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AI, Adequate Intake; AR, Average Requirement; DIA, Diet Impact Assessment; DRV, Dietary Reference Value; FBDG, Food-Based Dietary Guidelines; FNR2024, Finnish Nutrition Recommendations 2024; GHGE, Greenhouse Gas Emissions; NCM, Nordic Council of Ministers; NDH, Norwegian Directorate of Health; NGO, Non-Governmental Organisation; NNR2023, Nordic Nutrition Recommendations 2023; p-AR, Provisional Average Requirement; RI, Recommended Intake; UL, Upper Intake Level; WHO, World Health Organization; WWF, World Wide Fund for Nature

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From evidence to action: implementing the Nordic Nutrition Recommendations in national policy

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Abstract

The Nordic Nutrition Recommendations 2023 (NNR2023) serve as the scientific foundation for national dietary guidelines and nutrient recommendations across the Nordic and Baltic countries. We reviewed how NNR2023 was adapted into national food-based dietary guidelines (FBDG) in the Nordic countries and Estonia, focusing specifically on sustainability considerations and policy implications. National FBDG integrated both health and environmental aspects in all countries, except Norway, which addressed environmental aspects only in a separate report. Health impacts served as the primary principle in all countries. Additionally, national policy perspectives, such as domestic food security, were addressed in some countries, while the integration of social and economic sustainability remained very limited. In adopting NNR2023, all countries modelled how implementation would affect nutrient adequacy or health within their food environments, making minor adjustments based on these findings. Guidelines for animal source food groups showed the most variation between countries; Estonia and Denmark established the strictest recommended limits for red meat and total meat, respectively, while Norway was most liberal regarding milk products. Stakeholders participated in the consultation process. The agricultural sector and meat industry primarily maintained pro-meat discourse, which was particularly intense in Norway and Sweden. Transition towards healthy and sustainable diets demands multiple policy instruments – FBDG being just one – alongside a supportive environment and participation from all food system actors.

Current challenges in public health nutrition are complex with dietary patterns closely related to all domains of sustainability: ecological, social, economic, and cultural[1,2]. Sustainable healthy diets promote individuals' health and well-being, minimise environmental impact, and are accessible, affordable, safe, equitable and culturally acceptable[3]. Nutrition recommendations play a pivotal role in regional and national public health promotion[4]. They provide an evidence-based foundation to foster nutrition-related health and well-being throughout the life course, enhance work capacity, prevent chronic diseases, and promote health equity. Modelling studies, however, have shown nutrition recommendations' partly underutilised potential to reduce diet-related mortality and environmental impacts[5]. Recommendations inform health and food policies and guidance, set criteria for public food services, direct food product reformulation, and support education and research.

The Nordic countries (Denmark, Finland, Iceland, Norway and Sweden) have collaborated on setting nutrition recommendations for over 40 years, since 1980, under the mandate of the Nordic Council of Ministers (NCM). The latest update, the 6th edition of the Nordic Nutrition Recommendations (NNR2023) was published in June 2023 with subsequent revisions[6]. The new edition represents the culmination of a five-year collaborative effort, the largest and most extensive global project in Nordic cooperation to date. The core working group comprised two representatives from each Nordic country and, for the first time, also included an observer from each Baltic country (Estonia, Latvia and Lithuania). At the foundational phase, principles and methods were agreed upon, and a protocol for the work was drafted[7]. The evidence review phase, involving around 250 experts, included a thorough systematic examination of the

associations between dietary factors and health outcomes[8,9]. In the third phase, regional perspectives on diet and nutrient intake[10], physical activity[11] and key population health challenges were integrated into the evidence base. In the final phase, the NNR2023 working group integrated environmental perspectives[12–15] and set the final recommendations. This structured approach ensured the development of comprehensive, evidence-based, internationally harmonised and regionally relevant nutrition recommendations.

None of the Nordic countries are on track to reach the 2030 UN climate and biodiversity goals[14]. Under the strong mandate of the NCM (2020), NNR2023 integrated environmental sustainability into food-based dietary guidelines (FBDG). This integration reflects the growing recognition of the interconnection between dietary, health, and environmental issues[16–18]. This approach aligns with the Nordic vision of becoming the world's most sustainable region by 2030[19]. The new NNR edition updated dietary reference values for 36 nutrients, several for the first time, and expanded the FBDG to encompass 17 food groups, making NNR2023 the most comprehensive version to date. NNR2023 recommend a predominantly plant-based diet rich in vegetables, fruits, berries, legumes, potatoes, whole grains, with an abundant intake of fish and nuts, moderate intake of low-fat dairy products, and limited intake of red meat and poultry[6]. Consumption of processed meat, alcohol and processed foods high in fats, salt and sugar are recommended to keep at minimum.

NNR2023 serves as the scientific foundation for national nutrient recommendations and FBDG across the Nordic and Baltic countries. While nutrient recommendations are typically adopted at the national level with minimal changes, developing FBDG requires consideration of the national food system and the dimensions of social and economic sustainability. The NNR2023 working group provided background papers on integrating environmental sustainability into national FBDG[15] and on considering social and economic dimensions of food consumption[20]. Dietary modelling[21,22] was suggested as the foundation for setting the amounts of specific foods and food groups in national FBDG[15].

This review paper offers a comparative analysis of how Nordic and Baltic countries have adapted the NNR2023 within their national contexts, with particular focus on sustainability considerations and policy implications. Because of the rigorous evaluation of the evidence on health in relation to nutrient intake in the NNR2023 project, the dietary reference values (DRVs) from NNR2023 were directly adopted into all countries' dietary recommendations, excluding the higher vitamin D recommendation in Iceland (individuals aged over 10 years) and lower dietary salt in Finland (not to exceed 5 g per day) (Table 1).

