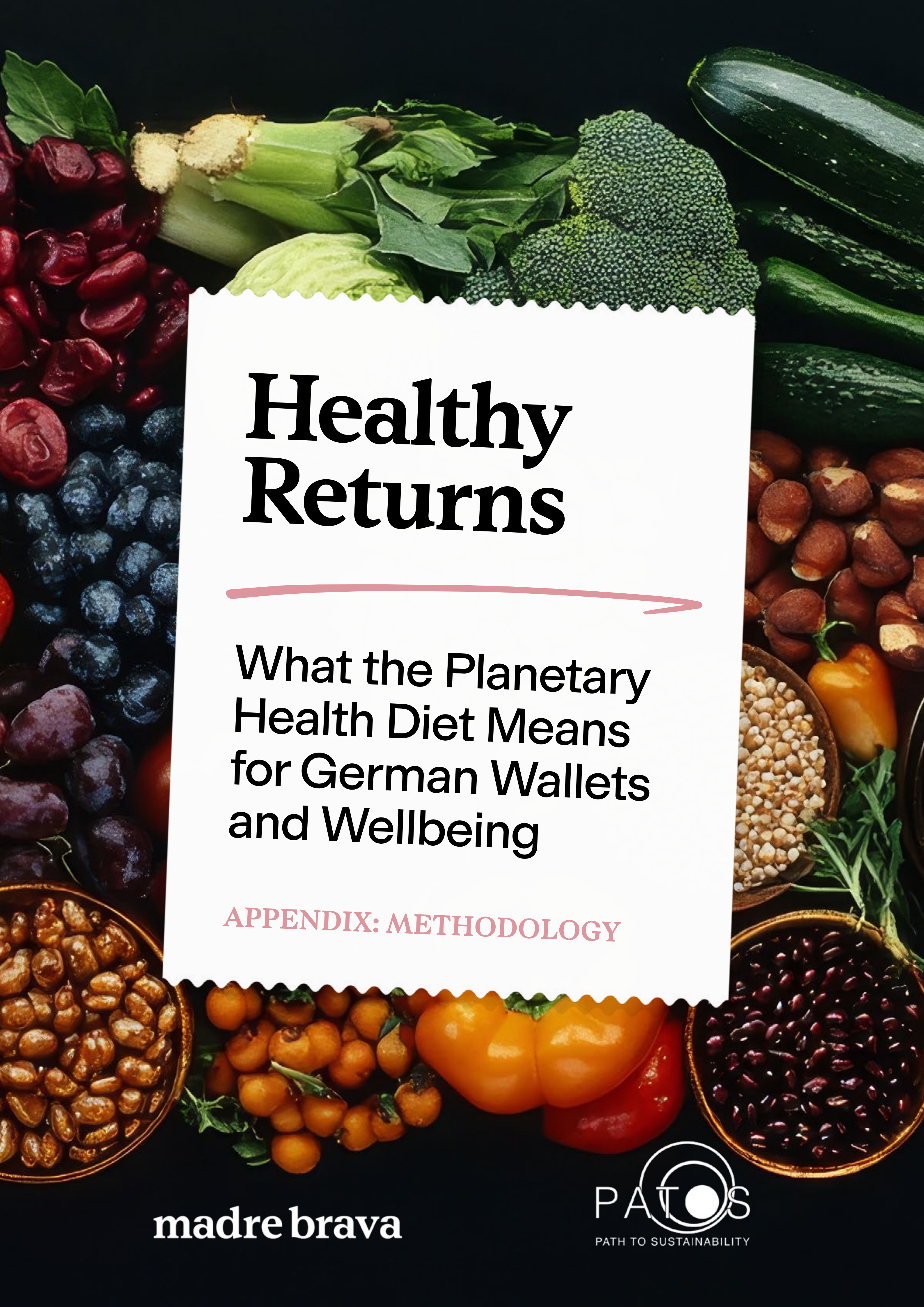

Healthy Returns

What the Planetary Health Diet Means for German Wallets and Wellbeing

APPENDIX: METHODOLOGY

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PATOS
PATH TO SUSTAINABILITY

