Assessing the nutritional, health and environmental dimensions of foods and diets: comparison of nutritional metrics

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Introduction:

Recently, the link between environmental impact of diets and its relationship with health and nutrition has gained special interest. With the Agenda 2030 and the UN sustainable development goals (United Nations General Assembly, 2015), new food policies encompassed with changes on food production and consumption have raised worldwide to achieve environmental and nutritional goals. However, there are still some challenges developing a standardized method that include nutrition, health and environment calculations when assessing food products and diets. Dietary indicators are used to classify foods and diets depending on their nutrient content (Fulgoni et al., 2009), diversity (Green et al., 2020) or its compliance with dietary guidelines (Krebs-Smith et al., 2018). The assessment is more complex, if digestibility, absorption and bioavailability of some nutrients are considered (Sonesson et al., 2017) or when the health impacts of food products and diets are assessed (Stylianou et al., 2021). However, a holistic approach of the nutritional, health and environmental (NHE) dimensions is needed to ensure food products and dietary patterns are not only environmental friendly but also more nutritious and healthy for the present and future generations. In a literature review, five types of health/nutritional indicators were identified, and classified as follows: 1) Group A, includes metrics that consider a ratio between the nutrient food content and reference amount for qualifying and disqualifying nutrients and/or food groups; 2) Group B: includes indices based on the adherence to specific guidelines on healthy eating; 3) Group C: is based on nutrients and food group diversity; 4) Group D: considers metrics that evaluate nutrient quality characteristics specific to one or more nutrients (bioavailability, digestibility, etc.); and 5) Group E: accounts for metrics that consider health impact of foods and diets based on dietary risk factors. The aim of this research is to compare different nutritional and health metrics on food products and evaluate their differences.

Methodology:

This study evaluated the nutritional-health-environmental (NHE) dimensions of 445 foods from the Swiss EuroFIR database. The EuroFIR is a comprehensive nutritional food database that includes a wide range of raw and processed food items (Becker et al., 2008). For this analysis, only single, food products were considered (e.g. apple, chicken meat or milk), and complex or processed foods were not evaluated (e.g. pizza, cake, etc.). Consequently, the metrics selected to assess the nutritional and health dimensions were indicators of group A and E. The analysis consisted of three phases. First, the nutritional content of food products was calculated according to three different nutritional indicators: i) NutriScore (NS); ii) Nutrient Balance Concept (NBC); iii) Nutrient Rich Food 9.3 (NRF9.3). Each of the selected nutritional indicators considers a different set of nutrients and food groups, which allows for a comparative analysis. Second, the health impacts were evaluated through the newly developed HENI score (Stylianou et al., 2021) based on fifteen dietary risk factors from the Global Burden of Disease study (Murray et al., 2020). Third, the environmental impacts (EnvI) of the different foods were considered by LCA (Poore & Nemecek, 2018). Finally, a ranking of the different foods was performed as well as correlations between the different indicators.

Results:

When analyzing the 445 single food products considered, results show that NRF9.3 and NBC are the two indices with the highest correlation (r = 0.78; p < 0.001). Both indices consider only qualifying and disqualifying nutrients, while NutriScore and HENI consider also food groups (e.g. read meat). In addition, results show that correlations between the different indices change depending on how food group aggregations are considered (e.g. analyzing all meats vs specific meat types). Table 2 shows, that when analyzed by food groups (Table 1), the number of correlations between the different indices differ (Table 2). In addition, when assessing foods products individually, results show that the choice of indicators changes how foods are ranked. Table 3 shows the results for five commonly consumed foods by different environmental, nutritional and health metrics. For example, walnuts rank first for HENI and greenhouse gas emissions (GhGe) but rank in last position when considering water scarcity or the NBC. Therefore, metric usage should always be very well defined and its interpretation has to be done adequately.

Table 1: Food group aggregation for the correlation analysis (n=445)

Food group aggregation
Vegetables
Fruits
Meat
Grains
Pulses
Dairy
Oils and fats
Fish and seafood
Nuts and seeds
Sugars and sugar products
Eggs
Miscellaneous

Table 2: Number (n) of significant correlations between the different indices when analyzed by food groups

	NRF9.3	HENI	NBC	NS
NRF9.3		5	6	7
HENI			1	8
NBC				4
NS				

*Note: The metrics represented in the table are: **HENI:** Health Nutritional Index; **NBC:** Nutrient Balance Concept; **NRF9.3:** Nutrient Rich Food Index 9.3; **NS:** NutriScore.*

Table 3: Food ranking depending on the nutritional, health or environmental indicator used

	HENI	NBC	NRF9.3	NS	Water scarcity	GhGe	Land use
Tomato	4	1	1	1	1	2	2
Salmon	2	2	3	4	5	4	4
Apple	3	4	4	2	2	1	1
Walnuts	1	6	2	5	6	1	5
Milk	5	3	6	3	3	3	3
Beef	6	5	5	6	4	5	6

Note: The ranking values decreases from 1 (green) as the one having the highest nutritional value or lowest EnvI to 6 (red), as the one having the poorest nutritional content or highest EnvI. The metrics represented in the table are: ***HENI:*** *Health Nutritional Index;* ***NBC:*** *Nutrient Balance Concept;* ***NRF9.3:*** *Nutrient Rich Food Index 9.3;* ***NS:*** *NutriScore.* ***Water Scarcity:*** *the data considered are Stress-Weighted Water Use (L/FU);* ***GhGe:*** *kg CO_2eq/FU;* ***Land use*** *(m^2/FU).*

Discussion

These results highlight the importance of choosing the adequate indicator when evaluating different food products. Effects on the results can be driven by: 1) qualifying/disqualifying nutrients considered in each indicator; 2) aspects of nutrient/health considered (quantity, quality, diversity, etc.); 3) dietary reference intake considered by different population groups (pregnant women, etc.); and 4) capping at the recommending intake and weighting nutrients to a set energy value. In addition, the results show the importance of including all NHE dimensions when evaluating food products and dietary patterns as opposite to only considering one metric. This research shows how the selection of a specific indicator will change the ranking of food products or diets, which needs to be taken into consideration when communicating the results to consumers. In addition, these indicators can be used as a functional unit (FU) or impact category to be included in the Life Cycle Assessment (LCA) of food products, meals or diets. However, in this case, the selection of the indicator should be dependent on the goal of the LCA study and the interpretation of the results should be done with caution as results using different FU might have different outputs. Also, this study focused on the evaluation of indicators for single food products, but other indicators might be needed when evaluating whole dietary patterns. In such cases, a nutrient content approach might not be sufficient when considering whole diets, where food matrix interactions are more relevant, and group D nutritional indices might be more adequate. In addition, when analyzing diets, aspects of diet adequacy against recommendations or food/nutrient diversity should also be discussed, thus, metrics pertaining to group B and C ought to be considered.

Conclusion:

Nutritional and health indices appear to be a useful tool when evaluating NHE dimensions of foods and diets. However, the results of this study showed that it is necessary to choose metrics carefully depending on the goal of the study, as well as when interpreting the results and its integration into LCA. While the food industry and policy stakeholders are aiming at developing a nutritional and health score which is easy to communicate to the consumer, it is important to ask for caution and not to oversimplify (especially when ranking health aspects of food products or dietary patterns) due to the complexity of the metrics.

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