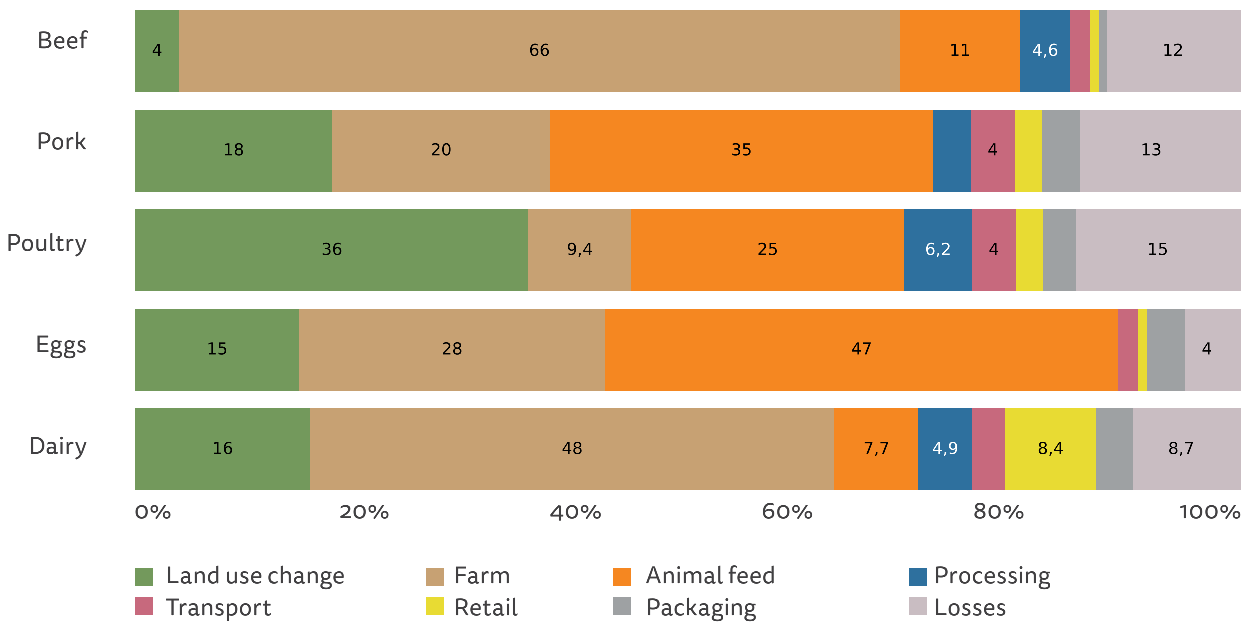

Figure 1. Shares of greenhouse gas emissions throughout the life cycle of selected food items. Source: Poore & Nemecek, 2018; Ritchie, 2020.

A wide variety of tools are used to study all these impacts, and hundreds of scientific studies analysing the environmental impacts of individual food items have been published. Recently, several important studies have collected, harmonised, and synthesised this body of knowledge. Poore and Nemecek (2018) compiled data on environmental impacts from 38,700 farms and 1,600 food processors, presenting the largest meta-analysis currently available. Petersson et al. (2021) developed a multilevel carbon and water footprint dataset of food commodities, comprising 3,349 data records on carbon footprints, and 938 on water footprints. This report builds on such scientific advances to ensure it is based on state-of-the-art knowledge.

1.4 Which Food Items Have the Largest Environmental Impacts?

Actual environmental impacts for individual food items may vary depending on the location, socio-economic characteristics of farmers, and the intensity and efficiency of agricultural operations. In general, however, animal products such as meat, dairy, and eggs have a much larger environmental footprint compared with plant-based products. The most striking difference between food items appear in the carbon footprint (CO_2eq emissions per product), land use footprint (area required to produce a certain item), and water footprint (litres of water required to produce a certain item), although results can vary depending on the climatic conditions (e.g., whether crops are produced in arid regions or in areas with sufficient precipitation).

Greenhouse gas emissions are particularly important to examine, as the global food system is responsible for a quarter to a third of all emissions (Pachauri et al., 2015; Poore & Nemecek, 2018). This share could increase with changing dietary patterns worldwide, especially with rising consumption of meat and dairy (FAO, 2023a; Godfray et al., 2018; Kastner et al., 2012; Tilman et al., 2011). While solutions to decrease greenhouse gas emissions in the energy, transport, and industry sectors have been discussed for years, studies indicate that reductions in the food system are limited on the production side (Poore & Nemecek, 2018). Changes in consumption are therefore necessary to achieve further reductions in emissions.

Land use is the most direct consequence of the food system. Most global land use is related to food production (FAO, 2023b; Ritchie & Roser, 2019), and there are limits to how much the terrestrial surface can continue to be converted to agricultural land – particularly given the climate and biodiversity crisis (Richardson et al., 2023). While intensification of agricultural land has prevented some natural areas from being converted (Byerlee et al., 2014), it has also lead to negative consequences, such as biodiversity loss (Rigal et al., 2023). It is therefore of the utmost importance to address the efficiency and sustainability of our food consumption in terms of land use – so that more food can be produced on less land with minimal environmental impacts.

Similar issues arise when examining the water footprint and eutrophication linked to the food system. The food system is the main global water user and driver of decreases to water quality (EEA, 2021; UN Water, 2020). Many animal-based food items are among the most water-intensive. Choosing a diet that relies more on less water-demanding food items is crucial, particularly in the current climate crisis, where freshwater is less readily available and many water basins are already depleted (Brauman et al., 2016).

Compared with many other countries, Slovenian agriculture is relatively efficient, meaning that environmental impacts may be lower. This applies particularly to beef and dairy, as studies indicate that the variability of environmental impacts is much smaller for other food items. Differences are seen, for example, between dairy and beef herds fed with fodder from grasslands managed for centuries or those fed on imported feed. The values for food products with a large share of imported agricultural inputs (e.g., feed for pigs and poultry) are likely similar to other European countries, due to the similarity of Slovenian commercial livestock systems.

Despite the potentially high variability of environmental impacts of individual food items, it is clear that animal-based products have considerably higher environmental impacts, often orders of magnitude greater than plant-based food items (Figure 2). This is because animals, like humans, require large amounts of energy to live, with significant amounts of feed energy being used in metabolism or to grow animal parts not used (e.g., skins, horns, bones). For example, producing 1 kg of pork – the most consumed meat in Slovenia – requires roughly 2.5kg of feed, while producing 1 kg of lean pork requires roughly 5.8 kg of feed, giving a conversion efficiency of 17%. When accounting for protein conversion (the proportion of protein produced relative to protein consumed), animal-based food – despite the fact that meat and dairy can be more protein-rich compared to plant-based food – are even less efficient. While eggs and whole milk yield, on average, 25% of the protein that was input in their production, poultry (20%), pork (9%) and beef (4%) are much less efficient. This demonstrates that energy production from animal sources is less efficient compared to plant-based food,[1] indicating that existing agricultural land could provide much more energy – in the form of calories and protein – if dietary patterns shifted towards more sustainable recommendations.

1 Here the focus is primarily on calories and protein. However, animal-based food also provides other nutrients important for human health, which are discussed in the health section of the Slovenian Nutrition Guidelines 2025.