Denmark

Denmark updated their FBDG to guide on a sustainable plant-rich diet in 2021 – before the NNR2023 were launched. The underlying scientific background was updated based on the NNR2023[23]. The approach taken was to use the previously developed healthy plant-rich diet, estimate its nutritional adequacy, and adjust the diet accordingly. The adjusted healthy plant-based diet was then incorporated to the Danish FBDG.

Determining healthy plant-rich diets for revision of the official Danish FBDG (2021)

The development of the Danish adapted plant-rich diet 2021 is described extensively in a report[24] and in a scientific article[25] and further summarised by Trolle et al.[23]. In brief, the plant-rich reference diet was developed through iterative modelling based on the EAT-Lancet Commission's global reference diet[17], adjusted for health evidence[24] and Danish dietary preferences. Using NNR2012 and Danish food composition data[26], the diet was optimised to be nutritionally adequate at energy intake of 10 MJ per day. The Danish Veterinary and Food Administration developed communication strategies for the revised FBDG through stakeholder workshops and consumer pre-testing, involving government agencies, non-governmental organisations (NGO), and industry representatives.

Adjusting the plant-rich diet 2021 and recalculation of the nutrient content

The Danish plant-rich diet from 2021 was updated to align with NNR2023 and recent Danish advisory work, including e.g. revised food group definitions and whole-grain recommendation. Using updated food composition data, the recalculated diet maintained its macronutrient distribution while showing some micronutrient changes: increased vitamin A, B_{12} and selenium, decreased folate, and minor reductions in iron, phosphorus and magnesium.

Scaling and assessing nutrient adequacy of the plant-rich diet

The plant-rich diet was scaled according to reference energy intakes for different age groups specified in NNR2023[6]. The nutrient content was compared with target levels set to provide adequate intake (AI) for 90 % of each population group. These target nutrient contents were calculated using sex- and age-specific DRVs and coefficients of variation from NNR2023. Recommended intake (RI) for iron was used for females aged 15–50 years, as iron requirements do not follow the normal distribution needed for 90 % adequacy calculations. The assessment identified several nutritional inadequacies; selenium and vitamin D were below target levels across most age groups, while calcium and iodine were insufficient in specific age groups[23].

Adjusting the food composition of the plant-rich diet to implement the NNR2023

Comparison of the plant-rich diet and the scientific advice on food group intake of NNR2023 revealed that adjustments may be necessary for whole-grain and fruit juice recommendations, and for coffee and plant-based fats. To address this, two versions of the adapted plant-rich diet were modelled and proposed[23], both featuring increased whole-grain (90 g per 10 MJ) and adjusted dairy content (increased for children 2–14 years and women 15–70 years, reduced for men 15–70 years). Compared to Version One, Version Two included 70 % more eggs and doubled the proportions of roe and liver within existing meat and fish limits of 50 g (cooked weight) per day of each. These adjustments resolved calcium and iodine inadequacies across all age groups, although selenium remained slightly low for adults over 18 years, and vitamin D remained insufficient. Environmental impact assessment is planned for 2025, with minimal changes to animal-based foods aiming to maintain the previously achieved one-third reduction in climate impact relative to average diets[27].

Adjustment of the official Danish FBDG

A scientific report was published to guide the Danish Food Administration in formulating the FBDG[23]. While recommending that most food quantities in the Danish adapted plant-rich diet remain unchanged, the report suggested revisions to whole-grain, dairy, and egg recommendations in accordance with Version Two of the proposed modelled diets. It also highlighted the

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Table 1. Summary of adapting NNR2023 to national recommendations in Nordic countries and Estonia*

Country and update timing	Responsible institution	National dietary assessments	Sustainability aspects	Implementation	Deviations from NNR2023
Finland 11/2024	National Nutrition Council (mandated by the Ministries of Social Affairs and Health and Agriculture and Forestry)	FNR2024 reference diets for adults (men/women) and children (1–3 and 4–6 years): 1) Recommended range limit nearest to current consumption 2) Range limits with best environmental impact → assessment of nutrient adequacy (AR, p-AR, AI for 90 % of the population, RI and UL) and comparison to current diets 38 macro- and micronutrients considered	Integrated in the FBDG: Environmental impact changes (%) from current to reference diet: GHGE, land use, and biodiversity Discussed in relevant sections: Social and economic sustainability, including expert hearings	Competitively tendered budget allocation for implementation as part of the National health and well-being programme by the Ministry of Social Affairs and Health	Long-term goal for red meat and poultry (total 350 g/week) Legumes 50–100 g/d Salt maximum 5 g/d
Denmark 6/2024	Veterinary and Food Administration, available at Altomkost.dk[28]	Update of FBDG from 2021, reference diets based on the plant-rich diet of the FBDG2021 (men/women: 2–70 years, 70+ years, and pregnant and lactating women to come) Comparison of nutrient content of the reference diets with target nutrient content (NNR: AR or p-AR to provide adequate intake for 90 % of the population groups)	Integrated in the FBDG: Environmental impacts based on NNR2023	Newsletters and webinars for nutrition and health professionals. The implementation strategy: (1) communication, (2) structural initiatives to improve food environments, and (3) stakeholder collaboration, including public-private partnerships	Total meat 350 g/week, or 50 g/d cooked meat Pulses 100 g/d Max for SSB and non-SBB and sugary and salty snacks provided (per 10 MJ/d) No amount per day mentioned for plant oils
Iceland DRV 2024 FBDG 2025	Directorate of Health in Iceland (DOHI)	Five-step framework to assess nutrition and environmental sustainability[22] in the general population (aged > 18 years) Based on two models: current FBDG 2014 and FBDG based on NNR2023. Criteria for macro- and micronutrients according to NNR2023	Integrated in the FBDG: Environmental impact based on NNR2023 GHGE, cropland use, nitrogen application, phosphorus application, consumption water use, extinction rate. Using available Icelandic data and relevant global data Planetary boundaries from the EAT-Lancet commission were applied[17,66] Discussed in relevant sections: Stakeholders included in the process to quantify sustainability aspects such as food waste, cultural aspects with the addition of including qualitative aspects for enabling factors for transitions to sustainable diets	DOH launched a campaign on social media, billboards and bus stops, with a press release and public briefing featuring the Minister of Health and Director of Health. The plan is to continue presenting recommendations to various groups in collaboration with health promotion approaches of DOHI.	Non-sugar-sweetened beverages included No amount per day mentioned for plant oil Vitamin D supplementation year-round for all
Norway DRV 11/2023 FBDG 8/2024	Norwegian Directorate of Health (NDH)	Nutrient adequacy of draft FBDG for adults, including pregnant and lactating women Comparison with AR and RI for all vitamins and minerals, energy needs, and consider UL for all target groups Two scenarios: 1. Lower intervals of the draft guidelines	Discussed in a separate section: Climate and environmental factors	NDH: campaigns, digital platforms, and resource toolkits for health care and educational settings, translation of relevant materials. Revision of related recommendations and guidelines have been initiated	No daily recommendation for plant oil Three portions of low-fat dairy daily Equal amounts of fruits/berries and vegetables