Appendix: Methodology

1. Methodology: Shopping Basket Definition

To analyze the costs and health impacts of different dietary patterns, a standardized shopping basket was developed to represent two dietary scenarios: the current average diet in Germany (the "current basket" or "baseline") and a transition basket designed to support a gradual shift toward the Planetary Health Diet (the "PHD-oriented basket" or "PHD transition").

a. Underlying Principles and Objectives

The aim of the shopping basket definition is to reflect realistic, practical, and comparable dietary patterns. In addition to the current consumption pattern ("baseline"), a transition scenario ("PHD transition") was developed that incorporates the Planetary Health Diet as an evidence-based model for a healthy and sustainable diet while also addressing common barriers to dietary change. Among other features, this scenario allows for increased consumption of plant-based meat alternatives and plant-based dairy alternatives while gradually reducing the consumption of animal-based products. In doing so, it represents a practical and achievable transition pathway for consumers.

All shopping baskets are initially standardized for one person over a one-week period. For the subsequent analysis, they are then scaled to daily, monthly, and annual values, as well as to represent the average two-person household in Germany.

b. Data Sources for the Diets

The underlying consumption quantities for the Planetary Health Diet and current consumption are based on the Planetary Health Diet dataset (EAT-Lancet Commission 2025) and its further processing in the dataset by Springmann et al. (2025).

The baseline diet represents average actual consumption in Germany (according to Springmann et al. 2026), aggregated along the defined food groups. The Planetary Health Diet follows scientifically defined target values for a health-promoting and sustainable diet.

c. Food Selection and Basket Structure

To operationalize the diets, a basket of 93 representative food items was defined. These cover all relevant food groups and reflect typical shopping habits.

Product selection was based on:

- → The aim of including only common and widely available products.
- → Assessments from food retailers.

All selected food items are available nationwide through German food retailers and are predominantly available as private-label products. This ensures that the shopping basket is realistic to purchase and accessible to a broad cross-section of the population.

The composition of the basket remains constant across both scenarios to ensure direct comparability of costs.

d. Allocation and Weighting of Food Items

Each of the 93 food items is assigned to a single food group. Exceptions include certain processed products (e.g., gnocchi and tortellini), which are allocated proportionally across multiple food groups according to their primary ingredients.

The complete list of food items includes:

Food Group	FG #	Product
Protein sources	FG1	Mixed ground meat
Protein sources	FG1	Chicken breast
Protein sources	FG1	Cooked ham
Protein sources	FG1	Salami
Protein sources	FG1	Fish sticks
Protein sources	FG1	Tuna in oil
Protein sources	FG1	Salmon fillet (frozen)
Protein sources	FG1	Pork schnitzel
Protein sources	FG1	Sausages (pork)
Protein sources	FG1	Turkey strips
Protein sources	FG1	Ground beef
Protein sources	FG1	Beef steak
Protein sources	FG1	Eggs
Protein sources	FG1	Chickpeas
Protein sources	FG1	Red lentils
Protein sources	FG1	Hummus
Protein sources	FG1	Kidney beans
Protein sources	FG1	Peanuts
Protein sources	FG1	Hazelnuts
Protein sources	FG1	Sunflower seeds
Protein sources	FG1	Almonds
Protein sources	FG1	Plain tofu
Protein sources	FG1	Smoked tofu
Protein sources	FG1	Plant-based chicken chunks

Protein sources	FG1	Plant-based ground meat
Protein sources	FG1	Plant-based cold cuts
Dairy and dairy alternatives	FG2	Whole milk
Dairy and dairy alternatives	FG2	Plain yogurt
Dairy and dairy alternatives	FG2	Sliced cheese
Dairy and dairy alternatives	FG2	Cream
Dairy and dairy alternatives	FG2	Oat drink
Dairy and dairy alternatives	FG2	Soy drink
Dairy and dairy alternatives	FG2	Almond drink
Dairy and dairy alternatives	FG2	Soy yogurt
Dairy and dairy alternatives	FG2	Plant-based grated cheese alternative
Dairy and dairy alternatives	FG2	Plant-based cooking cream
Dairy and dairy alternatives	FG2	Tortellini
Fats and oils	FG3	Olive oil
Fats and oils	FG3	Butter
Fats and oils	FG3	Sunflower oil
Fats and oils	FG3	Margarine
Fats and oils	FG3	Lard
Fats and oils	FG3	Canola oil
Fruits and vegetables	FG4	Bell pepper
Fruits and vegetables	FG4	Green beans (canned)
Fruits and vegetables	FG4	Tomatoes (chopped)
Fruits and vegetables	FG4	Tomato paste
Fruits and vegetables	FG4	Baby corn
Fruits and vegetables	FG4	Apples
Fruits and vegetables	FG4	Bananas