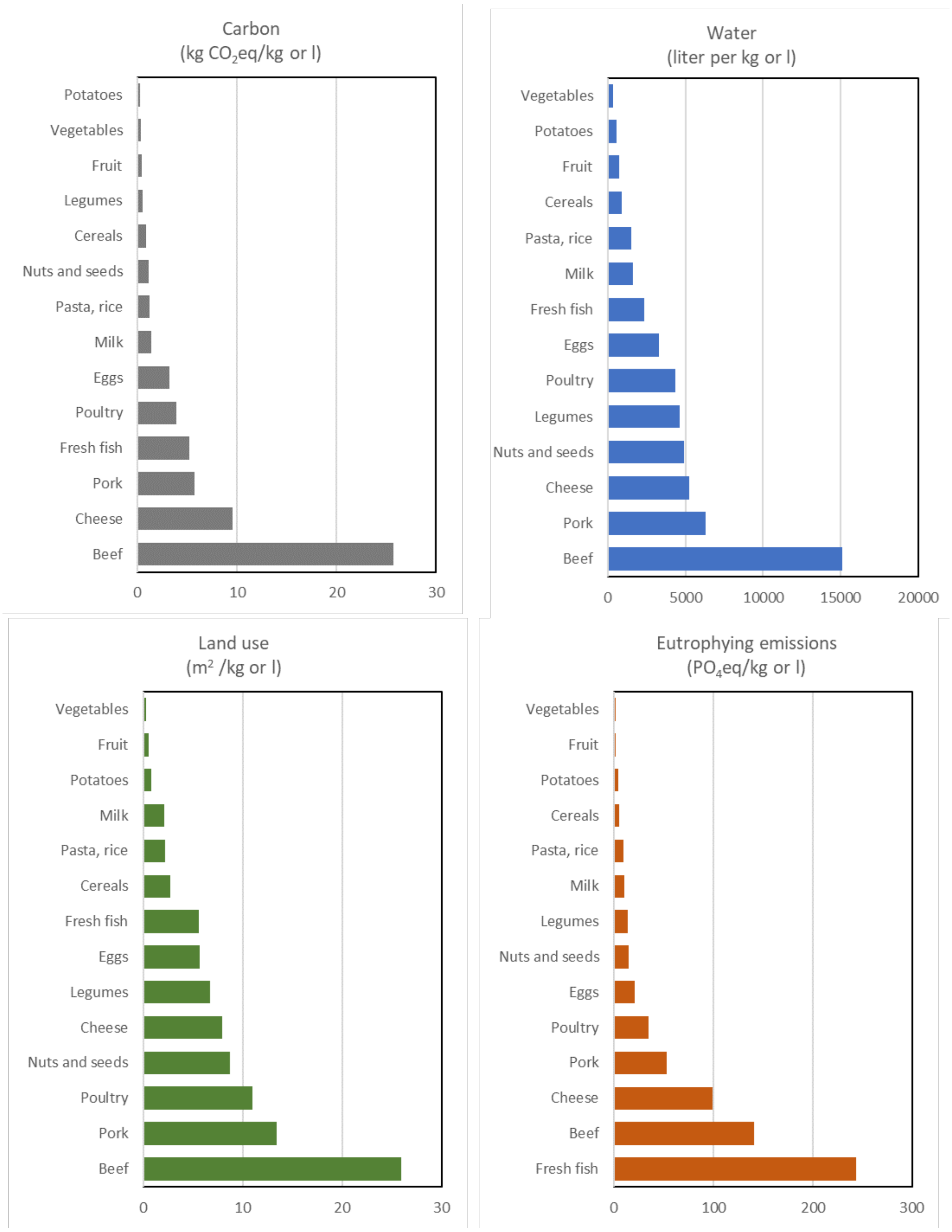

Figure 2. Carbon, water, land use, and eutrophication footprints of selected main food products. Values represent median estimates from Petersson et al. (2021) for carbon and water, and from Poore and Nemecek (2018) for land use and eutrophying emissions. Fruit excludes tropical varieties such as pineapple and bananas, which have considerably higher environmental impacts. Fresh fish refers to farmed fish; wild-caught fish generally have much lower eutrophying emissions..

1.5 The Need for This Report – Addressing the Myths of the Slovenian Food Sector

This report addresses a number of myths related to the (un)sustainability of the Slovenian food system. They are explained in detail in the following pages and summarised briefly here.

MYTH 1: SLOVENIA IS A MOUNTAINOUS COUNTRY, WITH THE MOST COMMON AGRICULTURAL LAND USE BEING GRASSLAND, MEANING RELIANCE ON BEEF AND DAIRY IS INEVITABLE AND WE CANNOT PRODUCE MORE PLANT-BASED FOOD.

While it is true that most of Slovenia is covered by forest, and that grasslands are the dominant agricultural land use, beef accounts for only about 25% of meat consumption. The majority of meat consumed is pork and poultry, which are not raised on mountain grasslands but are fed mainly with cereals and, more recently, soya – neither of which is grown on mountain pastures. Most of livestock feed in Slovenia is produced on fertile lowland plains in the east of the country. Greater quantities of food could be produced on this cropland if more cereals for bread, pulses such as beans, peas, and soya, and seed crops such as sunflower and pumpkin were grown for direct human consumption rather than for animal feed.

MYTH 2: INSTEAD OF DECREASING MEAT CONSUMPTION, SLOVENIA HAS TO ENSURE HIGHER SELF-SUFFICIENCY OF MEAT. THIS WILL ALSO LOWER TRANSPORT EMISSIONS OF MEAT.

Slovenia already imports large quantities of feed for its poultry sector, so claiming self-sufficiency in chicken is misleading. More than half of pork consumed is imported, and feed must also be imported for the domestic pig population. This means that increasing pig numbers to ensure self-sufficiency would result in even greater dependence on imported feed. While Slovenia is statistically self-sufficient in beef, beef accounts for only 25% of meat consumption. Furthermore, transport represents only a small share of total emissions from meat consumption.

MYTH 3: REDUCING MEAT CONSUMPTION WOULD MEAN IMPORTING AVOCADOS, WHICH CAN CAUSE WATER DEGRADATION AND DEPLETION IN OTHER PARTS OF THE WORLD.

Like many Europeans, Slovenians consume excessive amounts of meat. Reducing meat consumption in line with health recommendations would provide sufficient nutrients without the need to replace meat with avocados. Moreover, there are better local alternatives, such as cereals, vegetables, and nuts and seeds (e.g. walnuts, hazelnuts, pumpkin, flax, sunflower).

MYTH 4: REDUCING MEAT CONSUMPTION WOULD MEAN IMPORTING MORE SOYA FROM BRAZIL, LEADING TO EVEN MORE DEFORESTATION OR IMPORTING MORE GENETICALLY MODIFIED CROPS.

Almost all soya grown in deforested areas of Brazil and neighbouring countries is used for livestock feed, not direct human consumption. Slovenia already imports large amounts of feed from Brazil for poultry and pigs, and imported meat from neighbouring EU countries is also produced with Brazilian feed. Reducing meat consumption is therefore one of the most effective ways to reduce demand for Brazilian soya. In contrast, soya for direct human consumption can be grown on much smaller areas. Genetically modified soya for direct human consumption is not permitted in the European Union. However, nearly all soya (97%) imported by Slovenia and the EU from Brazil (or the USA) for livestock feed is genetically modified. This means that through meat consumption, genetically modified soya is already indirectly part of Slovenian diets.

MYTH 5: REDUCED MEAT CONSUMPTION CAN ONLY BE OFFSET BY EATING INSECTS OR LABORATORY-GROWN MEAT; THEREFORE, CURRENT LEVELS OF MEAT CONSUMPTION ARE BEST FOR HUMAN HEALTH.

