Sustainability indicators for foods benefiting climate and health

Supplementary material

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Table S1. Categorization and color-coding of food products and food subgroups according to the Swedish food based dietary guidelines.

Food group	Food subgroup	Food product	Rationale for color-coding
Dairy products	High fat and medium-fat milk and yoghurt	Milk, 3% fat, enriched with vitamin D	Higher fat alternative, to be replaced by fat-reduced alternatives
		Milk, 1.5% fat, enriched with vitamin D	Higher fat alternative, to be replaced by fat-reduced alternatives
		Yoghurt, natural flavor, 3% fat	Higher fat alternative, to be replaced by fat-reduced alternatives
	High fat cream, crème fraiche and sour cream	Whipping cream, 40% fat	Higher fat alternative, to be replaced by fat-reduced alternatives
		Crème fraiche, 34% fat	Higher fat alternative, to be replaced by fat-reduced alternatives
		Sour cream, 12% fat	Higher fat alternative, to be replaced by fat-reduced alternatives
	High fat cheese	Hard cheese, 28% fat	Higher fat alternative, to be replaced by fat-reduced alternatives
	Low fat milk, yoghurt and soured milk	Low fat milk, 0.5% fat, enriched with vitamin D	Lower fat alternative, to be preferred, compliant with Swedish Keyhole criteria
		Low fat soured milk. 0.5% fat	Lower fat alternative, to be preferred, compliant with Swedish Keyhole criteria
		Low fat yoghurt, natural flavor, 0.5% fat	Lower fat alternative, to be preferred, compliant with Swedish Keyhole criteria
	Light cream and crème fraiche	Light cream, 20% fat	Lower fat alternative but not compliant with Swedish Keyhole criteria
		Light crème fraiche, 15% fat	Lower fat alternative but not compliant with Swedish Keyhole criteria
	Low fat cheese	Low fat hard cheese, 17% fat	Lower fat alternative, to be preferred, compliant with Swedish Keyhole criteria
Plant-based dairy product substitutes	Enriched plant-based drinks	Soy drink, 1.5% fat, enriched	Lower-fat alternative, to be preferred, compliant with Swedish Keyhole criteria
		Almond drink, 1.3% fat, enriched	Lower-fat alternative, to be preferred, compliant with Swedish Keyhole criteria
		Oat drink, 1.1% fat, enriched	Lower-fat alternative, to be preferred, compliant with Swedish Keyhole criteria
	Plant-based cooking cream	Base for cooking, soy 17% fat	Not compliant with Swedish Keyhole criteria
		Base for cooking, oat 13% fat	Not compliant with Swedish Keyhole criteria
		Coconut milk, 24% fat	Not compliant with Swedish Keyhole criteria
Egg	Egg	Egg, hard boiled	Healthy protein source, to be preferred
Poultry	Poultry	Chicken breast with skin, fried	Healthy protein source, to be preferred
Meat	Minced meat (beef and pork)	Minced meat (67% beef, 33% pork), fried	Red meat, consumption to be reduced
	Red meat from ruminants (beef and lamb)	Beef entrecote, fried	Red meat, consumption to be reduced
		Lamb meat, fried	Red meat, consumption to be reduced
	Venison (deer bred in captivity)	Deer meat, oven baked	Red meat, consumption to be reduced
	Pork	Pork meat, fried	Red meat, consumption to be reduced
	Cold cuts	Pork ham, smoked, 1-3% fat	Red meat, consumption to be reduced
		Salami, 34-44% fat	Red meat, consumption to be reduced
	Liver paste	Spreadable liver paste, 24% fat	Red meat, consumption to be reduced
	Sausage	Sausage (ex. Chorizo), fried, 73% meat	Red meat, consumption to be reduced
		Pork sausage, 24% meat, fried	Red meat, consumption to be reduced
		Sausage, 51-54% meat, boiled	Red meat, consumption to be reduced
Fish and seafood	Salmon	Salmon, fried	Fish and seafood, consumption to be increased