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Table 1. (*Continued*)

Country and update timing	Responsible institution	National dietary assessments	Sustainability aspects	Implementation	Deviations from NNR2023
		2. Upper intervals of the draft guidelines The official meal planner was updated with new DRVs and menus across age groups			
Sweden 2025	Swedish Food Agency	Nutrient intake and health impact (mortality and disability-adjusted life-years) modelling of diet adhering to the FBDG, using the DIA tool	Integrated in the FBDG: Impacts on natural pastures, climate impact, ammonia emissions were calculated for two scenarios, population's food intake 5 % closer to the FBDG, and 20 % closer to the FBDG Discussed in relevant sections: food supply capacity during crises or war, magnitude of domestic food production	Health care sector	No daily amount of plant oil given Increase the proportion of whole grain products from all grain product consumption. Fish and seafood 2–3 times a week
Estonia DRV 2023 FBDG 2024	National Institute for Health Development	Nutrient intake modelling following the FBDG, cultural preferences and product availability considered when adopting NNR2023 Comparison of nutrient content with target nutrient content (at least 95 % of RI or AI in NNR2023) for sex and age groups (for 2-years-olds and older based on reference values for energy intake ranging from 4·2 to 15·1 MJ)	Integrated in the FBDG: Environmental impact based on NNR2023, and recommended fish species based on national fish guide[51]	Several institutions	Red meat limited to 150 g weekly Whole grains preferred, with bread containing minimum 6 g fibre/100 g Juice limited to one glass weekly Combined daily limit for SSB, snacks, sweets, and alcoholic drinks: 160 kcal (0·7 MJ)

*Abbreviations: NNR2023, Nordic Nutrition Recommendations 2023; FNR2024, Finnish Nutrition Recommendations 2024; AR, average requirement; p-AR, provisional average requirement; AI, adequate intake; RI, recommended intake; UL, upper intake level; FBDG, food-based dietary guidelines; GHGE, greenhouse gas emissions; SSB, sugar-sweetened beverages; DRV, dietary reference values; DOHI, Directorate of Health in Iceland; NDH, Norwegian Directorate of Health; DIA, Diet Impact Assessment.

need to explore strategies for increasing population selenium intake and to maintain recommendations on vitamin D supplements. The official Danish Dietary guidelines – good for health and climate – are available at Altomkost.dk[28], with updated guidelines for other population groups (daycare, schools, and workplaces) to follow in 2025 and 2026.

Finland

An expert working group appointed by the National Nutrition Council developed Finnish Nutrition Recommendations 2024 (FNR2024) (Table 1), partially applying frameworks by Perignon & Darmon[21] and Wood et al.[22] for FBDG (Table 2). First, example diets in accordance with the FBDG of the NNR2023[6] were developed. Second, nutrient adequacy and environmental impacts of those diets were assessed, and finally the FBDG formulated. The National Nutrition Council launched FNR2024[29] in November 2024.

Determining healthy diets for Finnish adults and children using the NNR2023 FBDG criteria

The expert group developed reference diets following NNR2023 for adults (men: 10 MJ/d, women: 8 MJ/d) and children (1–3 years: 4·6 MJ/d, 4–6 years: 6·3 MJ/d)[6]. Food group quantities were based on NNR2023 ranges where available, adjusted proportionally for energy intake. Other quantities, when not available in the NNR2023, were derived from the National FinDiet 2017 survey (adults)[30] and the Dagis study (children)[31]. Finnish consumption patterns guided the specific food choices within food groups.

Two scenarios were developed: 'Nearest to Present' and 'Environment Friendlier,' each with two meat options. 'Nearest to Present' included either 350 g/week red meat plus current poultry levels or 350 g/week combined red meat and poultry. 'Environment Friendlier' offered either poultry-only or meat-free options.