The first and most important step is to reduce meat consumption to levels recommended by dietary and health experts. This does not require replacement with insects or laboratory-grown meat, particularly as overweight remains a concern in Slovenia. The greatest potential use of insects is as livestock feed, since pigs and poultry naturally consume insects. This report does not endorse insects or laboratory-grown meat, though they could become niche products for interested consumers and may contribute to improved animal welfare.

MYTH 6: AS LONG AS OTHERS DRIVE LARGE CARS AND TAKE SEVERAL FLIGHTS A YEAR, IT MAKES NO SENSE TO REDUCE THE ENVIRONMENTAL IMPACT OF THE FOOD SYSTEM.

While it is true that in both Slovenia and the EU, agriculture is not the main source of greenhouse gas emissions (with around 10% of total emissions), the total food system (accounting for the whole life cycle of food) amounts to nearly 25% of total emissions. In addition, the food system is the main driver behind biodiversity loss, water and soil pollution, reductions in water availability and land degradation. These issues are critical for the survival of society and can only be addressed by making the food system more sustainable. Reducing meat consumption does not prevent action in other sectors such as transport, housing, industry, or clothing.

MYTH 7: SLOVENIA IS SMALL AND THE ENVIRONMENTAL IMPACTS OF ITS FOOD SYSTEM ARE GLOBALLY NEGLIGIBLE, SO IMPROVING THE SUSTAINABILITY OF OUR FOOD SYSTEM IS UNNECESSARY.

Slovenia is indeed small; however, it has a large environmental footprint per capita. In addition, improving the sustainability of the Slovenian food system is necessary to ensure a system more resilient to climate change, to reduce pressures on domestic water and soil resources, and to support biodiversity, including insect and bird populations. A more sustainable diet also improves health outcomes, contributing to longer and healthier lives.

Section 2. Characteristics of Slovenian Agriculture in the European Context

KEY MESSAGES

- Agricultural land in Slovenia is limited by terrain, soil, and climate characteristics, with most agricultural land being in areas with limitations for agricultural activities
- Permanent grasslands and pastures are the dominant agricultural land use, with arable land being dominated by production of feed for livestock. Livestock production therefore dominates agriculture of Slovenia.
- Slovenia's agricultural holdings are, compared to other EU countries, smaller, with lower livestock numbers, and lower shares of livestock in very large holdings
- Fertiliser and synthetic pesticide use, livestock numbers, as well as greenhouse gas emissions have decreased considerably in the past three decades
- Demand for animal-based products has increased in the same period, meaning Slovenia has become more reliant on importing food, particularly fruit and vegetables
- This also means that a large share of environmental impacts of Slovenia's food system occurs outside Slovenia, including in distant regions

2.1 Farms and Land Use in Slovenia

Food production starts with farmers, so this section begins with an overview of the characteristics of Slovenian agriculture and its farmers. Across nearly all agri-environmental indicators, the 67,927 agricultural holdings in Slovenia are, on average, smaller, less intensive, with fewer livestock, and a higher share of landscape features or wooded areas on their farms. This indicates that, on average, Slovenian farms have lower environmental impacts.

Compared with European farmers, Slovenia agriculture is more constrained by biophysical conditions, particularly terrain, soil, and climate. More than half (56.5%) of Slovenia lies at altitudes above 400 m, with 10.7% of the territory above 1,000 m (Perko, 1992). In addition, 38.2% of Slovenian land has slopes greater than 15% (Perko, 1992), which limits agricultural activities (such as mechanisation) and affects the quality of land suitable for agriculture (RS, 2008). In total, 76.1% of agricultural land in Slovenia are located in areas with limitations for agricultural activities (such as mountain areas, areas with natural limitations outside mountains, and other areas with special limitations) (Bedrač et al., 2022). These factors create more challenging conditions for production compared with countries that have larger areas of fertile lowlands.

Recent decades have seen an overall trend towards a reduction in the number of agricultural holdings, leading to abandonment of agricultural production in less-favoured areas, while production has become increasingly concentrated in more fertile regions. The number of agricultural holdings in 2020 was 21% lower than in 2000 (SURS, 2024).

In total, 58% of Slovenia are covered by forests, and only 24% (482,539 hectares) are used for agriculture (ARSO, 2024a). Slovenia also has one of the highest share of protected areas in Europe: 40% of Slovenia's territory is protected, with 52.2% of the country being designated as ecologically important areas (ARSO, 2024b, 2024c), and 24.8% of all agricultural areas are protected under the Natura 2000 conservation network (Bedrač et al., 2022). Of agricultural land, 36.5% lies at altitudes above 400 m and 34.1% on slopes that limit agricultural activities (Glavan et al., 2017).

This is reflected in the majority of Slovenian agricultural land being permanent grassland (56%) (KIS, 2022; SURS, 2023). Historically, producing protein for human consumption from plant biomass in hilly and mountainous areas was only possible through livestock (cattle, with sheep and goats to a lesser extent). Of the remaining cropland, only 37% is arable land, and 5.6% permanent crops (fruit, orchards, vineyards, and olive groves) (KIS, 2022). Despite the limited area for crop cultivation, most arable land is not used for direct human consumption: 71.1% is used to cultivate livestock feed (SURS, 2023). Production of cereals for direct human consumption has decreased by 19.7% since 1991 (Grabar, 2020).

Indicator	Slovenia	European Union
Farm size (ha of utilised agricultural area)	7,0	17,4
Share of wooded areas of total farm area (in %)	40,8	12,7
Share of permanent grasslands of total farm area (%)	30,8	25,2
Share of permanent grasslands in utilised agricultural area (%)	57,8	30,5
Livestock units per livestock holding (in LSU)	9,1	47,0
Livestock density (LSU per ha of agricultural area)	0,9	0,7

Table 2. Comparison of some farm level statistics between Slovenia (KIS, 2022) and the EU average (EUROSTAT, 2022)

2.2 Environmental Impacts of Slovenian Agriculture

Despite the seemingly lower impacts of Slovenian agriculture, the Slovenian environment can be more fragile to agricultural activities due to due to biophysical limitations. Nearly all Slovenians (97%) depend on groundwater resources, many of which lie beneath the most intensively farmed areas (Figure 3). While overall groundwater quality in Slovenia is high, in these intensive agricultural areas in the east of the country groundwater it is poor. Areas with poor groundwater quality overlap with regions of high-intensity cropland (primarily monoculture maize) and concentrated livestock production (large poultry and pig farms). Degradation of water resources is therefore among the main negative environmental impacts of Slovenian agriculture, especially as most of it is directly or indirectly associated with the livestock sector and the production of animal-based food products.