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	Pelagic fish	Herring, canned	Fish and seafood, consumption to be increased
		Baltic herring fillet, fried	Fish and seafood, consumption to be increased
	Cod	Cod fillet, boiled	Fish and seafood, consumption to be increased
	Crustaceans	Prawns, boiled	Fish and seafood, consumption to be increased
Legumes and plant-based meat substitutes	Legumes	Brown beans, boiled	Legumes, consumption to be increased
		Red lentils, boiled with salt	Legumes, consumption to be increased
		Chickpeas, canned	Legumes, consumption to be increased
		Black beans, canned	Legumes, consumption to be increased
	Plant-based meat substitutes	Chickpea burger (e.g. falafel), fried	Not compliant with Swedish Keyhole criteria
		Soy sausage, fried	Not compliant with Swedish Keyhole criteria
		Vegetarian minced soy protein, fried	Plant-based meat-alternative, to be preferred, compliant with Swedish Keyhole criteria
		Tofu	Plant-based meat-alternative, to be preferred, compliant with Swedish Keyhole criteria
Cereal products	Low fiber pasta	Pasta, boiled with salt	Refined grain, to be replaced by whole-grain alternatives
	Rice	Rice, long-grain, boiled with salt	Refined grain, to be replaced by whole-grain alternatives
	Wholegrain bread	Bread (e.g. graham-based), wholegrain, 13% fiber	Whole-grain alternative, to be preferred
		Crispbread, rye, wholegrain, 15.5% fiber	Whole-grain alternative, to be preferred
	Low fiber bread	White bread, 3.5% fiber	Refined grain, to be replaced by whole-grain alternatives
		White bread, 5% fiber	Refined grain, to be replaced by whole-grain alternatives
		Flat bread, with milk, 4% fiber	Refined grain, to be replaced by whole-grain alternatives
	Muesli and breakfast cereals	Muesli, whole grain, natural	Whole-grain alternative, to be preferred
		Muesli, wholegrain, fruit and berries	Whole-grain alternative, to be preferred
		Muesli, wholegrain, nuts and seeds	Whole-grain alternative, to be preferred
		Breakfast cereals (e.g. corn flakes), fortified	Refined grain, to be replaced by whole-grain alternatives
		Breakfast cereals, wholegrain (e.g. Special K)	Whole-grain alternative, to be preferred
	Porridge	Oat porridge, wholegrain, boiled	Whole-grain alternative, to be preferred
Fats	Margarine	Margarine, 80% fat, fortified	Not compliant with Swedish Keyhole criteria
		Light margarine, 40% fat, fortified	Not compliant with Swedish Keyhole criteria
	Vegetable oils	Rapeseed oil	Vegetable oil, to be preferred
		Olive oil	Vegetable oil, to be preferred
	Butter and other hard fats	Butter, 80% fat	Animal fat, to be replaced by vegetable alternative
		Mixed hard fat, 75% fat, fortified	Animal fat, to be replaced by vegetable alternative
Sugar-containing products and snacks	Honey, jams	Honey	Sweets and snacks, consumption to be reduced
		Strawberry jam	Sweets and snacks, consumption to be reduced
	Chocolate, candies	Dark chocolate, >70% cocoa	Sweets and snacks, consumption to be reduced
		Milk chocolate	Sweets and snacks, consumption to be reduced
		Jelly candies	Sweets and snacks, consumption to be reduced
		Foam candies	Sweets and snacks, consumption to be reduced
	Biscuits, cakes	Biscuits, unspecified	Sweets and snacks, consumption to be reduced

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		Cake (e.g. cream-layer)	Sweets and snacks, consumption to be reduced
	Ice-cream	Ice-cream, 12% fat	Sweets and snacks, consumption to be reduced
	Wheat buns, rusks	Sweetened wheat buns	Sweets and snacks, consumption to be reduced
		Wheat rusks	Sweets and snacks, consumption to be reduced
	Snacks	Chips, salted	Sweets and snacks, consumption to be reduced
		Popcorn, 22% fat	Sweets and snacks, consumption to be reduced
		Peanuts, roasted, salted	Sweets and snacks, consumption to be reduced
Vegetables and potato	Cabbage and broccoli	Cabbage	Vegetables, consumption to be increased
		Broccoli, boiled	Vegetables, consumption to be increased
		Kale	Vegetables, consumption to be increased
		Spinach	Vegetables, consumption to be increased
	Salad vegetables	Iceberg lettuce	Vegetables, consumption to be increased
		Tomato	Vegetables, consumption to be increased
		Cucumber	Vegetables, consumption to be increased
	Root vegetables	Potatoes, boiled with salt	Root vegetables, consumption to be increased
		Potatoes, boiled and fried	Not compliant with Swedish Keyhole criteria
		Potatoes, deep fried, 17% fat	Not compliant with Swedish Keyhole criteria
		Carrots	Root vegetables, consumption to be increased
		Beetroot	Root vegetables, consumption to be increased
		Swedish turnip, boiled	Root vegetables, consumption to be increased
Fruit and berries	Banana	Banana	Fruit, consumption to be increased
	Pome fruits and stone fruits	Apple	Fruit, consumption to be increased
		Pear	Fruit, consumption to be increased
		Peach	Fruit, consumption to be increased
	Citrus fruit	Orange	Fruit, consumption to be increased
		Clementine, mandarin, tangerine, satsumas	Fruit, consumption to be increased
		Grapefruit	Fruit, consumption to be increased
	Avocado	Avocado	Fruit, consumption to be increased
	Berries	Strawberry	Fruit, consumption to be increased
		Raspberry	Fruit, consumption to be increased
		Raspberry, frozen	Fruit, consumption to be increased
		Blueberry	Fruit, consumption to be increased
		Blueberry, frozen	Fruit, consumption to be increased
	Dried fruit	Raisin	Fruit, consumption to be increased
		Apricot	Fruit, consumption to be increased
Nuts and seeds	Nuts	Hazelnuts	Nuts, consumption to be increased
		Sweet almonds	Nuts, consumption to be increased
		Cashews	Nuts, consumption to be increased
		Walnuts	Nuts, consumption to be increased
	Seeds	Sunflower seeds	Seeds, consumption to be increased