Fruits and vegetables	FG4	Oranges
Fruits and vegetables	FG4	Broccoli
Fruits and vegetables	FG4	Onions
Fruits and vegetables	FG4	Garlic
Fruits and vegetables	FG4	Cucumbers
Fruits and vegetables	FG4	Fresh tomatoes
Fruits and vegetables	FG4	Frozen vegetable mix
Fruits and vegetables	FG4	Spinach (frozen)
Fruits and vegetables	FG4	Berry mix (frozen)
Fruits and vegetables	FG4	Beets
Fruits and vegetables	FG4	Carrots
Fruits and vegetables	FG4	Lemons
Fruits and vegetables	FG4	Avocado
Fruits and vegetables	FG4	Salad (fresh counter)
Grains/cereals	FG5	Bread rolls
Grains/cereals	FG5	Unsweetened corn flakes
Grains/cereals	FG5	Spaghetti
Grains/cereals	FG5	Whole-grain toast bread
Grains/cereals	FG5	Rice
Grains/cereals	FG5	Wheat flour
Grains/cereals	FG5	Whole-wheat flour
Grains/cereals	FG5	Rolled oats
Grains/cereals	FG5	Dark/gray/brown bread
Grains/cereals	FG5	Couscous
Grains/cereals	FG5	Bulgur
Grains/cereals	FG5	Quinoa

Grains/cereals	FG5	Wraps/tortillas
Grains/cereals	FG5	Whole-grain wraps
Grains/cereals	FG5	Whole-grain pasta
Grains/cereals	FG5	Gnocchi
Grains/cereals	FG5	Tortellini
Tubers and other starchy foods	FG6	Potatoes
Tubers and other starchy foods	FG6	Sweet potatoes
Tubers and other starchy foods	FG6	Gnocchi
Snacks high in added fats, salt, and sugar	FG7	Sugar
Snacks high in added fats, salt, and sugar	FG7	Fruit gummies
Snacks high in added fats, salt, and sugar	FG7	Alpine milk chocolate
Snacks high in added fats, salt, and sugar	FG7	Hazelnut-chocolate spread
Snacks high in added fats, salt, and sugar	FG7	Honey
Snacks high in added fats, salt, and sugar	FG7	Jam
Snacks high in added fats, salt, and sugar	FG7	Chocolate bar
Snacks high in added fats, salt, and sugar	FG7	Butter cookies
Snacks high in added fats, salt, and sugar	FG7	Brown sugar
Snacks high in added fats, salt, and sugar	FG7	Cocoa (powder)
Snacks high in added fats, salt, and sugar	FG7	Potato chips

Within each food group, products are weighted based on their actual consumption in Germany. Data from various national sources (including Destatis, landwirtschaft.de, and fischinfo.de) were used for this purpose.

The weighting thus reflects real consumption patterns: frequently consumed products carry a correspondingly higher weight in the basket than rarely consumed products. This ensures a close correspondence with actual dietary reality in Germany.

The quantities of the individual food items in the shopping basket are derived from the food group-specific consumption amounts for each dietary scenario. These amounts are broken down to the selected products and allocated according to their weighting within each food group.

e. Definition of the Transition Scenario ("PHD Transition")

The transition scenario ("PHD transition") was developed specifically to represent a realistic and socially acceptable dietary transformation. Its purpose is to depict a diet that already incorporates core principles of the Planetary Health Diet while giving greater weight to existing consumption habits.

Specifically, the scenario is characterized by the following adjustments: reduced—but still present—amounts of animal-based products compared with the PHD, while integrating plant-based alternative products (e.g., meat and dairy alternatives) to facilitate the transition toward higher legume consumption. Specifically, the increased legume intake is "subsidized" by plant-based meat alternatives in an amount equal to half of the previously consumed quantity of processed meat. Plant-based dairy alternatives replace 55% of the dairy products specified in the PHD. In each case, the corresponding dairy product is replaced with 55% plant-based alternatives (e.g., plain yogurt with soy yogurt, cream with plant-based cooking cream, etc.).