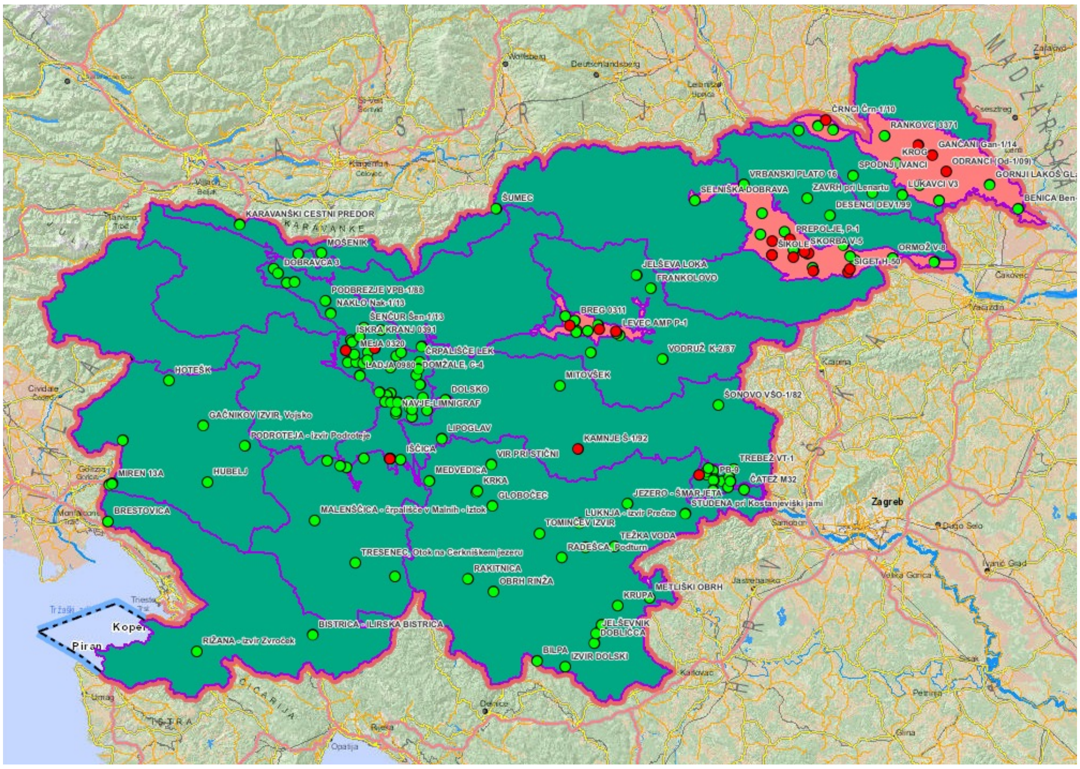

Figure 3. Quality of groundwater resources. Red means poor quality. The points show monitoring locations, with red points showing locations of insufficient quality. Source: (ARSO, 2024d).

2.3 Animal Welfare

Compared with most European Union Member States, animal welfare in Slovenia is relatively high when assessed by indicators of animal housing, which are related to health, feeding, and living conditions (Ingenbleek et al., 2011). Slovenian livestock farms are, on average, smaller, and a smaller share of livestock of all species is kept in very large livestock holdings, also referred to as megastables (farms with more than 500 livestock units; Figures 4 and 5) (Breeman et al., 2013; Debonne et al., 2022).

Improvements in animal welfare have been achieved through increases in free-range poultry and pigs, and cattle that graze outdoors for a large part of the year. A considerable part of improvements, however, was due to the closure of large pig farms in the past two decades, leading to an 80.5% decrease of pigs reared in megastables since 2005. The consumption of pork has however not followed the same trend, meaning Slovenia's self-sufficiency in pork has decreased considerably, likely offset by importing pork from neighbouring EU countries with lower animal welfare standards (measured by the share of animals housed in very large holdings).

While pig production in Slovenia runs counter to EU-wide trends towards more intensive rearing, trends in poultry production are in line with European patterns and are concerning.

The number of poultry in megastables in Slovenia has increased by 55% since 2005 (Eurostat, 2023), with most of the very large poultry holdings concentrated in the east, however also on fragile Karst geology or above important groundwater sources (Figure 3). Most megastables in Slovenia are poultry farms, housing the equivalent of 3,000 to 12,000 chickens in livestock units, though only a few such farms exist.

Country	Livestock total	Cattle	Pigs	Poultry
Denmark	77.3	38.0	92,5	81,2
Czechia	67.2	53.9	92,7	93,1
Slovakia	61.1	42.9	86,5	92,7
Estonia	60.0	45.1	96,2	95,0
Hungary	59.7	46.2	77,5	66,3
Cyprus	50.9	29.4	95,9	73,2
Spain	50.2	14.5	76,7	62,6
Netherlands	50.0	10.9	85,4	77,4
Italy	42.1	21.1	78,7	69,2
Belgium	39.3	8.8	61,8	74,3
Latvia	38.8	14.4	91,1	90,8
Portugal	38.4	12.9	78,9	68,5
Lithuania	36.3	16.6	90,6	81,0
Sweden	35.9	13.0	72,7	84,6
Germany	32.8	16.3	44,6	69,2
Bulgaria	32.1	9.4	92,0	69,6
Croatia	29.5	22.9	40,1	44,5
Poland	27.4	4.4	37,4	59,8
Romania	22.0	6.1	51,1	44,3
Finland	18.4	3.5	43,3	48,2
France	16.8	3.0	57,0	41,5
Greece	13.0	4.5	69,5	43,5
Ireland	10.4	4.2	92,8	50,4
Slovenia	7.8	1.3	13,5	42,2
Austria	3.0	0.1	5,1	15,6

Table 3. Share of livestock raised in megastables in EU Member States. MS marked with red are those from which Slovenia imported more than 5000 tonnes of meat in 2020. Source: (Eurostat, 2023)

Patterns indicate future improvements in some aspects of animal welfare, such as an increased share of both beef and dairy cattle that is grazing, pigs with access to outdoor areas and free-range chicken. Nevertheless, by not reducing meat consumption, Slovenia runs into the danger of increasing reliance on imported meat, shifting its impact on animal welfare to other countries.

Animal welfare characteristics	**Slovenia**	**European Union**
Poultry reared in megastables (% of livestock in farms with > 500 livestock units)	42.2	61.1
Pigs reared in megastables (% of livestock in farms with > 500 livestock units)	13.5	65.4
Cattle reared in megastables (% of livestock in farms with > 500 livestock units)	1.3	11.5
Cattle with access to outdoor pastures (% of all cattle)	34	Comparison with other alpine areas:
		Austria: 25 (Carinthia) to 60 (Tyrol)
		Italy: 3 (Lombardy) to 100 (Trento Alto Adige)
		Switzerland: 58 (Valais) to 100 (Graubünden)
		Germany: 17 (Bavaria) to 27 (Baden Württemberg)
		France: 89 (Alpes-de-Haute-Provence) to 94 (Savoie)

Table 4. Comparison of selected animal welfare characteristics for Slovenia (KIS, 2022) and the European Union (Eurostat, 2023)

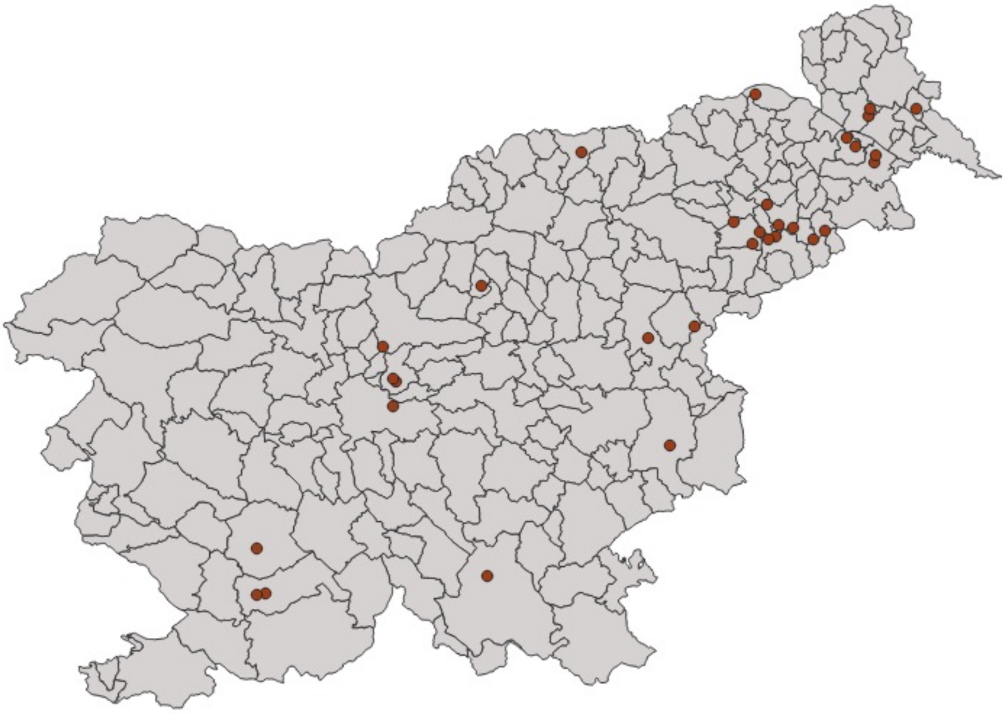

Figure 4. Locations of large poultry (26) and pig (7) farms that need to obtain environmental permits for their operation. Source: ARSO, 2024d.