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		Pumpkin seeds	Seeds, consumption to be increased
Drinks	Soft drinks	Carbonated soft drink	Sugary drinks, consumption to be reduced
	Juice	Orange juice	Processed fruit, consumption to be reduced
	Alcoholic drinks	Beer pilsner, % 3.5 vol.	Alcohol, consumption to be reduced
		Red wine, % 14 vol.	Alcohol, consumption to be reduced
	Fruit soup	Rosehip soup (pasteurized or from powder), fortified	Processed fruit, consumption to be reduced
		Fruit cream, unspecified	Processed fruit, consumption to be reduced

Adapted with permission from *Bianchi M, Strid A, Winkvist A, Lindroos AK, Sonesson U, Hallström E. Systematic evaluation of nutrition indicators for use within food LCA studies. Sustainability 2020;12:8992*. Coloring of the cells represents the Swedish food based dietary guidelines (*The Swedish National Food Agency. Hitta ditt sätt - Att äta grönare, lagom mycket och röra på dig (Find your way - To eat greener, adequate and to do physical activity) [in Swedish]. Sweden: The Swedish National Food Agency; 2017; The Swedish National Food Agency. Nyckelhålet (The Keyhole) [in Swedish] [Internet]. 2020 [updated 2019-01-07]. Available online: https://www.livsmedelsverket.se/livsmedel-och-innehall/text-pa-forpackning-markning/nyckelhalet (accessed on: 21 September 2020)*). Green cells indicate food subgroups we should increase consumption of, yellow cells indicate food subgroups we should exchange unhealthier options to, and red cells indicate food subgroups we should limit.

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Differences in results of the combined analysis of climate impact and nutrient density when nutrient density is calculated by NRF11.3 per portion size or per 100 kcal with weighting

Only small differences between the results of the combined analysis of climate impact and nutrient density were found when nutrient density in this complementary analysis was calculated by the reference unit *portion size* compared to the reference unit *100 kcal with weighting* (main analysis).

When nutrient density was calculated by portion size instead of 100 kcal with weighting, for the two-axis graph, where the relative climate impact was plotted against the relative nutrient density, only a few food subgroups changed category from high nutrient density (above the median) to low nutrient density (below the median) or vice versa, see Figure S1. For the high-climate impact groups, only low fat cheese changed category from high nutrient density to low nutrient density, and pork, red meat from ruminants (beef and lamb) and snacks changed from low nutrient density to high. For the low-climate impact groups, wholegrain bread, pelagic fish and salad vegetables changed categorization from high nutrient density to low nutrient density.

When nutrient density was calculated by portion size instead of 100 kcal with weighting, for the integrated score, in the first quintile, almost all the same food subgroups could be found, exceptions being that salad vegetables and wholegrain bread were exchanged with seeds and porridge. In the fifth quintile almost all the same food subgroups could be found as well, exceptions being that venison (deer bred in captivity) and red meat from ruminants (beef and lamb) were exchanged with rice and high fat cheese. For the ranking of all food subgroups when the integrated climate and nutritional score is calculated with nutrient density per portion size, see Table S2.

