A systematic evaluation of seven different scores representing the EAT–*Lancet* reference diet and mortality, stroke, and greenhouse gas emissions in three cohorts

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Different approaches have been used for translation of the EAT–*Lancet* reference diet into dietary scores that can be used to assess health and environmental impact. Our aim was to compare the different EAT–*Lancet* diet scores, and to estimate their associations with all-cause mortality, stroke incidence, and greenhouse gas emissions. We did a systematic review (PROSPERO, CRD42021286597) to identify different scores representing adherence to the EAT–*Lancet* reference diet. We then qualitatively compared the diet adherence scores, including their ability to group individuals according the EAT–*Lancet* reference diet recommendations, and quantitatively assessed the associations of the diet scores with health and environmental outcome data in three diverse cohorts: the Danish Diet, Cancer and Health Cohort (DCH; n=52 452), the Swedish Malmö Diet and Cancer Cohort (MDC; n=20 973), and the Mexican Teachers' Cohort (MTC; n=30 151). The DCH and MTC used food frequency questionnaires and the MDC used a modified diet history method to assess dietary intake, which we used to compute EAT–*Lancet* diet scores and evaluate the associations of scores with hazard of all-cause mortality and stroke. In the MDC, dietary greenhouse gas emission values were summarised for every participant, which we used to predict greenhouse gas emissions associated with varying diet adherence scores on each scoring system. In our review, seven diet scores were identified (Knuppel et al, 2019; Trijsburg et al, 2020; Cacau et al, 2021; Hanley-Cook et al, 2021; Kesse-Guyot et al, 2021; Stubbendorff et al, 2022; and Colizzi et al, 2023). Two of the seven scores (Stubbendorff and Colizzi) were among the most consistent in grouping participants according to the EAT–*Lancet* reference diet recommendations across cohorts, and higher scores (greater diet adherence) were associated with decreased risk of mortality (in the DCH and MDC), decreased risk of incident stroke (in the DCH and MDC for the Stubbendorff score; and in the DCH for the Colizzi score), and decreased predicted greenhouse gas emissions in the MDC. We conclude that the seven different scores representing the EAT–*Lancet* reference diet had differences in construction, interpretation, and relation to disease and climate-related outcomes. Two scores generally performed well in our evaluation. Future studies should carefully consider which diet score to use and preferably use multiple scores to assess the robustness of estimations, given that public health and environmental policy rely on these estimates.

Introduction

Both human and planetary health are suffering from our current diets.[1] The EAT–*Lancet* Commission on food, the planet, and health proposed a global reference diet, mainly including plant-based foods, some fish, and limited dairy and meat, which at a global level was estimated to keep the environmental impact within planetary boundaries while still providing adequate amounts of nutrients in accordance with established reference values.[1] Since its publication, several cohort studies have investigated the association between diet scores representing the EAT–*Lancet* reference diet and the risk of various health and environmental outcomes.[2–4] In a large European cohort, Laine and colleagues estimated that shifting from the lowest level of adherence (no adherence) to the highest level of adherence (perfect adherence) to the EAT–*Lancet* diet could prevent 54–63% of premature deaths and lower greenhouse gas emissions by up to 50%.[5] Findings such as these are essential in guiding national policies. However, these findings are highly dependent on the translation of the EAT–*Lancet* reference diet into a diet score that can be used to characterise different levels of adherence. Therefore, it is important that such a score reflects the intended global reference diet.

Although the EAT–*Lancet* report stated specific intake targets for food groups, the translation of this global reference diet into a dietary score has differed between studies. Indeed, there is currently no consensus on how to quantify adherence to the EAT–*Lancet* reference diet. First, Knuppel and colleagues[6] quantified dietary patterns and found that increased adherence to the EAT–*Lancet* diet was associated with a reduced incidence of ischaemic heart disease, type 2 diabetes, and all-cause mortality, but not stroke. Since then, several other studies have constructed diet scores via different approaches, to investigate disease outcomes and environmental indicators.[2,6–12] For example, methods have differed in how some food groups are classified (ie, encouraged or discouraged), the scoring criteria (ie, meeting the recommendation or not, or a proportional scoring system), and the cutoff points used. Thus, estimates from these scores have been inconsistent, particularly for the risk of all types of stroke.[2,6]

Our aim was to compare the different diet scores representing the EAT–*Lancet* reference diet both qualitatively (ie, by how they are constructed) and quantitatively (ie, by comparing intakes of people with different levels of adherence), and to estimate their association with all-cause mortality, stroke incidence, and greenhouse gas emissions.

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Methods

Systematic review

We systematically searched for publications investigating a diet score representing adherence to the EAT–*Lancet* reference diet and impact on various health outcomes. The systematic search was registered on PROSPERO (CRD42021286597) and reported according to the PRISMA guidelines.[13] This project was nested in the registered systematic search, after which we extracted unique diet scores for assessment. Details of the review are provided in appendix 1 (p 29). In brief, we searched PubMed, Embase, Scopus, and Web of Science between Jan 1, 2019, and March 1, 2022, for prospective cohort studies that investigated adherence to the EAT–*Lancet* reference diet and risk of any outcomes. In addition, preprint servers were searched and experts in the field were contacted.

See Online for appendix 1

Qualitative assessment

From the identified papers we extracted the name of the score, the number and types of dietary components, the individual components included, the type of scoring system (binary, ordinal, or proportional), a score descriotion, and possible score range. Based on this information, we formulated an interpretation of each score. All identified scores in the current paper are referred to by the name of the first author and cited in table 1.