2.4 Agri-Environmental Indicators

Based on many indicators, agriculture in Slovenia has lower environmental impacts compared with European counterparts. This is due not only to smaller farms and fewer large, intensive agricultural holdings, but also to efforts in Slovenian agricultural policy to reduce environmental impacts of agriculture over the past three decades (Šumrada et al., 2021).

One of the main agri-environmental indicators is the use of synthetic pesticides and nutrients, as they are among the most significant pollutants of surface and groundwater in Slovenia. These originate from phytopharmaceuticals, animal manure, mineral fertilisers, and other organic fertilisers (IPSUM, 2021). Soil and water can also be polluted by other organic inputs, such as agricultural wastewater, particularly from livestock farms.

The use of phytopharmaceuticals (fungicides, herbicides, insecticides, and others), has more than halved (-55%) in Slovenia between 1992 and 2021. Most pesticides used in Slovenia are fungicides applied on permanent cropland (orchards, vineyards, and hop plantations). A large share of phytopharmaceuticals is therefore used for products that do not contribute directly to Slovenia's food security, such as wine and beer production. Vineyards and hop plantations account for 57.5% of the total area of permanent crops, with only 42.5% being fruit for direct human consumption (KIS, 2022; SURS, 2023). This is particularly problematic, as Slovenia has a very low self-sufficiency in fruit (29.5%, discussed in the next section) (ARSO, 2024e; Bedrač et al., 2022), and high consumption of alcoholic beverages, which exceeds both the European average and recommended health guidelines (EUROSTAT, 2021; NIJZ, 2023).

Shifting production on permanent cropland from alcohol to food has been identified as one of the main opportunities to improve the sustainability of agriculture in Slovenia and across the European Union (Scherer et al., 2018). Reducing alcohol consumption (and production) could therefore create additional positive synergies between public health and environmental sustainability.

Nutrient balances also show significant progress. The gross nitrogen balance has decreased by 54% between 1992 and 2021, with the net nitrogen balance decreasing even more, by 87% (ARSO, 2024f; IPSUM, 2021). This was achieved through both reduced nitrogen application (to a lesser extent) and more efficient nitrogen management, which improved plant uptake. Similar progress has been made for phosphorus: the phosphorus balance has decreased by 97% between 1992 and 2019, and the actual use of phosphorus fell by 41% (ARSO, 2024g). The main agricultural source of both nitrogen and phosphorus in Slovenia is animal manure (48% and 57%, respectively) from livestock farms (ARSO, 2024g, 2024f), indicating that animal-based food products are the primary contributors to nutrient surpluses and to soil and water pollution, particularly through feed production on arable land.

Despite these relatively lower impacts domestically, Slovenia imports food from many regions where intensive agriculture leads to high nitrogen exceedance and poor water quality (Figure 5).

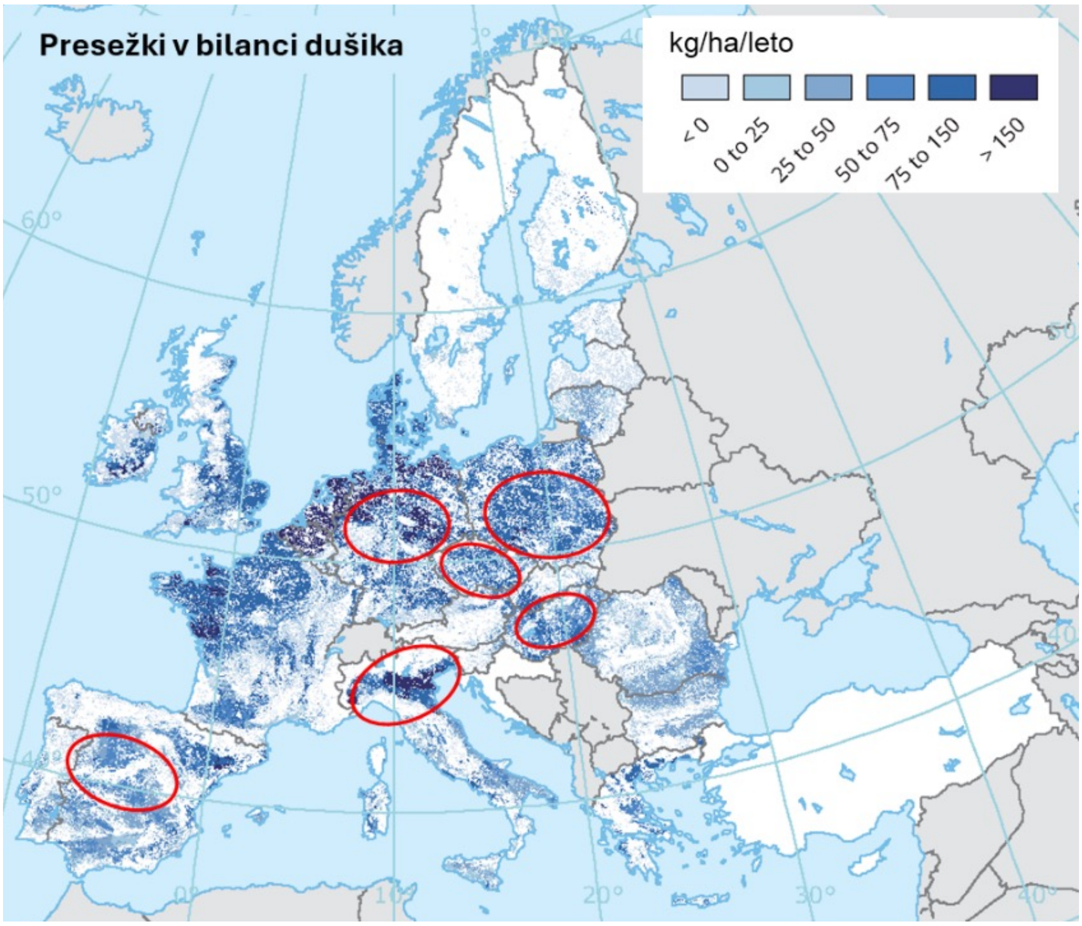

Figure 5. Nitrogen exceedance in EU Member States. Red circles indicate areas with high nitrogen exceedance and low groundwater quality, from which Slovenia imported more than 5,000 tonnes of meat in 2020. Source: EEA (2019).