Assessing nutrient adequacy of NNR2023 adhering diets

Reference diets' nutrient contents were calculated using the Finnish national food composition database Fineli®[32] and assessed against age- and sex-specific DRVs: average requirement (AR), provisional average requirement (p-AR), RI, upper intake level (UL) and AI for 90 % of each population group, following the same principles as described in the Danish section above. All NNR2023-compliant reference diets improved fat quality and fibre intake but required macronutrient balancing to ensure an adequate

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Table 2. Food-based dietary guidelines in the Nordic and Baltic countries updated based on the NNR2023[*,†]

	NNR2023	Denmark	Finland	Iceland	Norway	Sweden	Estonia[‡]
Vegetables, fruit, and berries	≥ 500–800 g/d or more	≥ 600 g/d	Same as NNR2023 with additional guideline: half fruits and berries and half vegetables	Same as NNR2023 with additional guideline: at least half of the amount should consist of vegetables	Same as NNR2023 with additional guideline: half fruits and berries and half vegetables	≥ 500 g/d	Vegetables: ≥ 400 g/d Fruits: ≥ 200 g/d Berries: ≥ 40 g/d
Potatoes	Higher consumption recommended	Included in the plant-rich diet (100 g suggested)	Same as NNR2023	Same as NNR2023	Same as NNR2023	Same as NNR2023	1000 g/week
Pulses (legumes)	Higher consumption recommended	100 g/d	50–100 g/d	Choose for dinner at least once a week, and as side dish or spread	Choose for dinner at least once a week, and as side dish or spread	Eat often, preferably every day	300–400 g/week
Nuts (and seeds)	20–30 g/d nuts It is also recommended to include seeds in the diet	Nuts: 30 g/d + seeds	Same as NNR2023	Same as NNR2023	Same as NNR2023	Same as NNR2023	Nuts: 20–30 g/d Seeds: 30–40 g/week, all unflavoured
Whole grains	≥ 90 g/d (dry weight)	Same as NNR2023	Same as NNR2023	Same as NNR2023	Same as NNR2023	Same as NNR2023 (Pictures illustrating examples of 90 g/d)	Bread ~ 115 g/d; fibre content at least 6 g/100 g) porridge, pasta (preferably whole grain) 300–400 g/d
Fish and seafood / week, cooked weight	300–450 g/week, of which ≥ 200 g/week fatty fish. Recommended to consume fish from sustainably managed fish stocks	350 g/week, of which 200 g/week fatty fish	Same as NNR2023 with addition: Prefer MSC- and ASC-certified fish and use the WWF fish guide	Same as NNR2023 with addition: Limit processed fish products	Same as NNR2023 with addition: Include other seafood in the diet	Eat fish 2–3 times a week (unchanged in anticipation for risk/benefit assessment)	Example of preferable fish per week: 150 g of salmon, 70 g of Baltic herring, 100 g of pike and 100 g of perch
Red meat	≤ 350 g of red meat, including as little as possible of processed red meat. For environmental reasons, consumption should be considerably less than 350 g/ week	See recommendation for total meat	Same as NNR2023	Same as NNR2023	Same as NNR2023 but no mention of environmental considerations	Same as NNR2023 environmental considerations mentioned in complementary information	100–150 g/week, including as little as possible meat products/ processed meat
Poultry	Consumption of processed poultry should be as low as possible. Poultry consumption should not be increased from current levels, and may be lower for environmental reasons	350 g/week of total meat, including poultry	Same as NNR2023 with addition: For environmental reasons, consumption of all poultry should be reduced from current levels	Choose preferably white meat rather than red meat	Choose preferably white meat rather than red meat	No special recommendation for unprocessed poultry	300–350 g/week; Choose preferably white meat or fish rather than red meat
Total meat		350 g/week of total meat, reduce beef and lamb the most, and for processed meat: as little as possible	Long-term goal: ≤ 350 g/ week of total meat (red meat and poultry)	Only limit set for red meat in total			

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Table 2. (*Continued*)

	NNR2023	Denmark	Finland	Iceland	Norway	Sweden	Estonia‡
Egg	A moderate intake of egg	3 eggs/week	Same as NNR2023 with addition ≤ 1 egg/d including eggs used in cooking and baking	Same as NNR2023	Same as NNR2023	No recommendation	3–4 eggs per week
Milk and dairy products	350–500 g/d of low-fat milk and dairy. If consumption is lower than 350 g/d, should be replaced with fortified milk replacements or other foods	250–350 g/d of low-fat liquid dairy and 20 g/d cheese. Age-specific recommendations	Same as NNR2023	Same as NNR2023	500 g/d of low-fat milk and dairy	Same as NNR2023	Unflavoured milk, and fermented milk products, curd, and cheese a total of 0·9–1·4 MJ/d
Fats and oils	≥ 25 g/d vegetable oil (or similar amounts of alphalinoleic acids from whole foods. Limit consumption of butter and tropical oils	same as NNR2023 but no numerical recommendation for vegetable oils	Same as NNR2023	Same as NNR2023 but no numerical recommendation for vegetable oils	Same as NNR2023 but no numerical recommendation for vegetable oils	Same as NNR2023 but no numerical recommendation for vegetable oils	About 20 g/d vegetable oil or butter
Beverages	Coffee: Moderate consumption of filtered coffee (about 1–4 cups/d) and tea. For children, a safe caffeine intake is 3 mg per kg/weight/d. Consumption of unfiltered coffee should be limited. SSB: should be limited. Water: High-quality tap water is the preferred choice	Coffee: same as NNR2023 SSB (including non-SSB): limit (4–6 years: max 25 cl/week, 7–10 years: max 33 cl/week, above 10 years and adults: max 5 dl/week Water: water for thirst	Coffee: same as NNR2023, except the coffee amount 1·25–5 dl/d and 'Coffee consumption should be low also for environmental reasons. SSB: limit (including energy drinks) Water: same as NNR2023	Coffee: same as NNR2023 Limit SSB and drinks with non-sugar sweeteners (including energy drinks). Energy drinks are not for children and teenagers. Water: Drink water	Coffee: same as NNR2023 SSB: limit (including energy drinks) Children and adolescents should not drink energy drinks. Water: Drink water	Water: Choose water over other drinks	SSB: A recommendation provided together with sweet and salty snacks Water: Drink water
Sugar-containing foods and drinks	Limit consumption	Limit intake. Max intake defined for age/sex groups	Products with high amount of free sugar as little as possible	Limit intake of candy, snacks, sweet pastries, and drinks with sugars and/or sweeteners	Limit intake of candy, snacks, and sweet pastries	Limit consumption of sweets, chocolate, ice cream, pastries, and especially sweet drinks	Foods with free sugars as little as possible. Energy from sweet-salty snacks, SSB, sweet and alcoholic drinks should not exceed 160 kcal kcal/d (0·7 MJ)
Fruit juices	Low or moderate intake can be a part of a healthy diet. Limited intake in children	≤ a small glass (1 dl/d)	Recommended amount of fruits can include 1 glass of fruit juice	Low to moderate intake (1 dl/d) of fruit juice may be part of a healthy diet	same as NNR2023 (≤ half a glass (1 dl/d) of 100 % fruit/vegetable juice can count as one portion of fruit and veg/day)		Juice is not recommended at more than 1 glass a week
Alcohol	No safe lower limit established. For children, adolescents, and pregnant women abstinence from alcohol is advised	Similar to NNR2023, additional reference to Danish Board of Health	Same as NNR2023	Same as NNR2023 Avoid alcohol or limit consumption	Same as NNR2023	Limit consumption of alcoholic beverages	Same as NNR2023, with remark: 'there is no safe level of alcohol consumption. Minors and pregnant and lactating mothers may not consume alcohol'