Each identified EAT–*Lancet* diet score was compared to the EAT–*Lancet* reference diet outlined by Willett and colleagues.[1] We used the following features from Burggraf et al[14] to create a diet index construction score: index dimensions, index components, component types (nutrients *vs* food groups), scaling procedure, cutoff values, and valuation function. We adapted recommendations for each relevant feature to align with the EAT–*Lancet* reference diet. The variety component within the EAT–*Lancet* diet's vegetable components was not included as this is often not well separated in food frequency questionnaires (FFQs), and total vegetable intake is likely to correlate with variety.[15] Individual food items that were rarely reported in FFQs of our investigated populations (described herein), such as lard, tallow, and palm oil, could not be quantified and were not included in the construction score; instead, we used the nutrients of saturated fat and unsaturated fat as proxies. Each feature was scored 1 point for following the recommended approach[14] and 0 points for not. We summed the points to a total, reflecting the quality of the index construction, whereby a higher score reflected better diet index construction. The scoring was done independently by two authors (DBI and DS) and conflicts were resolved by discussion.

We also grouped a set of 15 components in the EAT–*Lancet* diet (wholegrains, tubers, vegetables, fruits, dairy, red meat [beef, lamb, and pork], poultry, eggs, fish, legumes [dry beans, lentils, and peas], soy foods, nuts [peanuts and tree nuts], unsaturated fat, saturated fat, and added sugar) according to how they were categorised in each diet score (as a food to promote, balance, or limit) and compared these categorisations to the description in the EAT–*Lancet* reference report by Willett and colleagues.[1]

Quantitative assessment

The STROBE-nut guidelines were used for reporting the results from quantitative assessments.[16] We used the Danish Diet, Cancer and Health Cohort (DCH),[17] the Swedish Malmö Diet and Cancer Cohort (MDC),[18,19] and the Mexican Teachers' Cohort (MTC)[20] to quantify the ability of the different scoring approaches to construct a diet score reflecting adherence to the EAT–*Lancet* reference diet (ie, consistency), and to assess how different scores translate into health and environmental outcomes.

DCH is a prospective cohort study established between December, 1993, and May, 1997, with an enrolment of 57 053 participants from the general population without cancer aged 50–64 years residing in the greater Copenhagen and Aarhus areas, Denmark.[17] MDC is a prospective cohort study established from Jan 1, 1991, to Sept 25, 1996, with an enrolment of 28 098 participants from the general population aged 44–74 years from Malmö, Sweden.[18,19] MTC is a prospective cohort study established between June 15, 2006, and Nov 15, 2010, with an enrolment of 115 313 female public-school teachers aged 25 years or older from 12 states in Mexico.[20] In all cohorts, participants completed questionnaires for the collection of information about health behaviours, socioeconomic status, and health conditions.

We excluded individuals with a prebaseline diagnosis of cancer, diabetes, or cardiovascular disease, individuals with missing information on dietary intakes or relevant covariates, and individuals who reported implausible energy intakes (for women: <500 or >3500 kcal/day; for men <800 or >4200 kcal/day).[21] In addition, to align the baseline age of the population in the cohorts, participants younger than 45 years in the MTC were excluded. Inclusions and exclusions for the current assessment are presented in appendix 1 (p 22). All studies were approved by regional ethical committees and all participants gave written informed consent to participate.

In the DCH and MTC, dietary information was collected using validated semiquantitative FFQs, with 192 items and 140 items, respectively.[20,22] More details on dietary assessment methods in each cohort are provided in appendix 1 (pp 29–31). The FFQs evaluated the mean consumption of specified units or portion sizes of foods and beverages during the previous year. FFQ responses of each item were converted to servings per day and then to grams per day with use of prespecified portion sizes and comprehensive food composition data. In the MDC, dietary information was collected with a validated, modified diet history method, including a 7-day food diary, an FFQ, and a 60-min interview. The interview was shortened to 45 min on Sept 1, 1994.[23]

	Name of score	Number of dietary components (positive, balanced, negative)*	Type of score†	Score description	Possible score range	Diet index construction score (0–6)‡	Consistency across cohorts (0–14)§
Knuppel et al (2019)[6]	EAT–*Lancet* diet score	14 (3, 1, 10)	Binary score	1 point if intake is above or below a set intake threshold, 0 if not. Intakes are based on g/day. The total score is the sum of points for each component.	0–14	0	7
Trijsburg et al (2020)[11]	World Index for Sustainability and Health	13 (4, 9, 0)	Proportional score	0 points if intake is below a lower limit for emphasised foods or above a limit for balance and de-emphasised foods. Proportional score up to or down to optimal intake. Score of 10 within optimal range for de-emphasised and balance foods or above optimal threshold for emphasised foods. Intakes are based on g/day.	0–130	4	8
Cacau et al (2021)[9]	The Planetary Heath Diet Index	16 (5, 7, 4)	Proportional score	0 points if no intake of emphasised foods or too high intake of de-emphasised foods. Proportional score up to 10 points for optimal intake and, for balance foods, proportional score between the upper and lower intake limits. Includes ratios of the types of vegetables included, with each ratio scored up to 5 points. Intakes are based on caloric density from food.	0–150	6	NA
Hanley-Cook et al (2021)[7]	EAT–*Lancet* diet score with minimum intake values	14 (0, 13, 1)	Binary score	1 point if intake is within the recommended range, 0 if not. Intakes are based on g/day. The total score is the sum of points for each component.	0–14	2	4
Kesse-Guyot et al (2021)[12]	EAT–*Lancet* diet index	14 (3, 0, 11)	Proportional score	Used a formula to derive the score: $\{100 \times [\text{sum of all components } (a_i \times \{\text{cutoff}_i - [\text{consumption}_{ij} \times 2500/\text{energy intake}_{ij}]\}/(\text{cutoff}_i)]\}/14$, where *i* refers to one of the 14 food groups, *j* is the individual, and a_i is 1 for components to limit and –1 for components to promote. Each food has a specific cutoff. Intakes are based on g/day.	No set range	2	5
Stubbendorff et al (2022)[8]	EAT–*Lancet* index	14 (7, 0, 7)	Ordinal score	Between 0 and 3 points according to level of adherence to the component. The total score is the sum of points for each component.	0–42	5	11
Colizzi et al (2023)[10]	Healthy Reference Diet	14 (5, 7, 2)	Proportional score	0 points if no intake in emphasised foods or too high intake in de-emphasised foods. Proportional score up to 10 points up to optimal intake range. 10 points is within optimal range. For foods to balance, score proportional to upper and lower intake limits. Intakes are based on g/day.	0–140	4	7