In the health impact assessment, meat and dairy alternatives are assigned the same health effects as processed meat and dairy products. These are conservative estimates, particularly for meat alternatives, as the health effects of plant-based meat alternatives are likely to be lower than those of processed meat.

The PHD-oriented shopping basket therefore serves as a practical intermediate step between current consumption patterns and a fully sustainable dietary pattern.

2. Methodology: Price Data Analysis

a. Price Data Sources and Coverage of Food Retail

To provide a realistic representation of food prices in Germany, price data were collected across the major segments of the German food retail market. The data collection included both discount retailers (Aldi Nord, Aldi Süd, and Lidl) and full-assortment retailers (Rewe and Edeka), thereby capturing the primary grocery shopping options available to consumers in Germany.

This broad retailer selection ensures that both lower-priced and higher-priced shopping environments are represented and that the results reflect actual market conditions.

b. Regional Coverage

Price data were collected in three German federal states: Bavaria, North Rhine-Westphalia, and Saxony-Anhalt. This selection allows for a differentiated assessment of regional price levels across Germany.

At the same time, both urban and rural areas were deliberately included (including Augsburg and Cologne as urban areas, and Salzwedel and Münster as less densely populated regions). This ensures that the findings are broadly applicable across different living situations.

c. Data Collection Methodology and Time Period

Prices were collected manually in physical retail stores to ensure the highest possible data quality and comparability. For Aldi Süd and REWE, some price data were obtained from their location-specific online stores.

Price data were collected in three collection rounds: January 2026, February 2026, and March 2026, each during the second week of the month. This repeated data collection allows short-term price fluctuations to be smoothed and more robust average prices to be calculated.

d. Price Definition and Standardization

Standardized unit prices (€/kg or €/l) were used consistently for all products. This makes products with different package sizes and formats directly comparable and avoids distortions resulting from differences in package size.

The selection of specific products in the market follows a clear hierarchy:

1. The retailer's private-label products were selected whenever available.
2. If no private-label product was available, the least expensive comparable alternative was selected.
3. Where multiple varieties of a product were available, either a representative standard product (e.g., vine tomatoes where several tomato varieties were available) or, where appropriate, the least expensive variety was selected.

This approach ensures that the prices are both realistic and representative of typical consumer purchasing decisions.

e. Data Processing and Handling of Missing Values

Prices were collected for each of the 93 predefined food items across the participating retailers. If a product was unavailable at a particular store, it was recorded as a missing value (NA) and excluded from the corresponding average price calculation.

To ensure data quality, additional plausibility checks were conducted, including:

- → Comparison of mean and median.
- → Identification and review of potential outliers.

f. Calculation of Shopping Basket Costs

Shopping basket costs are calculated at the product level by multiplying the collected prices by the corresponding consumption quantities specified in each shopping basket. Total basket costs are then calculated as the sum of the costs of all individual products.

Two main pricing scenarios are used for the analysis:

Average Shopping Basket

The average shopping basket cost is based on the average prices of all surveyed products across:

- → All retailers.
- → All regions.
- → All data collection dates.

This scenario represents the typical price level faced by consumers in Germany.

Lowest-Cost Shopping Basket

In addition, a cost-optimized basket is calculated per region. For this, the lowest observed price for each product is used across:

- → All retailers.
- → All data collection dates.

This scenario illustrates the costs that are theoretically achievable through highly price-conscious shopping on average over the course of a year (as it incorporates prices from multiple data collection periods).

g. Analytical Robustness

By combining broad retailer coverage, regional differentiation, repeated price collection, and the calculation of average prices, the analysis provides a robust assessment of the actual costs of different dietary patterns in the German food retail sector.

Across all regions, retail formats, and pricing scenarios considered, the results consistently show that a diet aligned with the Planetary Health Diet can be implemented at low cost and offers financial savings compared with current consumption patterns.

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3. Methodology: Health Impact Assessment — Springmann et al. (Avoided Deaths)

a. Overall Approach

To assess the health impacts of different dietary patterns, the analysis estimates the number of avoidable deaths resulting from dietary changes ("avoided deaths") and the associated economic effects on the healthcare system.