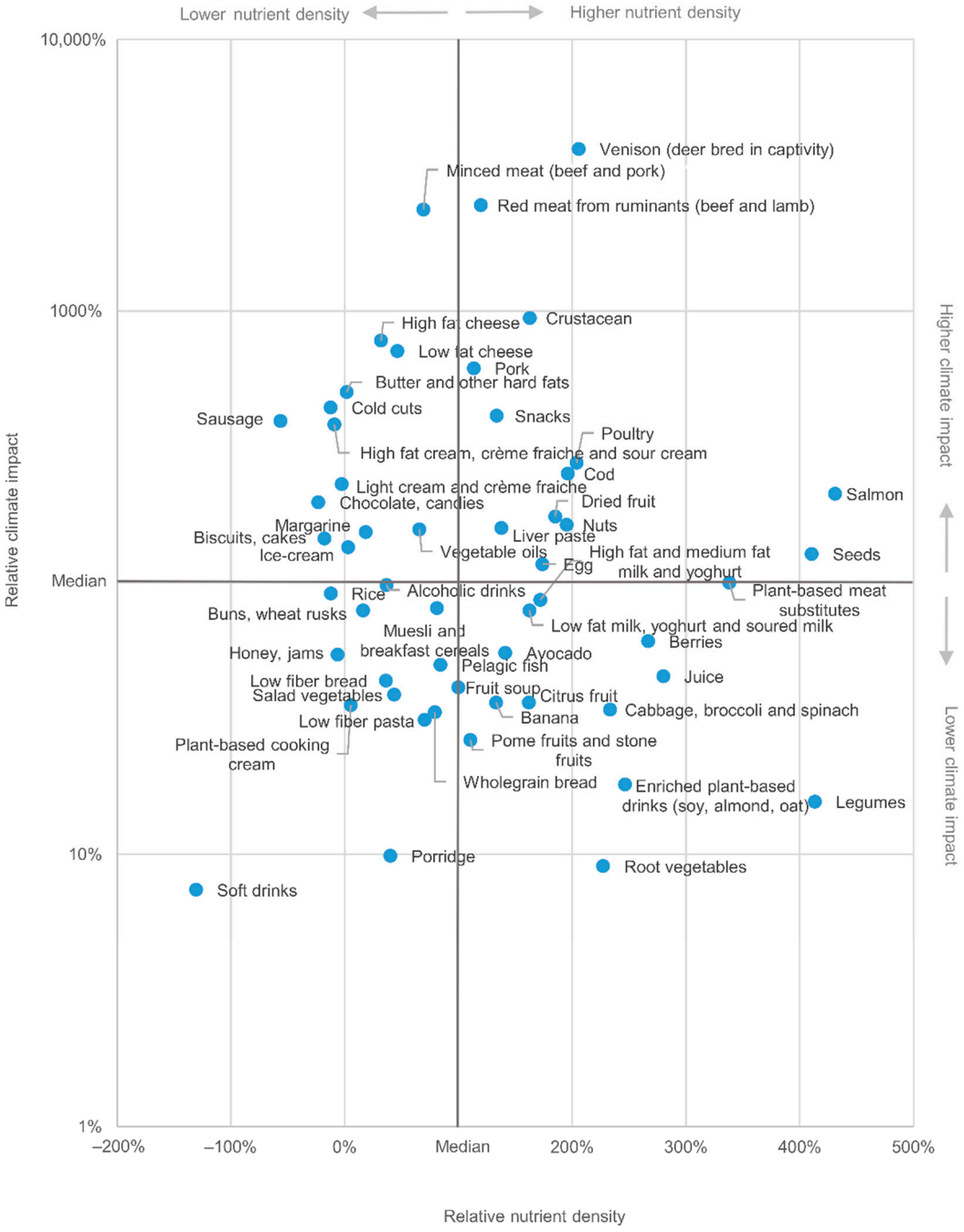

Figure S1. A combined analysis of nutrient density and climate impact of 53 food subgroups. Nutrient density was calculated by NRF11.3 per portion size and climate impact was expressed as kg CO_2e/kg food subgroup (at the stage of industry gate and including transport to Sweden for imported food; cooked weight for foods that require preparation). The thicker lines represent the median of all food subgroups included, i.e., median score of 0.44 for nutrient density and median value of 1.2 kg CO_2e/kg food subgroup for climate impact. Nutritional information was retrieved from version 20171215 of the Swedish food composition database. Abbreviations: NRF, Nutrient Rich Foods index; CO_2e, carbon dioxide equivalents.

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Table S2. Ranking of 53 food subgroups based on nutrient density calculated by NRF11.3 per portion size, climate impact expressed per kg at the stage of industry gate and including transport to Sweden for imported food; cooked weight for foods that require preparation, and a combined climate impact and nutrient density score.