Agri-environmental indicators	Slovenija	European Union
Pesticide use (kg/ha of utilised agricultural area)	4,1	3,1
Gross nitrogen balance (kg/ha of utilised agricultural land)	od 32 do 48	53
Gross phosphorus balance (kg/ha of utilised agricultural land)	od –0,9 do 4,5	2,2
Organic agricultural land (% of utilised agricultural area)	10,8	9,9

Table 5. Comparison of selected agri-environmental indicators for Slovenia (KIS, 2022) and the EU (EUROSTAT, 2022)

2.5 Birds in Agricultural Landscapes

Birds in agricultural landscapes, as indicators of agricultural biodiversity, have declined over the past decade. The Slovenian Farmland Bird Index (FBI) for the period 2008–2019 showed an overall decline in farmland birds (-22.7%) and an even greater decline in grassland specialist birds (-37.4%) (Rigal et al., 2023; Šumrada et al., 2021).

The drivers behind this decline are complex. Recent studies point to forest succession, the loss of mosaic landscapes with high cropping diversity, and the decline of extensive farming with very low stocking density (< 0.7LU/ha) as the most critical factors of biodiversity loss (Rigal et al., 2023; Šumrada et al., 2021). For grassland specialist species, the restructuring of dairy and beef production – marked by the double trend of abandonment of production in some areas and locally intensified productions – appears to be an additional driver (Rigal et al., 2023; Šumrada et al., 2021). The intensification of production is reflected not only in terms of LU/ha at farm level, but also in changing farming practices, such mowing dates, levels of fertilisation, crop yields, and the presence of landscape features.

2.6 Self-Sufficiency and Imports

Given the characteristics of Slovenian agriculture – smaller farms and, on average, lower environmental impacts – it is important to consider how well domestic production can satisfy demand for different food items. This is particularly relevant since the consumption of food products with the highest environmental impacts (meat and dairy products) is comparable, or even higher than, other EU Member States with higher disposable incomes and more intensive agriculture. Slovenia's high intake of animal-based products, which require more land to produce the same amount of nutrients compared with plant-based foods (Kaufmann et al., 2022), does not reflect its farming, geographic, and socio-economic conditions.

It is often claimed that Slovenia is highly self-sufficient in many food products, but the reality is more complex. First, a large share of agricultural inputs, important in the production of animal-based products, particularly feed, is imported. Most imported feed is used to feed Slovenia's poultry and pig populations, while bovine feed predominantly consists of domestic grass and hay. This is not only limited to importing feed from other EU Member States or neighbouring countries, but also from Brazil and Argentina, primarily in the form of soya. Annual imports of soya ranged from 100,000 to 204,000 tonnes between 2015 and 2022 (Bedrač et al., 2022).

Second, a considerable share of animal-based food products is exported, while domestic demand is partly met by imported meat, which is often cheaper and of lower quality. Third, the majority of fruit and vegetables are imported, with self-sufficiency levels particularly low.

When total biomass self-sufficiency is considered (including imported agricultural inputs), Slovenia is among the European regions with lowest levels (Kaufmann et al., 2022). It is therefore necessary to distinguish between the environmental impacts of food produced in Slovenia and those of food actually consumed by the population, a large proportion of which is imported. According to the Global Footprint Network (GFN, 2018), Slovenia requires 2.4 times its territory to sustain the lifestyles of its population, with almost 25% of the total ecological footprint linked to food and beverages (Lin et al., 2018). GFN data show that 60% of Slovenia's area would be necessary to produce the food and beverages consumed, which clearly indicates the reliance of Slovenia on other countries, as in reality only 34% of its territory is agricultural land.

Increasing self-sufficiency in many food items is therefore largely dependent on reducing consumption of animal-based products.

Meat	Poultry consumption (kg per capita)	31,5
	Self-sufficiency with poultry (% of produced meat vs consumed meat)	112
	Import of chicken as a share of consumption (%)	38,4
	Pork consumption (kg per capita)	32,7
	Self-sufficiency with pork (% of produced meat vs consumed meat)	43
	Import of pork as a share of consumption (%)	88,1
	Beef consumption (kg per capita)	19,6
	Self-sufficiency with beef (% of produced meat vs consumed meat)	111
	Import of beef as a share of consumption (%)	34,7
Jajca in mleko	Egg consumption (kg per capita)	11
	Self-sufficiency with eggs (% of produced eggs vs consumed eggs)	96,8
	Import of eggs as a share of consumption (%)	16,2
	Milk consumption (kg per capita)	204,1
	Self-sufficiency with milk (% of produced milk vs consumed)	316,5
	Import of milk products as a share of consumption (%)	7,4
	Fermented dairy product consumption (kg per capita)*	20,2
	Self-sufficiency with fermented dairy (% of produced vs consumed)	107,9
	Import of fermented dairy products as a share of consumption (%)	33,3
	Cheese consumption (kg per capita)*	16,8
	Self-sufficiency with cheese (% of produced vs consumed)	44,5
	Import of cheese as a share of consumption (%)	82,7
	Cream consumption (kg per capita)*	6,9
	Self-sufficiency with cream (% of produced vs consumed)	81,9
	Import of cream as a share of consumption (%)	2,7
	Butter consumption (kg per capita)*	2,2
	Self-sufficiency with butter (% of produced vs consumed)	51,5
	Import of butter as a share of consumption (%)	52,8
Sadje in zelenjava	Fruit consumption (kg per capita)	58,6
	Self-sufficiency with fruit overall (% of produced vs consumed)	13,8
	Self-sufficiency with fresh fruit (% of produced vs consumed)	23,0
	Vegetable consumption (kg per capita)	118,5
	Self-sufficiency with vegetables (% of produced vs consumed)	43,2

Table 6. Consumption, imports and self-sufficiency for selected food products (Zagorc et al., 2023). For meat and dairy products, where Slovenia records high levels of self-sufficiency while simultaneously exporting and importing large quantities, estimates have been provided on the share of imports in total consumption.

Section 3. How Can We Reduce Environmental Impacts as Consumers?

KEY MESSAGES

- Considerable reductions in the carbon, water, and land footprint are possible by following a healthier diet –even without improving agricultural operations
- Carbon footprint can be reduced by 36–63% (EAT Lancet and SFG2024)
- Water use for food production can be reduced by 37–48% (Mediterranean, EAT Lancet and SFG2024)
- Land-use footprint can be reduced by 31–51% (SFG2024)
- Eutrophication footprint can be reduced by 28% (SFG2024)

We examined different nutritionally balanced dietary guidelines, as provided by the evidence base on healthy diets (the new Slovenian Dietary Guidelines). These were compared with the current Slovenian dietary profile in terms of sustainability, focusing on three key dimensions: carbon, water, and land footprint. The current dietary profile (SI-Menu) is characterised by high levels of consumption of animal-based foods (Gregorič et al., 2022), and is based on reported consumption for a representative sample of the Slovenian population. The Mediterranean diet was included due to its overall health benefits and its familiarity to Slovenians (Castaldi et al., 2022). The analysis also considered the impacts of WHO guidelines (WHO and FAO, 2004, 2003), the planetary diet EAT-Lancet (Willett et al., 2019), and the newly developed Slovenian recommendations. The dietary patterns and amounts of consumed food products in each of these guidelines are provided in the Appendix.

To compare the different dietary guidelines, synthesised data on carbon, water, and land-use footprints were used from publicly available databases and life cycle analyses (Petersson et al., 2021; Poore & Nemecek, 2018; Springmann et al., 2018). These datasets that have also been applied in other assessments of environmental impacts of the food system, such as the German report on environmental effects of dietary change (Springmann, 2023).