Scores are ordered by year of publication, then alphabetically by first author name. NA=not available. *A positive component is a component that is emphasised in the diet and is provided a higher score for greater intakes. A balance component is a component for which the highest score is provided in some range of intake, where greater or lower intakes gives a lower score. A negative component is a component that is de-emphasised in the diet and is provided a lower score for greater intakes. †A binary score is defined as a score for which points for each component are given for either adhering to specific criteria or not. An ordinal score is one for which points for each component are given according to different levels of adherence. A proportional score is a score that is given proportional to some target intake for each component. ‡The diet index construction score was based on an adapted version of the guidelines proposed by Burggraf and colleagues[14] to align with the EAT–*Lancet* diet (appendix 1 p 11). Six features were included in the scoring: index dimensions, index components, component types, scaling procedure, cutoff values, and valuation function. Each feature was scored 1 point for following the recommended approach[14] and 0 points for not. The diet index score was the sum of points for each feature. §Each point represents when intake for one of 14 components in the EAT–*Lancet* diet (wholegrains, tubers, vegetables, fruits, dairy, red meat [beef, lamb, and pork], poultry, egg, fish, legumes [dry beans, lentils, and peas], soy foods, nuts [peanuts and tree nuts], unsaturated fat, saturated fat, and added sugar; with merging of the soy and legume components because of low intake in the cohorts) divides individuals with high and low adherence according to what is expected on the basis of the EAT–*Lancet* reference diet, and that this is consistent across the investigated cohorts (Danish Diet, Cancer and Health Cohort, Malmö Diet and Cancer Cohort, and Mexican Teachers' Cohort). The Cacau score was not included because it was only used in one of the three cohorts. The score is the sum of points for the 14 components (appendix 1 p 14).

Table 1: **Overview of EAT–*Lancet* diet scores identified from the systematic search**

For each cohort, we calculated adherence to the EAT–*Lancet* reference diet using the different diet scores. If data were insufficient for specific dietary components in one of the cohorts, we harmonised the scores, so that they were comparable across cohorts. For the Stubbendorff score, the DCH data were not sufficient to separate red meat into beef and lamb or pork, and thus these were aggregated into total red meat

(including processed red meat) across cohorts. Because of the varying assessments of food sources of fat, in all cohorts we calculated total saturated and unsaturated fat instead of food sources and used the same cutoff points as for food sources as described in each adherence score construction. Data on energy contribution from individual foods were not available for the MDC and data management constraints prevented us from estimating the energy contribution from individual foods in the MTC, thus the score by Cacau was not calculated in these cohorts. Definitions of food groups as applied in the cohort studies are provided in appendix 1 (p 2).

We evaluated whether each diet score grouped individuals according to intended intakes of the EAT–*Lancet* reference diet and whether this was consistent across the DCH, MDC, and MTC. Components of the EAT–*Lancet* diet were assessed in quartiles of adherence for each of the EAT–*Lancet* diet scores. A score for consistency across cohorts was constructed, awarding 1 point for each of the components when the intake in the highest quintile was closest to the EAT–*Lancet* diet target and the intake in the lowest quintile was furthest from the EAT–*Lancet* diet targets and this pattern was observed in all cohorts. A higher consistency score reflected better grouping of individuals according to the EAT–*Lancet* reference diet across cohorts.

Data on all-cause mortality were available in all three cohorts, and stroke incidence was available in the DCH and MDC. Only self-reported diagnosis of stroke has been reported in the MTC and thus the cohort was not included to assess associations with stroke. We included stroke incidence as an outcome as the various approaches to quantify the EAT–*Lancet* reference diet in a diet score might indicate a different impact depending on the outcome. To quantify the environmental consequences of different diet scores representing adherence to the EAT–*Lancet* reference diet, we used the MDC, which has data available on greenhouse gas emissions. Greenhouse gas emissions for foods and ingredients have not yet been included in the other cohort databases.