The central question is to what extent a healthier and more sustainable diet not only reduces individual health risks but also lowers costs to society as a whole. The analysis considers only health effects associated with mortality. Non-fatal disease outcomes are not monetized.

The diseases and risk factors considered by Springmann et al. (2021) are shown below:

<table>
<tr><th>Disease</th><th>Risk factors</th></tr>
<tr><td rowspan="2">Cardiovascular disease and heart disease</td><td>Whole grains</td></tr>
<tr><td>Vegetables</td></tr>
<tr><td rowspan="2">Stroke</td><td>Fruit</td></tr>
<tr><td>Legumes</td></tr>
<tr><td rowspan="2">Cancer</td><td>Nuts and seeds</td></tr>
<tr><td>Red meat</td></tr>
<tr><td rowspan="2">Type 2 diabetes</td><td>Processed meat</td></tr>
<tr><td>Underweight</td></tr>
<tr><td rowspan="2">Respiratory diseases (tracked but not monetized)</td><td>Overweight</td></tr>
<tr><td>Obesity</td></tr>
</table>

b. Data Sources

The health impact assessment is based on the modeling by Springmann et al. (2021) and the underlying data from the EAT-Lancet Commission (2025).

These studies quantify the health effects of different dietary patterns, particularly with respect to diet-related risk factors and their impact on diet-related diseases (e.g., cardiovascular disease, stroke, and certain types of cancer).

The estimated effects reported in these studies are adopted directly in this analysis and are not independently modeled. However, we adjust the PHD consumption pattern to reflect the modeled PHD transition pathway. Specifically, processed meat consumption is not reduced to zero, as in Springmann's assessment of the PHD, but is instead set equal to the consumption of plant-based meat alternatives (28.8 grams per person per day), because, as described above, plant-based meat alternatives are assumed to have the same health effects as processed meat. Legume consumption is adjusted accordingly (see description above). The resulting health effects, or mortality reductions, are then scaled proportionally based on these consumption levels. The remaining consumption data for both the current diet and the PHD are taken from Springmann's underlying dataset (Springmann et al., 2025).

c. Geographic Scope

The underlying estimates of avoided deaths are specific to Germany.

For the economic assessment of health effects, we use the cost calculation by Springmann et al. (2021) for Germany-specific diet-related healthcare costs. These are not published in disaggregated form for:

→ Direct and indirect costs.
→ Disease categories.
→ Risk factors / food groups.

As a result, Germany-specific cost estimates can only be reported at the aggregate level (per capita or for Germany as a whole), but not for specific diseases or food groups.

d. Valuation Approach and Monetization

The economic valuation of health effects fully follows the approach of Springmann et al. (2025).

In this approach, diet-related risk factors are linked to specific disease categories ("causes") using established epidemiological relationships. The resulting changes in mortality are quantified as avoided deaths.

These avoided deaths are then monetized by accounting for both direct healthcare costs (e.g., treatment, care, and medication) and indirect costs (e.g., productivity losses resulting from premature mortality).

Adopting this established model ensures a consistent and scientifically sound assessment of the health and economic effects.

e. Scope of Methodological Decisions

As part of the analysis, we deliberately do not attempt to independently allocate healthcare costs to individual diseases, food items, or risk factors.

This decision is intended to ensure methodological consistency and to avoid introducing additional assumptions that could reduce the robustness of the results. Instead, the aggregated effects of the respective dietary patterns are adopted directly from the published literature.

The assessment is thus based entirely on an established and internationally recognized modeling approach.

For this reason, we use the health cost assessment methodology described in Section 4, based on Seidel et al. (2023, 2026) (see below), to estimate individual healthcare costs and to differentiate costs across different food groups.

f. Presentation of Results

The health and economic effects are presented at both the individual and societal levels.

The results are reported as costs per person per day and scaled up to annual values. In addition, the results are aggregated at the population level to illustrate the potential cost savings for society as a whole.

g. Analytical Robustness

The combination of epidemiological modeling and economic valuation enables an integrated assessment of the effects of diet on health and costs.

The results show that a diet aligned with the Planetary Health Diet not only brings health benefits and reduces avoidable deaths, but can also lead to a noticeable easing of the burden on the healthcare system.