When comparing the current Slovenian diet with more sustainable ones, it is clear that Slovenians could considerably reduce their environmental impact by following dietary patterns more aligned with human dietary requirements and recommendations. The analysis demonstrates that shifting to a healthier diet can yield important co-benefits for the environment and has substantial potential to reduce diet-related environmental impacts.

Consumers can considerably decrease greenhouse gas emissions related to their diet by opting for healthier diets with a higher share of plant-based food items. With moderate improvements – such as following a WHO-recommended diet – emissions can be reduced by 36%. By choosing a planetary diet – such as those recommended by EAT-Lancet or the new Slovenian guidelines, greenhouse gas emissions could be reduced by 63% compared to the average Slovenian diet (Figure 6).

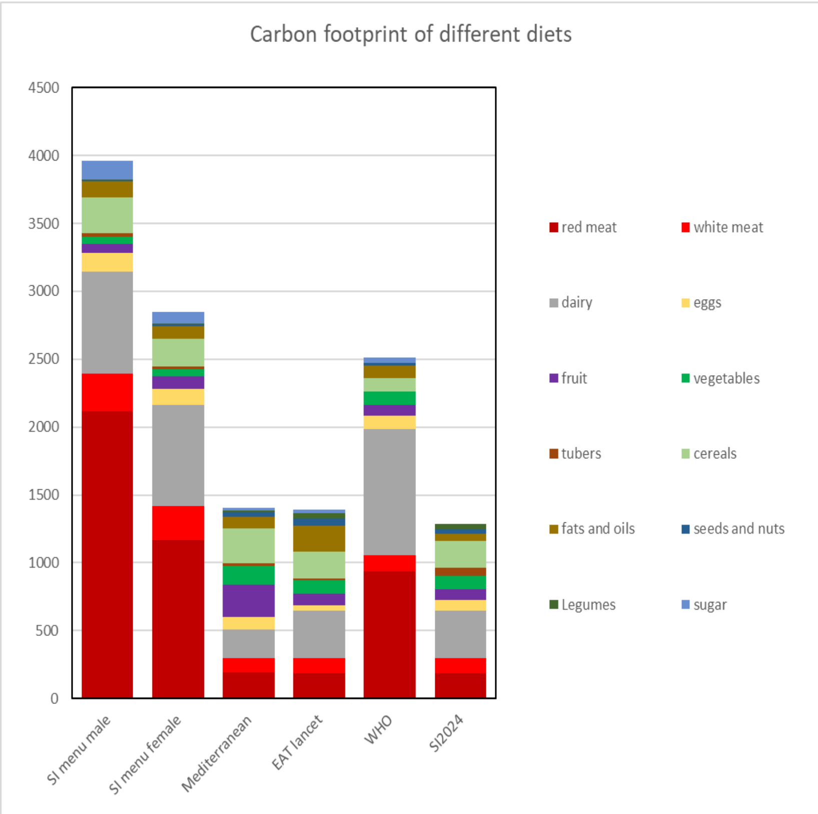

Figure 6. Carbon footprint of different dietary guidelines (based on Petersson et al. 2021). Note that the food group fish is not included in the calculations.

When it comes to environmental impacts in terms of water use, it is possible to nearly halve (-47%) the water footprint by adopting a healthier and more sustainable diet as recommended by the new Slovenian guidelines, the EAT-Lancet or Mediterranean diet. Adopting the WHO-recommended diet can decrease the water footprint related to water use by 27% (Figure 7).

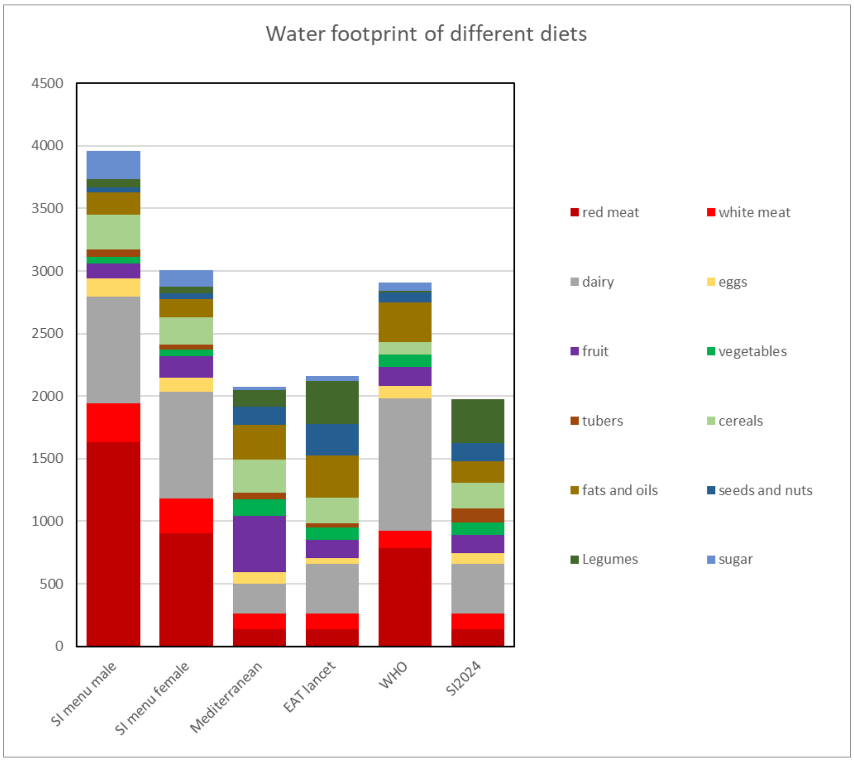

Figure 7. Water footprint of different dietary guidelines (based on Petersson et al. 2021). Note that the food group fish is not included in the calculations.

Changing dietary patterns can also decrease the amount of land necessary to produce the required nutrients and energy (Figure 8) – a particularly important factor for a small country with Slovenia's geographical limitations. By adopting the new Slovenian dietary guidelines or the Mediterranean diet, the amount of land needed to meet nutritional requirements could be reduced by 51%.

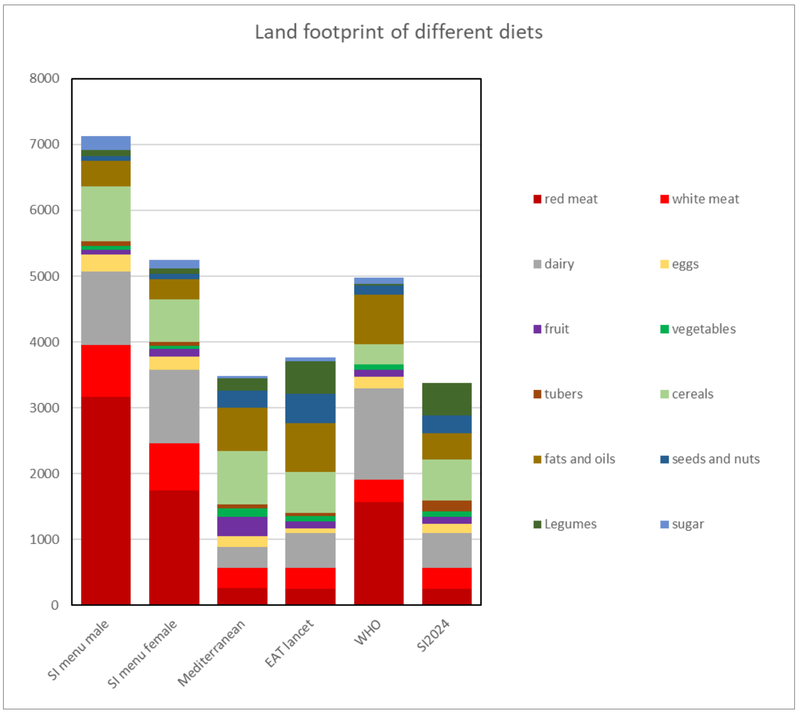

Figure 8. Land footprint of different dietary guidelines (based on Poore & Nemecek, 2018). Note that the food group fish is not included in the calculations.