In the DCH, all-cause mortality was obtained through linkage to the Danish Civil Registration System.[24] In the MDC, vital status and emigration status were obtained from the Swedish Tax Agency, Statistics Sweden, and the National Board of Health and Welfare.[18] In the MTC, deaths were identified through employer databases (updated once a year), next-of-kin reports, cross-linkage with three major pension fund manager databases, and linkages with national death registry data (Mexico's Ministry of Health's mortality surveillance dataset). All deaths in the MTC were cross-linked with the death registry via a probabilistic record linkage program (Link Plus, version 2.0) designed specifically for the mortality surveillance dataset.[25,26] In the DCH and MDC, stroke cases were identified through register linkage (to the Danish National Patient Registry and Swedish Hospital Discharge Register, respectively). In addition, in the DCH, stroke cases were verified by review of medical records.[27] Further details on stroke case ascertainment are in appendix 1 (p 31).

Daily greenhouse gas emission data were estimated for participants in the MDC. Details of these estimations are to be reported in a future paper. In brief, data on greenhouse gas emissions were based on lifecycle assessment data with system boundaries from cradle to consumer, including emissions from losses and waste of edible food along the food system studied. Home cooking was excluded because most food intake was reported in raw portions. Greenhouse gas emissions for 117 food groups were based on values from Hallström et al,[28] complemented with data for some food items from the Research Institutes of Sweden food climate database 2021 and Moberg et al.[29] The data from other sources were harmonised to the same system boundaries as in Hallström et al.[28] Intake amounts were matched with climate data by adjusting for non-edible parts of the food and weight changes in cooking. Greenhouse gas emission values were added to 117 food groups and summarised for every participant in the MDC. In the current evaluation, we present the unadjusted mean amount of dietary greenhouse gas emissions for included participants.

We collected information on relevant covariates. In all cohorts, age, sex, education, and smoking status were assessed with a lifestyle questionnaire. Alcohol and total energy intake were estimated with the respective dietary assessment method in each cohort. Bodyweight and height were measured with standardised protocols in the DCH and MDC and self-reported in the MTC. Self-reported weight (Pearson's r=0·92) and height (r=0·86) were validated in a subset of 3413 participants against standardised technician measurements in the MTC.[30] BMI was calculated as weight in kg divided by height in meters squared (kg/m^2).

Baseline characteristics in each cohort were reported with use of standard statistical summary measures. We used Cox proportional hazards models to estimate the hazard ratios (HRs) with corresponding 95% CIs for the association between diet scores indicating adherence to the EAT–*Lancet* diet, and risk of all-cause mortality and stroke. Only covariates that we were able to harmonise across cohorts were included given the aim to investigate consequences of differences in diet score within and between cohorts. Thus, the measures of association estimated in this study should not be interpreted as fully adjusted models. Age was set as the underlying timescale. Follow-up was counted from study entry until censoring, which was death, incidence of stroke (when the outcome was stroke), emigration (DCH and MDC), or 10 years after entering the cohort, whichever came first. 10 years was chosen to align the observation time across cohorts. Death due to other causes also led to censoring in the analyses of incidence of stroke. The proportional hazards assumption was evaluated with use of log-log plots

For the **Research Institutes of Sweden food climate database** see https://www.ri.se/en/what-we-do/expertises/rise-food-climate-database

For **Link Plus** see https://www.cdc.gov/national-program-cancer-registries/registry-plus/link-plus.html?CDC_AAref_Val=https://www.cdc.gov/cancer/npcr/tools/registryplus/lp.htm

with no violations detected. We evaluated each diet score as a continuous variable using a 10% increment in the score. The scores were also modelled using restricted cubic splines with four knots to assess non-linearity. The reference point was set as the median diet score on each scoring system for each cohort.

Multivariable models included a crude model (model 1), adjusted for age (as the underlying timescale) and sex. Model 2 further adjusted for education (categorised as time in education), smoking status (current, former, or never), alcohol intake (g/day, continuous, per 1-unit increase), total energy intake (kcal/day, continuous, per 1-unit increase), and BMI (kg/m², continuous, per 1-unit increase). Time in education was defined for each cohort (DCH: elementary school, <3 years of additional education, 3–4 years of additional education, and >4 years of additional education; MDC: ≤8 years, 9–10 years, 11–13 years, and university degree; and MTC: <9 years, 9–12 years, and >12 years). Due to the recruitment strategy in the DCH, we stratified by age and date at study entry in tertiles, to allow for different baseline hazards. In the MDC, we further adjusted for the season and the diet assessment method version. The MTC was conducted in several Mexican states and hence we also adjusted for state for that cohort. Because the MTC only included female teachers, the analyses for this cohort did not adjust for sex and education in the main models.

In the MDC, we estimated the marginal mean difference in greenhouse gas emissions at the minimum and maximum observed score and at the 10th and 90th percentile of the diet scores, by comparing predicted marginal means, with 95% CIs derived from a Wald test. We also evaluated the association between the EAT–*Lancet* diet scores and greenhouse gas emissions with standard linear regression using a 10% increment in the scores, and Wald test to compute 95% CIs for β coefficients.

In sensitivity analyses we: (1) used food sources of fat instead of fat content when applying the scores from Stubbendorff, Colizzi, Trijsburg, and Kesse-Guyot, and Cacau score in the DCH; (2) separated red meat into beef and lamb or pork and used fat sources instead of fat content for the MDC and MTC when investigating the score from Stubbendorff; (3) conducted analysis of the MTC without restricting the analytical sample to participants who were aged 45 years or older at baseline; (4) conducted analysis of the MTC adjusting for education; and (5) for the scores by Colizzi and Trijsburg, we estimated the proportion of participants with a score of either 0 or 10 points, to assess how many participants were not grouped by a proportional score.