*Unless otherwise stated, quantities refer to per 10 MJ/d. All quantities are provided in ready-to-eat form.
†Abbreviations: NNR2023, Nordic Nutrition Recommendations 2023; MSC, Marine Stewardship Council; ASC, Aquaculture Stewardship Council; WWF, World Wide Fund for Nature; SSB, sugar-sweetened beverages.
‡For Estonia, recommendations are given for a person with a daily energy requirement of 2000 kcal (8·4 MJ).

proportion of energy from carbohydrates. Women's diets required attention to B_{12}, calcium and riboflavin intake, particularly in the 'Environment friendlier' scenario where fortified plant-based drinks became crucial when reducing dairy. Children's diets met most DRVs, except vitamin D, confirming the continued need for supplementation.

Assessing environmental impacts of NNR2023-adherent diets

The climate impact and the land-use-based, global impact on species loss (biodiversity impact) of the reference diets were estimated using the impact factors of the FoodMin diet model for product groups[33,34]. The climate impacts between the different diets differed by about 30 percentage points for children and about 35 percentage points for adults. The biodiversity impacts differed by just under 30 percentage points for children and just under 40 percentage points for adults. The differences in climate impact were particularly influenced by the consumption of red meat, while the differences in biodiversity impact were influenced by differences in poultry meat consumption. Limiting combined red meat and poultry to 350 g/week reduced both climate and biodiversity impacts by at least 10 % relative to scenarios with 350 g red meat plus current poultry levels.

Formulating Finnish sustainable FBDGs

FNR2024 included a few deviations from NNR2023 (Table 1), notably for meat and legumes. For environmental reasons, poultry consumption should be reduced and a long-term goal of 350 g/week combined red meat and poultry was set. FNR2024 also specifies 50–100 g/d for pulses and legumes and adds sustainability-based guidance for fish species. The draft FBDG underwent four weeks of public consultation, with official responses published on the website. While FNR2024 considers social sustainability and national security of food supply, the FBDG are based on health and environmental evidence.

Iceland

The expert advisory group updated the dietary recommendations according to NNR2023[6]. Iceland adopted NNR2023 DRVs, with only the increased vitamin D recommendations for individuals over the age of 10 years. The Icelandic FBDG were developed following the NNR2023 guidelines, with consideration of the National Dietary Survey 2019–2021 data[35] (Table 2). While focused primarily on health outcomes and disease prevention, each guideline includes environmental impact information based on NNR2023. The new FBDG were launched in March 2025[36].

Determining the gap in diets of Icelanders using the NNR2023 FBDG criteria

To assess nutritional adequacy in Iceland, data from the 2019–2021 National Dietary Survey was analysed[35]. Results revealed that participants' average intake of folate, vitamin C, potassium, and iodine, and in women also iron, fell below AR. Non-supplemented individuals lacked vitamin D. While protein intake was adequate, most Icelanders consumed insufficient carbohydrates and fibre from whole grain, vegetables and fruits and nuts, but excessive saturated fat from dairy, meat, and sweets. In a recent Icelandic study utilising data from the 2019–2021 National Dietary Survey, researchers observed that dietary GHGE exceeded levels reported in other Nordic and European studies[37]. The dietary habits of most participants (86 %) exceeded the 2014 recommended ranges for both red meat (500 g/week) and dairy consumption (≤ 500 g/d)[37].

Implementation and supplementary analysis

Stakeholders were invited in November 2024 to discuss FBDG[36] implementation and public communication strategies. Guidelines for different school levels, pregnant and lactating women, and the elderly will be updated in the coming years in accordance with the new FBDG. Food cycle and plate models have been updated accordingly. In addition, the approach suggested by Wood et al.[22] was followed to provide evidence on nutritional and environmental performance of the FBDG (Table 1).