Finally, adopting healthier diets could generate positive synergies for soil and water quality, as all recommended diets also lead to lower eutrophying emissions (Figure 9). These emissions – reduced through lower fertiliser use for animal feed production and decreased nitrogen emissions from animal manure – can be lowered by up to 70% when following healthier diets such as the new Slovenian guidelines, or the Mediterranean and EAT-Lancet recommendations.

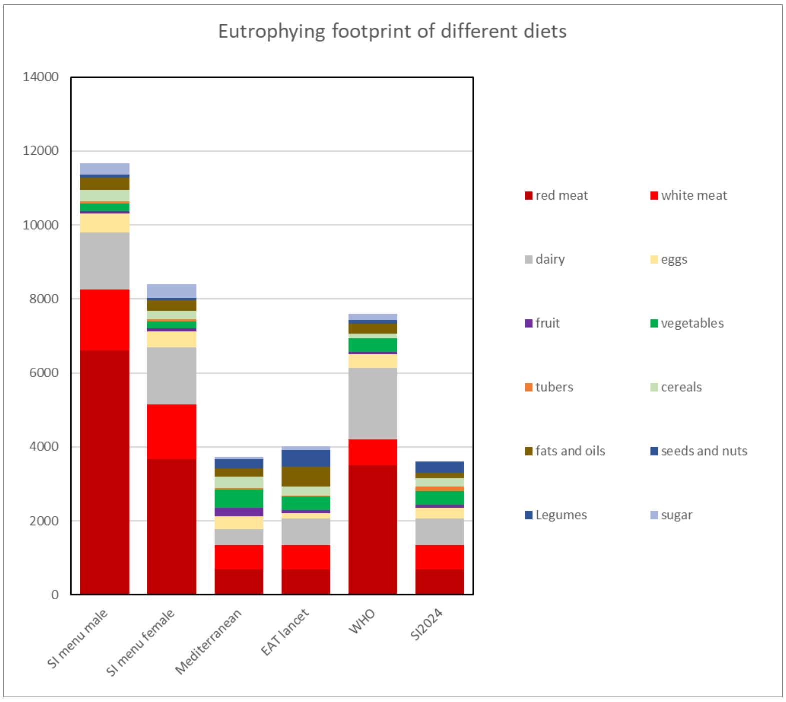

Figure 9. Eutrophication footprint of different dietary guidelines (based on Poore & Nemecek, 2018). Note that the food group fish is not included in the calculations.

Section 4. Concluding Remarks

Reducing the environmental impacts of the food system will require combined efforts from producers (farmers), processors (the food and beverage industry), retailers, and consumers. This report has briefly outlined the potential for transitioning towards a more sustainable food system by addressing the demand side – consumers.

Slovenia, with dominantly small farms often situated in areas with geographic limitations such as remoteness, poor soil, harsh terrain, and climatic characteristics, cannot simply rely on farmers alone to change and adopt new practices. In mountainous areas, production of plant-based food may not always be possible, and overall, transforming livestock farming into vegetable production is not straightforward and may be unfeasible in some contexts. However, reducing demand for animal-based products would lower the need for imported meat and agricultural inputs, easing pressure on farmers to produce as much meat as possible at the lowest price. Moreover, focusing solely on the agricultural side without reducing consumption risks increasing reliance on food imports; if production of animal-based food items declines but consumption does not, environmental impacts will merely shift elsewhere.

By changing our consumption patterns and diets, consumers can therefore take the most important step towards a more sustainable food system – one that is more cost-efficient compared to investing millions into new technologies, less dependent on food imports, as more plant-based food can be produced on smaller areas than animal-based food, and healthier for the population.

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Appendix 1. Different diet profiles considered in this report

Daily consumption in g		**SI menu men**	**SI menu women**	**Mediterranean**	**Eat Lancet**	**WHO**	**Slovenian draft guidelines**
Dairy	Dairy without cheese	534	531	150	250	662	250
	Cheese	35	32	11			
Vegetables	**Vegetables**	163	158	400	300	300	300
Fruit	**Fruits**	162	226	600	200	200	200
Legumes	**Legumes** (**kidney beans, green beans, lentils, etc.**)	15	11.6	29	75	4	75
Nuts and seeds	**Fresh and processed nuts and seeds**	8	10	30	50	16	30
Tubers	**Potatoes**	99	76	86	50		200
Cereals and bread	**all cereals and bread**	307	239	300	232	114	230
Fish	**Fish**	26.5	18.2	86	28	18	28
Meat	Red meat	137	76	14	14	80	14
	Poultry	72	65	29	29	31	29
	Processed meat	52	28	0	0	12	0
Fats and oils	Vegetable oils and margarines	20	16	40	40	46	25
	Butter and other animal fat	8	7	0	12	0	0
Sweets	**High sugar food**	98	107	20	31	50	0
Eggs	**Fresh and food incorporated eggs**	44	36	29	13	31	25

Appendix 2. Environmental impacts of different food items from different data sources

(we can provide estimates from other guidelines, e.g. Denmark, Germany, Netherlands... to indicate the potential range of values – however, these are relatively similar, especially with plan-based items)

		SuEATableLife (Peterson et al. 2021)		**Poore and Nemecek 2018**	
category	item	**carbon (kg CO2eq per kg)**	**water (liter per kg or l)**	**land use (m2 per kg)**	**eutrophication (g PO43-eq per kg)**
Dairy	dairy without cheese	1,4	1599	2,1	2,9
	milk	1,4	1599	2,1	2,9
	yogurt, cheese, milk cream	2,55	1540	20,2	26,3
	Cheese	9,59	5253	7,9	26,3
Vegetables	Vegetables	0,33	336	0,3	1,2
Fruit	Fruits	0,4	748	0,5	0,4
Legumes	Legumes and legumes products (kidney beans, green beans, lentils, etc.)	0,52	4615	6,7	1,6
Nuts and seeds	Fresh and processed nuts and seeds	1,11	4918	8,7	6,6
Tubers	Potatoes	0,27	554,8	0,8	0,6
Cereals and bread	all cereals and bread	0,86	901,8	2,7	1
	Breakfast cereals	2,64	2196,5	2,7	1
	Pasta, rice	1,21	1508,5	2,2	2,9
Fish	Fresh fish	5,19	2313	5,6	58,3
Meat	beef	25,75	15.139	25,9	79,8
	pork	5,7	6299	13,4	29,5
	Poultry	3,88	4325	11	22,7
	Processed meat	5,99	6177	13,4	295
Beverages	Sugar-containing soft beverages	0,48	1019	0,9	0,5
Fats and oils	Vegetable oils and margarines	2,11	6792	16,3	5,8
	Butter and other animal fat	8,84	5659	7,9	26,3
Sweets	Sugar and confectionary	0,78	1294,5	1,8	3,3
	Cakes, cookies	1,99	1870,3	1,8	3,3
	Desserts	3,16	2158	1,8	3,3
Eggs	Fresh and food incorporated eggs	3,2	3270	5,7	12