As a result, in addition to individual health gains, there is potential for savings at the societal level that could, over time, contribute positively to the stability of healthcare systems and the trajectory of healthcare expenditures.

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4. Methodology: Health Impact Assessment — Seidel et al. (DALY)

a. Overall Approach

In addition to the assessment using the Springmann et al. (2025) model, this study draws on a second approach to represent the health and economic consequences of dietary change as robustly as possible.

To this end, we use the cost-of-illness model developed by Seidel et al. (2026), based on the Global Burden of Disease (GBD) Study by the Institute for Health Metrics and Evaluation (IHME).

While Springmann et al. quantify health effects primarily through avoided deaths, Seidel et al. extend this perspective with two key additions: first, the full disease burden (mortality and morbidity) is captured through DALYs (“Disability-Adjusted Life Years”), i.e., healthy life years lost. Second, 15 diet-related risk factors are modeled instead of seven, allowing for a much more detailed representation of the underlying pathways through which diet affects health.

The calculation serves two purposes:

- → It provides an alternative estimate of societal health costs and thus serves as a methodological robustness check of the study’s central findings.
- → It enables the results to be expressed in terms of healthy life years lost or gained, providing a particularly consumer-friendly metric for communicating the health impacts of dietary change.

The diseases and risk factors considered are listed below:

Disease	Risk factor
Cardiovascular Diseases (includes stroke)	Processed meat
	Red meat
	Sodium
	Sugar-sweetened beverages
	Trans fats
Cancer	Calcium
	Fiber
	Fruit
	Legumes
	Milk
Type 2 diabetes	Nuts and seeds
	Omega-6 PUFA
	Seafood omega-3
	Vegetables
	Whole grains

The classification of risk factors and diseases differs from the Springmann methodology. This reflects methodological decisions made by the authors.

b. Data Sources

The calculation combines the following data sources:

- → Seidel et al. (2026), Supplementary Materials S2: Provides the cost-of-illness values for Germany in 2024 (cardiovascular disease, diabetes, and neoplasms) as well as the diet-related DALY shares (q-values) for each risk factor and disease, derived from the IHME GBD 2021 study.
- → IHME GBD 2023 (vizhub.healthdata.org/gbd-results): Provides the absolute DALY values for Germany by disease group, which serve as the reference basis for the DALY calculations.
- → Consumption data: The consumption quantities described in the “Methodology: Shopping Basket Definition” section for both the baseline and the PHD transition scenario.
- → The TMREL values (“Theoretical Minimum Risk Exposure Level,” the optimal consumption value per risk factor) were taken from the GBD 2019 Risk Factor Collaboration, supplemented by Lescinsky et al. 2022 (red meat) and the underlying Aune et al. (2017) meta-analyses. These are not reported in Seidel et al. itself, since Seidel’s methodology does not require them for the cost calculation. However, we need this data basis for rescaling to the PHD transition scenario.

c. Geographic Scope

All calculations are specific to Germany. The cost-of-illness values reported in Seidel et al., S2 (row: Germany) are adopted directly and correspond to 2024 USD values. The 2024 ECB reference rate (1 EUR = 1.082 USD) is used to convert to euros. The population base is 84,552,242 (Destatis, 2024).

d. Assessment Approach: Cost-of-Illness × DALY Share

The model follows the core formula developed by Seidel:

$$HC\_diet_{r,d} = COI\_d \times q\_x_{r,d}$$

Where HC_diet denotes the diet-related healthcare costs per risk factor (r) and disease (d), COI_d the total cost of illness for the respective disease (direct treatment costs plus indirect productivity losses), and q_x the share of DALYs for disease d that is diet-related and caused by risk factor r (population attributable fraction from IHME GBD).