We present estimates of association with 95% CIs. When p values are presented, a two-sided p value less than 0·05 was considered statistically significant. Statistical analyses were conducted in Stata (version 14 for the MTC; version 16 for the DCH; and version 17 for the MDC).



Figure: **Overview of how each food group in the EAT–*Lancet* reference diet has been included in the seven diet scores**

*The interpretation of whether each component in each scoring system was a food to promote, balance, or limit was based on definitions in the EAT–*Lancet* reference report by Willett and colleagues;[1] for fish, the categorisation was not entirely clear from the EAT–*Lancet* report, so we decided that it was a food to promote based on beneficial health effects and variable climate impact.[1] †The Knuppel score included all types of grains (ie, refined grains as well as wholegrains); wholegrains were scored as a component to limit because there was an upper limit to their intake.

Results

Diet scores

After removing duplicates, 890 publications were screened. Among those publications, we identified five unique diet scores reflecting the EAT–*Lancet* reference diet.[6–9,11] One additional score was included from medRxiv[10] and another was provided by an expert in the field,[12] giving a total of seven unique scores (appendix 1 p 23).

Table 1 provides an overview of the seven EAT–*Lancet* diet scores, and tables in appendix 1 (pp 3–10) show the formulation of each of the scores. Trijsburg[11] included 13 dietary components in the score, Knuppel,[6] Hanley-Cook,[7] Stubbendorff,[8] Colizzi,[10] and Kesse-Guyot[12] included 14 components, and Cacau[9] included 16 components (table 1). Cacau, Colizzi, Trijsburg, and Kesse-Guyot used a proportional scoring system, Knuppel and Hanley-Cook used a binary system, and Stubbendorff used a ordinal scale system. The scores with the widest ranges were the proportional scores, followed by the ordinal score, and the binary scores. The Cacau and Kesse-Guyot scores took total energy intake directly into account in the score calculations. The Stubbendorff and Cacau scores achieved 5 or 6 points on the diet index construction score (table 1; appendix 1 p 11). Across the seven scores, vegetables and fruits were always considered as foods to promote except in

the Hanley-Cook score (considered as foods to balance; figure). Beef, lamb, and pork, and added sugar, were considered as foods to limit in all scores except the Hanley-Cook score (beef, lamb, and pork considered as foods to balance). The remaining foods were less consistently included in the same category (figure; appendix 1 pp 12–13).

For the scores by Hanley-Cook, Stubbendorff, Cacau, Colizzi, and Trijsburg, a higher score can be interpreted as being closer to the EAT–*Lancet* diet intake ranges. A high score on the Kesse-Guyot score can be due to high intakes of foods to promote, low intake in foods to limit, or a combination, according to the score definitions. For the binary score by Knuppel, a high score can reflect very different diets, for example a diet including only vegetables, fruits, and nuts; meanwhile, a low score can reflect a diet that includes high intakes of fish and legumes, despite these being promoted in the EAT–*Lancet* reference diet, and also high intakes of the foods to limit according to the reference diet (appendix 1 pp 12–13). Only for the Stubbendorff, Cacau, and Colizzi scores could a lower score be interpreted as being further away from the reference diet intake ranges. For the Hanley-Cook score, a low score could represent very different diets, including a diet with high intakes of fruit, vegetables, legumes, fish, and wholegrains, and low intake of red meat and dairy.

Differences in dietary intakes

In total, 52 452 individuals were included from the DCH, 20 973 from the MDC, and 30 151 from the MTC (appendix 1 p 22). The estimated dietary intakes were generally more similar between the two Nordic cohorts versus the MTC cohort (table 2). The EAT–*Lancet* score that was able to classify participants according to the EAT–*Lancet* recommendations and that was most consistent across the three cohorts was the Stubbendorff score, followed by the Trijsburg, Colizzi, and Knuppel scores (table 1; appendix 1 p 14). The least consistent scores were the Hanley-Cook and Kesse-Guyot scores. The Cacau score was not evaluated for consistency because it was only used to assess individuals in one cohort (DCH). Individuals with the highest adherence score on the Hanley-Cook score had a higher total meat (beef and lamb, pork, and poultry) intake than those with the lowest adherence score. Intakes across adherence quartiles for each of the diet scores for each cohort are reported in appendices 2–4.

See Online for appendices 2–4

Association with health outcomes

During a median of 10 years of follow-up, we identified 3238 deaths in the DCH, 1420 in the MDC, and 567 in the MTC, and 1359 and 694 incident stroke cases in the DCH and MDC, respectively. In the DCH and MDC, increased adherence to the EAT–*Lancet* reference diet indicated by higher scores on the Stubbendorff, Colizzi, and Trijsburg scores was consistently associated with the lowest risk of all-cause mortality. The same direction of association was observed in the MTC for these scores, although the confidence intervals were broad and included the null (table 3; crude model in appendix 1 p 15). Whereas higher adherence scores on the Hanley-Cook and Kesse-Guyot scores were associated with decreased all-cause mortality in the DCH and MDC, there was no such association in the MTC. In spline analysis, the majority of scores showed close to linear associations in the DCH and MDC (appendix 1 pp 24–26). The curves for the MTC were mostly flat around the null until the median value, then showed a decreased mortality risk for score values higher than the median.