Norway

The Norwegian Directorate of Health (NDH) followed standard guideline development procedures[38] with transparent documentation on their project site[39]. As per a political decision, the FBDG are based on NNR2023[6] but focus solely on diet-health relationships and disease prevention. Environmental aspects are addressed separately in an article by the Norwegian Environment Agency on the NDH website[40]. The development process included four main elements: establishing nutrient reference values, ensuring consumer understanding, engaging stakeholders and assessing nutrient adequacy.

Revision of the official reference values for energy and nutrients

In November 2023, NDH published the new reference values for energy and nutrients[41]. While maintaining all NNR2023 recommendations for energy, vitamins and minerals, the content was condensed, made more user-friendly and translated into Norwegian.

Consumer understanding and preferences

NDH prioritised making the new dietary guidelines user-friendly and inspiring. Consumer research, including both quantitative and qualitative surveys of the general population and health professionals, showed preferences for practical, meal-based recommendations over specific quantities, and indicated that fewer and positively framed guidelines would enhance both memorability and adherence. For example, recommending fruits and vegetables at every meal proved more approachable than specifying 500 g daily.

Stakeholder involvement

NDH held a stakeholder meeting in January 2024 (38 participants), followed by a question-and-answer session with researcher from the NNR2023 committee to address concerns about red meat and dairy recommendations[39]. After internal review, the draft FBDG underwent eight weeks of public consultation, receiving 235 comments[42]. Public feedback supported the reduced number of recommendations and the more positive framing of the guidelines. The public consultation also led to an expanded beverage recommendations including water, sugar-sweetened beverages, energy drinks, coffee, tea and alcohol.

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Assessing nutrient adequacy of draft guidelines and adjusting final guidelines

The Norwegian Scientific Committee for Food and Environment (VKM) assessed nutrient adequacy of the draft FBDG for adults, including pregnant and lactating women. Two scenarios were developed representing lower and upper extremes of recommended FBDG ranges, incorporating commonly consumed foods from national surveys[43]. These scenarios covered only FBDG-specified foods (53–76 % of energy requirements), allowing room for additional healthy food consumption.

Based on VKM's findings, the daily recommendations of low-fat dairy in the final FBDG increased to 3 portions/day (for calcium and iodine adequacy) and the inclusion of seafood in the diet was specified (for selenium intake). The comprehensive dietary guidance, the official Norwegian meal planner, has been updated with new reference values (RI) and age-specific weekly menus (children 7–10 years, adolescents 11–15 years, adults 18–24 years)[44]. The official Norwegian dietary guidelines for good health and good lives were published in August 2024[42].

Sweden

Swedish FBDG are primarily based on the health effects of food consumption but have discussed environmental impacts of food already in 2015[45]. In the current update, the government tasked the Swedish Food Agency with three aspects to take into consideration: strengthening supply capacity during crises or war, increasing domestic food production, and improving environmental sustainability by reducing negative impacts and enhancing positive ones. The development process included development of health-based FBDG based on the NNR2023[6]. The above-mentioned aspects could lead to modifications only if such changes would not reduce the potential for achieving good public health outcomes. Public acceptability could justify modifying the advice if such changes were considered beneficial for the effectiveness of the FBDG. Based on these assessments, the FBDG were modified when necessary.

Development of FBDG considering only health evidence

The initial FBDG proposal was developed based solely on public health evidence, drawing from NNR2023 and recent reports, including studies on iron content and bioavailability in vegetarian meat alternatives[46]. Health effects of food groups were evaluated using Global Burden of Disease data. A health impact assessment was conducted to estimate the public health impacts of the population's dietary habits[47]. The evaluation considered the number of premature deaths and disability-adjusted life-years avoided if the population's food consumption shifted 5 % (scenario 1) and 20 % (scenario 2) closer to the FBDGs. This was done using the Diet Impact Assessment model (DIA) provided by the WHO[48]. Toxicological considerations incorporated the Swedish Food Agency's existing advice and assessments. The resulting recommendations from this stage are referred to as health-based FBDG.

Assessment of inclusion of other than health goals

Mutual effects between the health-based FBDG and the other goals were examined. If a change in consumption (resulting from health-based FBDG) was deemed to affect goal achievement (such as improved ability to supply food in crisis and war), potential adjustments to the FBDG were considered. However, any modifications to the FBDG were not allowed to compromise the projected health benefits of the diet.

Assessment of acceptance of the FBDG

The potential impact of incorporating these additional goals on public acceptance of the FBDG was evaluated. If adjusting specific advice could lead to greater impact on consumption patterns, this might have warranted modification of the advice.

Combining public health and other factors in the FBDG

The FBDG were developed with careful consideration of all established factors, ensuring they address each goal as fully as possible without compromising the estimated public health improvements. The advice was supplemented with information on how to make environmentally smart choices and on the advantages of food produced in Sweden. The conclusion based on scientific knowledge was that public health requires a change in consumption, from a high proportion of animal-based foods to an increased proportion of vegetables (Table 2).

Estimated impacts of the new FBDG

The updated FBDG[49] are expected to improve public health, thus also yielding economic savings. They may lower GHGE and ammonia pollution but could negatively impact Sweden's natural pastures. The impacts on all the environmental changes considered were modest (1·2–3·7 % in the scenario of population diet 20 % closer to the recommendations)[49,50]. Increased consumption of Swedish foods could enhance domestic production, although EU trade remains important for the food supply in Sweden. The guidelines' effects on Swedish food producers depend on the adaptation of the producers and policy. The FBDG are not anticipated to affect Sweden's food supply during a crisis, but healthier eating in peacetime could strengthen resilience in such circumstances.