Three diet-associated disease groups are considered: cardiovascular disease (CVD), diabetes mellitus (DM), and neoplasms (cancer). Across all 15 GBD risk factors, this results in a diet-related cost burden for Germany under the status quo (BMK) of **USD 84.81 billion annually**.

e. Scaling to the PHD Transition Scenario

The key methodological extension beyond Seidel's approach is the application of the cost calculations to the PHD transition scenario. Because the full GBD dose-response functions are not publicly available, a transparent linear TMREL-based scaling approach is used:

$$Scaling = (Consumption\_PHD - TMREL) / (Consumption\_BMK - TMREL)$$

For risk factors characterized by overconsumption (e.g., processed meat), a scaling factor of 0 indicates that consumption under the PHD scenario reaches the optimal level (TMREL), meaning that the attributable healthcare costs are fully avoided. A scaling factor of 1 indicates that the risk contribution remains unchanged. The same principle applies analogously to risk factors characterized by underconsumption (e.g., whole grains and legumes). Scaling factors are constrained to the interval [0, 10] to avoid extreme values when consumption levels are very close to the TMREL.

This approach is conservative: on average, it is more likely to underestimate the effects because it replaces the typically convex GBD risk curves with a linear approximation. A sensitivity analysis using the full relative risk (RR) functions would be possible but would likely adjust the results upward.

f. DALY Calculation

While the cost calculations only require the DALY shares (q), translating this into absolute healthy life years saved requires multiplying by the absolute DALY totals per disease:

$$DALY\_diet_{r,d} = DALY\_totald \times q\_x_{r,d}$$

The DALY totals for Germany were retrieved from the currently available GBD 2023 data basis (vizhub.healthdata.org):

- → 5,703,830 DALYs/year for CVD.
- → 853,508 for diabetes mellitus.
- → 5,709,228 for neoplasms.

The proportional reduction (78–80%) is independent of the choice of DALY totals and follows directly from the model's scaling factors; the absolute figures scale linearly with the GBD update.

g. Converting DALYs to Healthy Life Days per Person

By definition, one Disability-Adjusted Life Year (DALY) represents one healthy year of life lost due to disease or premature mortality. The total number of DALYs avoided each year can therefore be converted into an intuitive per capita measure by dividing by the population and multiplying by 365 days:

Healthy life days / capita / year = (ΔDALY ÷ population) × 365

This translation should be understood as an even distribution of the avoidable disease burden across the total population. It does not reflect the individual effect of a dietary change, but rather the aggregated health benefit to society, as actual individual effects may, of course, be significantly higher or lower depending on factors such as pre-existing conditions, age, and socioeconomic status.

This conversion should be distinguished from the international WHO/IHME metric "Healthy Life Expectancy" (HALE), which estimates the remaining healthy life years from birth. By contrast, the calculation presented here quantifies the per-capita share of the aggregated DALY gain attributable to dietary change and is intended to aid understanding of the DALY concept.

h. Handling of Data Gaps

Four of the 15 GBD risk factors do not correspond to a direct WWF food category (salt, trans fats, calcium, fiber). For these risk factors, transparent hybrid assumptions were applied: salt according to the WHO recommendation of 9 g/day (status quo, RKI) was reduced to 5 g/day (PHD); trans fats remain unchanged (BMK = PHD = 0.66% E) (also based on current consumption levels in Germany and WHO recommendations, equated with the PHD); calcium and fiber intake were modelled using the GBD-standard differential intake approach.

It is also assumed that processed plant-based protein sources carry a similar (equal) health burden to processed meat. This is a conservative assumption (see above). Plant-based alternative proteins play a role in our PHD transition diet, which is why it is important to model them here.

An additional risk factor (omega-6 PUFA) was excluded from the calculation due to the lack of a clear food assignment, which makes the results slightly more conservative.

i. Comparison of the Springmann and Seidel Models

Both models examine the same subject matter from complementary perspectives:

Aspect	Springmann et al.	Seidel et al. 2026
Target metric	Avoided deaths, monetized	Cost-of-illness × DALY share
Risk factors	7 + BMI pathway	15 (without BMI pathway)
Diseases	CVD, stroke, cancer, T2DM	CVD (overall), DM, neoplasms
Cost concept	Direct + indirect COI (due to productivity losses from mortality)	Direct + indirect COI (due to productivity losses during illness)
DALY output	No	Yes, directly derivable

The Seidel analysis complements the Springmann analysis by providing (a) a second, methodologically independent estimate of the same order of magnitude, serving as a robustness check; (b) a more detailed breakdown of dietary risk factors, enabling the identification of the most influential dietary levers; and (c) a DALY-based translation into "healthy life days gained", making the results easier for consumers to interpret.

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