Similar patterns of associations as for mortality were observed for incidence of stroke in the DCH and MDC. Higher scores on all diet scores, except the Cacau score, were associated with a decreased risk of stroke in the DCH (adjusted HR range 0·73–0·87), whereas only the Stubbendorff, Trijsburg, and Kesse-Guyot scores showed this association in the MDC (adjusted HR range 0·86–0·88; appendix 1 p 16). Results of the crude model are presented in appendix 1 (p 15). The majority of splines showed close to linear associations in the DCH. In the MDC, the curves were less pronounced and closer towards the null with increased variability (appendix 1 pp 27–28).

Association with greenhouse gas emissions

The overall unadjusted mean for dietary greenhouse gas emissions in the MDC was 5·85 kg CO_2 equivalents per day (SD 1·80). The predicted marginal mean greenhouse gas emissions among individuals with the highest and lowest adherence scores in the MDC showed significant differences for the scores by Hanley-Cook, Stubbendorff, Colizzi, and Kesse-Guyot (table 4). For three of these scores (Stubbendorff, Colizzi, and Kesse-Guyot), the highest adherence score was predicted to have significantly lower greenhouse gas emissions than the lowest score. We observed similar patterns when comparing the 10th and 90th percentiles. A score at the 90th percentile (higher than 90% of the cohort) was associated with lower greenhouse gas emissions than a score at the 10th percentile (higher than 10% of the cohort) for the Colizzi, Stubbendorff, and Kesse-Guyot scores (table 4). By contrast, we observed higher greenhouse gas emissions for higher adherence score on the Hanley-Cook score. In linear regression, we found a significant negative association between a higher adherence score and greenhouse gas emissions for the Stubbendorff, Colizzi, and Kesse-Guyot scores, and a significant positive association between the Hanley-Cook score and greenhouse gas emissions (appendix 1 p 17).

Sensitivity analyses

We observed similar patterns of associations for all-cause mortality and stroke incidence when using the food sources of fat instead of fat content (appendix 1 p 18), when dividing beef, lamb, and pork into beef and lamb or pork, and using fat sources, for the score by Stubbendorff (appendix 1 p 19), when using unrestricted

	DCH (n=52 452)			MDC (n=20 973)			MTC (n=30 151)		
	Median or n (%)	10th percentile	90th percentile	Median or n (%)	10th percentile	90th percentile	Median or n (%)	10th percentile	90th percentile
Age, years	56	51	63	57	48	69	48	45	55
Sex									
Female	27 985 (53·4%)	NA	NA	12 625 (60·2%)	NA	NA	30 151 (100%)	NA	NA
Male	24 467 (46·6%)	NA	NA	8348 (39·8%)	NA	NA	0	NA	NA
<9 years of education	7664 (14·6%)	NA	NA	8511 (40·6%)	NA	NA	1953 (6·5%)	NA	NA
Current smoker	18 762 (35·8%)	NA	NA	5791 (27·6%)	NA	NA	3570 (11·8%)	NA	NA
Alcohol intake, g/day	13·3	2·0	47·3	7·4	0·0	25·9	0·5	0·0	3·0
BMI, kg/m²	25·5	21·4	31·0	25·2	21·2	30·5	27·8	22·7	33·7
Energy intake, kcal/day	2259	1567	3118	2177	1547	3050	1743	1063	2717
Food intake, g/day									
Total cereals	185	106	289	131	74·3	238	117	57·2	203
Wholegrains	127	64·5	223	58·7	9·6	149	40·9	15·9	82·2
Vegetables	157	64·3	297	145	63·5	279	202	79·6	481
Fruits	142	32·9	373	166	54·7	351	410	135	963
Tubers	128	55·8	256	109	44·1	207	25·0	8·1	81·3
Dairy foods	300	81·1	773	392	140	746	208	42·2	629
Eggs	21·3	8·7	50·7	19·1	4·2	46·4	8·9	2·1	26·6
Beef, lamb, or pork	105	54·1	186	97·2	45·4	174	56·5	25·0	108
Poultry	17·7	5·3	41·4	4·7	0·0	41·9	34·3	6·7	34·3
Fish	37·8	16·0	73·9	38·9	6·1	88·0	24·3	9·0	68·9
Legumes	0·6	0·1	2·8	2·4	0·0	17·6	48·8	12·5	116
Nuts	0·8	0·0	4·1	0·0	0·0	5·0	5·2	1·2	20·8
Micronutrients, g/day									
Unsaturated fatty acids	40·5	25·5	61·5	45·0	28·9	68·9	27·1	15·8	45·3
Saturated fatty acids	31·3	18·9	48·2	37·8	22·8	62·2	17·0	9·4	29·1
Added sugar	29·9	11·6	67·5	50·0	22·6	94·9	46·9	20·6	106

Categorical variables are presented as n (%); continuous variables are presented as median, 10th percentile, and 90th percentile, with values ≥100 presented as whole numbers and values <100 presented to one decimal place. Definitions of food groups as applied in the cohort studies are provided in appendix 1 (p 2). DCH=Danish Diet, Cancer and Health Cohort. MDC=Malmö Diet and Cancer Cohort. MTC=Mexican Teachers' Cohort. NA=not applicable.