However, FBDG were delayed until April 2025 due to political intervention. The government requested an additional in-depth impact analysis of the proposed dietary guidelines for red and processed meat, examining effects on public health, food production, climate, biodiversity, and food security[50]. The analysis modelled two scenarios: 5 % and 30 % more than present of the population adhere to reducing consumption from 500 g to 350 g weekly, while considering both unchanged Swedish production and increased domestic consumption. The assessment aimed to specifically examine primary production impacts and compare climate effects of domestic *v.* imported meat, along with health outcomes at both consumption levels. The overall conclusion of the in-depth analysis was that even small changes may have a positive effect on public health, while having a relatively small impact on food production, climate and biodiversity[50].

Implementation

The basis of the FBDG are summarised in the report *Livsmedelsverkets generella kostråd för den vuxna befolkningen*[49]. The FBDG as expressed in the report are not intended for consumers. Target group-adapted information for consumers is available at the web, in printed form, etc., and on the Swedish Food Agency's website[51] and in other channels.

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Estonia

A working group was formed for development of the official FBDG, in which the external members (i.e. outside of the National Institute for Health Development (NIHD)) were from various ministries, agencies, universities and health colleges and associations. The development of the dietary recommendations consisted of modelling healthy food choices, developing plain language guidelines, and integrating health, sustainability and safety aspects.

Food choice modelling based on sex and age groups

In Estonia, modelling reference diets were constructed in an iterative manner to ensure nutritional adequacy, Estonian eating habits, food safety, and environmental sustainability. These factors and NNR2023[6] for food consumption were considered in the choice of foods for modelling. The modelling was performed with the Estonian nutrition programme Nutridata (www.nutridata.ee). Intakes of macronutrients were kept within the recommended range and vitamins and minerals at least 95 % of RI or AI according to NNR2023. Environmental sustainability was addressed by incorporating red meat as little as possible, while ensuring sufficient iron intake, and by utilising a fish guide by World Wide Fund for Nature[52] for choosing the fish in the diet.

With a daily energy intake of 7·5 MJ, only 80 % of the iron needs of menstruating women was met (unpublished results from Nutridata dietary analysis). The modelling also showed that in persons with very low energy requirement (< 5·9 MJ), intake of some nutrients may be less than 95 % of the RI. This is expressed in the FBDG, and dietary supplements and consultation of a health care professional are recommended for individuals with low energy requirements.

Plain language communication of the FBDG

In the Estonian FBDG[53], foods are divided into five main food groups (mainly based on food source and production method, if necessary also considering the nutritional composition), which are considered equally important in the omnivore diet: (1) Vegetables, fruits and berries, (2) Cereal products and potatoes, (3) Dairy products, (4) Nuts, seeds and oleaginous fruits, and added fats and (5) Fish, egg and meat. Although all five main food groups are equally important, the first two food groups should be eaten in bigger quantities. The FBDG are communicated using serving sizes, household measures and visualisations such as a food pyramid.

Detailed food group recommendations based on health, sustainability and safety aspects

Key recommendations emphasise food variety and safety. Estonian FBDG[53] align with NNR2023, except for red meat (100–150 g/week) (Table 2). To manage dioxin exposure[54], fish intake restriction from the Baltic Sea is advised, with vitamin D and iodine recommended to be sourced from other fish, fortified dairy and iodised salt[53]. Guidelines warn against over-browning starchy foods and target ages 2+ years.

Summary

The updated NNR2023[6] established the scientific basis for Nordic and Baltic FBDG, but implementation has varied based on national circumstances and priorities. All national FBDG integrated both health and environmental considerations, except Norway, which addressed environmental aspects only in a separate report[40]. Additionally, other national policy perspectives were addressed. In response to recent global crises, some countries adjusted their national priorities. Sweden, for example, considered the national priority of enhancing domestic food supply resilience during crises and wartime. 'Consideration' typically meant examining and documenting a perspective alongside the guidelines such as assessing how FBDG-adherent diets might affect specific societal goals. These considerations rarely influenced the final FBDG, especially when they would have required compromising health-based guidelines. Denmark had previously based its national FBDG on a nationally adapted healthy plant-rich diet informed by the EAT-Lancet reference diet[17], recent health and environmental evidence, and nutritional adequacy[24,25]. In adopting NNR2023, Denmark continued a strong environmental focus[28]. The integration of social and economic sustainability into the Nordic and Estonian FBDG was limited by the absence of commonly used reliable indicators and limited scientific evidence; only the Finnish[29] and Swedish FBDG[51] included discussion on these topics. These sustainability considerations will most likely become more prominent in the further implementation phase in all countries.

The Nordic and Baltic countries differ in their geographic conditions, which affects the countries' agri- and aquacultural foci. Finnish and Swedish food cultures centre on dairy production, Norway and Iceland rely heavily on fish, Iceland faces overgrazing from sheep farming[55], and Denmark is a major exporter of dairy and serves as the Nordic region's primary pork producer[14,56]. Despite their differences, all five countries need to better align food consumption and production and optimise regional potential to contribute to a more sustainable global food system. National circumstances were reflected in FBDG; Sweden's environmental assessment showed minimal gains from dietary change of 20 % closer to the FBDG, potentially attributable to their policy of unrestricted dairy consumption. Environmental impact assessments varied by country; Finland focused on climate, land use and biodiversity[29]; Sweden emphasised pastures, climate and ammonia pollution[51]; and Iceland conducted a comprehensive analysis of GHGE, land use, nutrient cycles, water use and biodiversity[37].