Quintile[1]	Ranking based on nutrient density	Ranking based on climate impact	Ranking based on combined nutrient density and climate impact
1	Salmon	Soft drinks	Pulses
	Pulses	Root vegetables	Enriched plant-based drinks (soy, almond, oat)
	Seeds	Porridge	Root vegetables
	Plant-based meat substitutes	Pulses	Cabbage, broccoli and spinach
	Juice	Enriched plant-based drinks (soy, almond, oat)	Juice
	Berries	Pome fruits and stone fruits	Citrus fruit
	Enriched plant-based drinks (soy, almond, oat)	Low fiber pasta	Berries
	Cabbage, broccoli and spinach	Wholegrain bread	Pome fruits and stone fruits
	Root vegetables	Cabbage, broccoli and spinach	Porridge
	Venison (deer bred in captivity)	Plant-based cooking cream	Banana
	Poultry	Citrus fruit	Seeds
2	Cod	Banana	Plant-based meat substitutes
	Nuts	Salad vegetables	Avocado
	Dried fruit	Fruit soup	Wholegrain bread
	Egg	Low fiber bread	Low fiber pasta
	High fat and medium fat milk and yoghurt	Juice	Low fat milk, yoghurt and soured milk
	Crustacean	Pelagic fish	Salmon
	Low fat milk, yoghurt and soured milk	Honey, jams	High fat and medium fat milk and yoghurt
	Citrus fruit	Avocado	Salad vegetables
	Avocado	Berries	Pelagic fish
	Liver paste	Low fat milk, yoghurt and soured milk	Egg
3	Snacks	Buns, wheat rusks	Nuts
	Banana	Muesli and breakfast cereals	Muesli and breakfast cereals
	Red meat from ruminants (beef and lamb)	High fat and medium fat milk and yoghurt	Liver paste
	Pork	Rice	Low fiber bread
	Pome fruits and stone fruits	Alcoholic drinks	Fruit soup
	Fruit soup	Plant-based meat substitutes	Cod
	Pelagic fish	Egg	Poultry
	Muesli and breakfast cereals	Seeds	Dried fruit
	Wholegrain bread	Ice-cream	Soft drinks[2]
	Low fiber pasta	Biscuits, cakes	Alcoholic drinks
	Minced meat (beef and pork)	Margarine	Vegetable oils

4	Vegetable oils	Vegetable oils	Snacks
	Low fat cheese	Liver paste	Buns, wheat rusks
	Salad vegetables	Nuts	Pork
	Porridge	Dried fruit	Plant-based cooking cream[2]
	Alcoholic drinks	Chocolate, candies	Crustacean
	Low fiber bread	Salmon	Margarine
	High fat cheese	Light cream and crème fraiche	Honey, jams[2]
	Margarine	Cod	Low fat cheese
	Buns, wheat rusks	Poultry	Venison (deer bred in captivity)
	Plant-based cooking cream	High fat cream, crème fraiche and sour cream	Red meat from ruminants (beef and lamb)
5	Ice-cream	Sausage	High fat cheese
	Butter and other hard fats	Snacks	Rice[2]
	Light cream and crème fraiche	Cold cuts	Minced meat (beef and pork)
	Honey, jams	Butter and other hard fats	Biscuits, cakes[2]
	High fat cream, crème fraiche and sour cream	Pork	Ice-cream
	Rice	Low fat cheese	Light cream and crème fraiche[2]
	Cold cuts	High fat cheese	Chocolate, candies[2]
	Biscuits, cakes	Crustacean	Butter and other hard fats[2]
	Chocolate, candies	Minced meat (beef and pork)	High fat cream, crème fraiche and sour cream[2]
	Sausage	Red meat from ruminants (beef and lamb)	Sausage[2]
	Soft drinks	Venison (deer bred in captivity)	Cold cuts[2]

Qualitative nutrients in NRF11.3 are protein, fiber, iron, potassium, calcium, magnesium, vitamin A, vitamin C, vitamin E, vitamin D and folate, and disqualitative nutrients are sodium, saturated fat and added sugars. The combined climate impact and nutrient density score was calculated by dividing kg CO_2e/kg food group with NRF11.3 per portion size. Negative NRF values were capped at the lowest positive value in the sample before calculating the combined index. [1]Quintile 1 represents the food products with highest nutrient density score, lowest climate impact and lowest climate impact per nutrient density score. [2] Food subgroups including food products with negative NRF values. Nutritional information was retrieved from version 20171215 of the Swedish food composition database (http://www7.slv.se/soknaringsinnehall, accessed on 19 July 2019). Abbreviations: NRF, Nutrient Rich Foods index.