Table 2: **Baseline characteristics of participants in each cohort study**

age data from the MTC, and after adjusting for education in the MTC (appendix 1 p 20). The proportion of participants who were scored outside the range of optimal intake with a proportional method was generally lower with the Colizzi score than with the Trijsburg score in the DCH and MDC (appendix 1 p 21). In the sensitivity analyses for greenhouse gas emissions, we observed stronger associations than in the main analysis between the Stubbendorff score and greenhouse gas emissions when categorising red meat and fat sources into different groups (table 4; appendix 1 p 17).

Discussion

Seven different diet scores reflecting adherence to the EAT–*Lancet* reference diet were identified, for the period between 2019 and 2022, each having different interpretations, associations with health outcomes, and climate impact. The scores by Stubbendorff and Colizzi were among the most consistent in grouping participants according to the EAT–*Lancet* reference diet

	Score		Adjusted hazard ratio (95% CI)*		
	Range	Increment	DCH (n=52 452)	MDC (n=20 973)	MTC (n=30 151)
Knuppel	0–14	1·4	0·91 (0·87–0·95)	0·94 (0·88–1·00)	0·95 (0·85–1·06)
Hanley-Cook	0–14	1·4	0·88 (0·85–0·91)	0·92 (0·87–0·97)	0·99 (0·91–1·08)
Cacau	0–150	15	0·90 (0·85–0·95)	NA	NA
Trijsburg	0–130	13	0·87 (0·83–0·90)	0·92 (0·86–0·98)	0·93 (0·86–1·03)
Kesse-Guyot	Variable†	Variable†	0·80 (0·74–0·85)	0·86 (0·80–0·93)	0·97 (0·92–1·03)
Stubbendorff	0–42	4·2	0·83 (0·78–0·87)	0·88 (0·81–0·95)	0·92 (0·83–1·03)
Colizzi	0–140	14	0·83 (0·80–0·87)	0·89 (0·83–0·94)	0·95 (0·86–1·05)

DCH=Danish Diet, Cancer and Health Cohort. MDC=Malmö Diet and Cancer Cohort. MTC=Mexican Teachers' Cohort. NA=not available (Cacau score not assessed in these cohorts). *Adjusted for age, sex, education, smoking status, alcohol intake, BMI, and total energy intake. DCH was additionally adjusted for date and age at inclusion as strata. MDC was additionally adjusted for dietary assessment method and season. MTC was additionally adjusted for state (12 states in Mexico). †There is no set range for this score as the range depends on the observed data. The range for DCH was 7 to 110, increment of 10·3, for MDC −143 to 179, increment of 32·2, and for MTC −202 to 279, increment of 27·9.

Table 3: **Association between diet scores and risk of mortality per 10% increment in score**

	Observed adherence score	Greenhouse gas emissions, kg CO_2eq/day	
		Marginal mean (95% CI)*	Marginal mean difference (95% CI)
Knuppel score			
Lowest	4	5·79 (5·72 to 5·87)	..
Highest	14	5·91 (5·83 to 5·98)	0·11 (–0·03 to 0·26)
10th percentile	7	5·82 (5·79 to 5·86)	..
90th percentile	11	5·87 (5·83 to 5·91)	0·05 (–0·01 to 0·11)
Hanley-Cook score			
Lowest	0	5·65 (5·59 to 5·70)	..
Highest	10	6·16 (6·08 to 6·24)	0·51 (0·38 to 0·65)
10th percentile	2	5·75 (5·72 to 5·78)	..
90th percentile	6	5·95 (5·92 to 5·99)	0·21 (0·15 to 0·26)
Trijsburg score			
Lowest	2·13	5·85 (5·78 to 5·92)	..
Highest	107·63	5·84 (5·75 to 5·93)	–0·01 (–0·17 to 0·15)
10th percentile	33·52	5·85 (5·82 to 5·88)	..
90th percentile	63·58	5·84 (5·82 to 5·87)	0·00 (–0·05 to 0·04)
Kesse-Guyot score			
Lowest	–143·03	7·24 (7·15 to 7·32)	..
Highest	179·30	3·37 (3·22 to 3·52)	–3·87 (–4·10 to –3·64)
10th percentile	–56·63	6·20 (6·17 to 6·23)	..
90th percentile	3·19	5·48 (5·46 to 5·51)	–0·72 (–0·76 to –0·68)
Stubbendorff score			
Lowest	8	6·16 (6·09 to 6·22)	..
Highest	35	5·36 (5·26 to 5·46)	–0·80 (–0·96 to –0·64)
10th percentile	15	5·95 (5·92 to 5·98)	..
90th percentile	22	5·74 (5·72 to 5·77)	–0·21 (–0·25 to –0·17)
Colizzi score			
Lowest	3·8	6·07 (6·01 to 6·14)	..
Highest	110·6	5·53 (5·44 to 5·62)	–0·55 (–0·70 to –0·39)
10th percentile	32·3	5·93 (5·90 to 5·96)	..
90th percentile	64·3	5·76 (5·74 to 5·80)	–0·16 (–0·21 to –0·12)
Stubbendorff score; sensitivity analysis†			
Lowest	5	6·45 (6·38 to 6·53)	..
Highest	35	5·07 (4·97 to 5·16)	–1·38 (–1·55 to –1·22)
10th percentile	14	6·04 (6·01 to 6·07)	..
90th percentile	22	5·67 (5·64 to 5·70)	–0·37 (–0·41 to –0·33)

CO_2eq=CO_2 equivalents. *Adjusted for dietary assessment version, season, and total energy intake. †Mirroring the original score by separating red meat into beef and lamb or pork, and defining fat sources instead of fat content.