All countries modelled how adopting NNR2023-based FBDG would affect nutrient adequacy or health within their food environments, leading to adjustments in food group guidelines in some countries. This marks a methodological advancement from previous update rounds, potentially facilitated by existing modelling guidelines and tools (e.g.[15,21,22,48]). Sweden used WHO's new DIA tool[48] to directly assess health impacts. The modelling results partially reflected differences in food environments and food cultures. The most common finding was insufficient vitamin D intake, as previously identified, confirming the relevance of recommendations for supplementation. Different national supplementation and fortification policies across Nordic countries have resulted in varying vitamin D status[57]. Modelling analyses showed that intake of key nutrients, including calcium, iodine and vitamin B_{12}, must be monitored both at population level and among specific groups (such as those following predominantly plant-based diets) during the transition toward more plant-based diets.

The modelling analyses were constrained by partly outdated national food consumption data[10]. For instance, recent trends in the consumption of new plant protein sources were not yet reflected in most national dietary surveys. Data on environmental impacts of food consumption, in general, remain incomplete, especially with knowledge gaps from the Baltic countries[15]. Local

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data, however, would not change the need to reduce consumption of animal-based foods, particularly meat and dairy, for environmental sustainability[13,56]. In addition, while scenarios and modelling can project future dietary impacts, they typically fail to incorporate possible production scale changes. Stakeholders were engaged in consultation and will play a key role in FBDG implementation across all countries. Public hearings of the FBDG were conducted in Finland, Sweden, and Norway. In Denmark, stakeholders were involved in the previous FBDG development in 2021 and were informed about the new minor adjustments in 2024.

Guidelines for animal source food groups showed the greatest variation in how different countries had adopted the FBDG. Iceland, Norway and Sweden maintained NNR2023's red meat guidelines, whereas Danish and Estonian FBDG preserved their already environmentally ambitious approaches. Finland maintained NNR2023 meat guidelines but also set stricter meat limits framed as a long-term objective[29]. Estonia, a first-time observer in the NNR update round, placed strong emphasis on environmental aspects, recommending minimal red meat consumption[53]. Guidelines for poultry varied considerably, from Finland's recommendation to reduce consumption to Norway's advice to favour poultry over red meat. Dairy guidelines also varied, with Norway adopting more liberal approaches. Sweden and Estonia opted for more moderate recommendations for vegetables, fruits and berries. Estonia quantified potato intake guidelines, while this country and Denmark and Finland also specified legume consumption targets. Only Finland maintained NNR2023's quantitative fat recommendations.

Norway's leadership of the NNR working group coincided with intense domestic debate over meat recommendations[58], paralleling similar public discourse in Sweden[56]. Pro-meat arguments emphasised regional constraints: limited arable land, optimal use of grazing areas, domestic food security, preservation of cultural landscapes and their biodiversity, lack of Nordic data, nutritional inadequacies and support for rural communities[56,58]. These arguments mirrored global debates, as exemplified by the 'Dublin Declaration'[59] and its subsequent response also from Nordic researchers[60]. Nordic researchers outside the official nutrition recommendation committees called for research, policy and industry to adopt measures to downsize livestock production and consumption to meet sustainability targets and facilitate a just transition. Common misunderstandings about food's environmental impact were expressed by stakeholders, particularly pro-meat narratives promoted by the agricultural sector[56,58]. While dietary guidelines are typically mandated by national health institutes, Finland and Denmark issued theirs through food/agricultural/veterinary authorities – notably this did not weaken their environmental sustainability focus.

Even without projected population growth to 9·7 billion by 2053, food systems likely already operate beyond planetary boundaries, making food system transformation urgently necessary[3,61]. Ethical concerns arise both from maintaining high-income countries' current consumption levels[e.g.(62,63)] and from food system transitions that may worsen existing inequalities[e.g.(64)]. Future FBDG face pressure to address broader sustainability aspects, including animal welfare, social sustainability, food security, livelihoods, and economic factors[56]. These aspects interconnect through the food system, yet FBDG – being primarily based on health evidence and focused on consumption behaviour – cannot effectively address all objectives. However, establishing targets for healthy and environmentally sustainable diets can drive national interventions to improve their acceptability, accessibility, affordability and social and economic sustainability in relation to dietary and food system changes. Integrating complex dimensions requires reliable indicators to measure and monitor social and economic sustainability, as well as standards for judging, evaluating and deliberating justice in food system transitions[64].

To conclude, NNR2023 provided the scientific foundation for Nordic and Baltic FBDG to advance towards more plant-based, healthy and sustainable diets. This shift was accomplished, with health impacts serving as the primary principle of FBDG in all countries. Health considerations largely aligned with environmental impacts, although countries varied in how they made these visible. The effectiveness of FBDG depends on successful implementation across all population groups. Effective FBDG implementation requires coordinated policy support through health and sustainability promotion programmes, aligned public procurement standards and cross-governmental coherence. Agricultural strategies, public-private partnerships and food sector regulations must align with FBDG to prevent policy contradictions[5]. Creating sustainable and resilient food systems demands multiple complementary strategies. For example, financial incentives for farmers managing semi-natural pastures and legislation requiring cattle grazing rights could effectively preserve biodiversity-rich pastures[56]. Retailers, as gatekeepers between suppliers and consumers, have untapped potential to influence market transformation[63,65]. Ultimately, the sustainability transition, keeping focus on both health and environment, requires diverse policy instruments – with FBDG being just one – alongside a supportive environment and engagement from all food system actors.

One of the key takeaways is how political interests may shape national FBDG. Our review revealed evident attempts by various stakeholders to embed political agendas within nutrition recommendations. The extent to which politics influence FBDG varied across countries and was partly determined by the institutional authority responsible for their development. We highlighted a concerning case in Norway, where environmental considerations were ultimately excluded from national FBDG due to external political pressure[58]. Such instances underscore the importance of addressing commercial and political influences when formulating sustainable FBDG, particularly to safeguard the inclusion of evidence-based environmental considerations.

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