Table 4: **Predicted mean greenhouse gas emissions for individuals with different observed adherence scores for the EAT–*Lancet* diet in the Malmö Diet and Cancer Cohort (n=20 973)**

recommendations, and higher scores were associated with decreased risk of mortality across cohorts, and predicted greenhouse gas emissions decreased when going from lower to higher adherence scores. However, with the marked differences across all scores, the question remains as to whether one score is the best (ie, can be applied systematically at the global level).

Comparison of different scores across cohorts

The most consistent score was the Stubbendorff score. This is the only score that uses an ordinal scale to score each dietary component, making it simple to use and interpret. However, a challenge of this approach is that it limits the statistical power in discriminating participants. By contrast, the Colizzi score retains power by using a continuous score. That being said, the semi-quantitative method that many FFQs use does not provide sufficient precision to estimate intake on a continuous scale. Small dietary intakes among individuals are hard to capture. The Stubbendorff score was the only one to separate red meat into beef and lamb or pork. This separation was done mainly for environmental reasons,[1,8] as the climate impacts of beef and lamb versus pork are very different, with beef and lamb having approximately 5-times greater greenhouse gas emissions than pork.[31] In our sensitivity analysis, when separating red meat into the subcomponents, the results were strengthened for greenhouse gas emissions, but not for all-cause mortality or stroke incidence. The score by Stubbendorff also uses a consistent system, with adherence groups for each component defined by a set percentage deviation from the reference value provided by the EAT–*Lancet* reference diet. A limitation of this consistent system is that it only categorises components into those that were emphasised or limited, which might not necessarily reflect the balance between health and environmental impact.

Another score that performed moderately well across criteria and populations was the score by Colizzi. The score uses a continuous scoring system wherein proportional scores are given within specific thresholds. This approach is similar to the score by Trijsburg, although some intervals were very narrow in the Trijsburg score compared with in the Colizzi score, meaning that, in practice, many individuals are scored in a binary way with the Trijsburg score, as shown in our sensitivity analysis.

The score by Cacau performed well on the diet construction index. A limitation of our study was that we could not evaluate the Cacau score in all cohorts and in further evaluations, and hence we cannot give a specific recommendation, although it is promising.

The score by Kesse-Guyot showed a strong inverse association between greater adherence score and greenhouse gas emissions. One reason could be the mathematical formula used to derive the score. Because there is a natural lower limit of no consumption, the formula gives foods to emphasise, such as fruits, vegetables, and nuts, a higher score for higher intake; and a lower score with higher intake of foods to limit. This method makes the score hard to interpret as a higher intake of foods to limit can be offset by consuming very high amounts of foods to emphasise.

Two scores, by Knuppel and Hanley-Cook, were binary. Although the interpretation of the scores is

simple, consistency was moderate to low across populations. The Hanley-Cook score includes minimum intakes to ensure adherence to the reference diet complies with adequate nutrient intakes. However, setting these minimum values to a binary score appeared to have unintended consequences. Individuals with the greatest adherence score on the Hanley-Cook score had a high total intake of meat (ie, red meat and poultry), leading to increased greenhouse gas emissions. This finding highlights the importance of balancing health and environmental impact when creating scores to reflect adherence to the EAT–*Lancet* recommendations.

Strengths and limitations

We used a systematic approach to identify and compare, both qualitatively and quantitatively, different diet scores that aimed to reflect adherence to the EAT–*Lancet* reference diet. We included two Nordic cohorts and one Latin American cohort to increase diversity in populations and dietary intakes. We investigated different outcomes including all-cause mortality, stroke incidence, and greenhouse gas emissions. Unfortunately, self-reported diagnosis of stroke has not been validated in the MTC and greenhouse gas emissions data were only available for the MDC. Additionally, the MTC had limited power due to the small number of deaths, and uncertainty around the effect estimates was high. Analyses conducted across cohorts were made as comparable as possible, with the inclusion of similar age groups, harmonisation of food groups, adjustment for similar covariates, and the same follow-up time. Results for the DCH and MDC were more consistent, with differences observed for the MTC. There are several explanations for this discrepancy. First, although we restricted the MTC to women aged 45 years or older, the age distribution of the cohort of teachers was younger than for DCH and MDC. Second, the distribution of causes of death differed by cohort, with the main cause of death being breast cancer in the MTC, cancer in the MDC, and cardiovascular disease in the DCH.[17–20] As opposed to high-income countries, breast cancer in Mexico often occurs in young women, even after adjusting for population age structure.[32,33] Last, in comparison with the Nordic cohorts, the consumption of wholegrains in the MTC was low. Although tortillas were included as a source of wholegrains, they are often consumed with red meat, and thus consumption of an encouraged food by the EAT–*Lancet* reference diet is consumed with a discouraged food. As a general point, it is important to recognise that dietary patterns modelled as scores as used in this study might represent a vaguely defined intervention.[34] That is, there are several ways in which populations could achieve the same diet score, and each of these combinations could have a different relationship with the outcome of interest.

Implications for future studies

Dietary recommendations, such as the EAT–*Lancet* reference diet, are based on evaluations of individual foods and nutrients. However, what is ultimately important for public and environmental health is the collective set of recommendations, as interactions and synergies might exist between individual components. Therefore, a dietary pattern score that properly reflects the recommendations is important to improve our understanding of these complexities. Such a score should be able to balance both health and environmental concerns, given that they are interconnected, and guide future policies in different global and regional contexts. This large task will need concerted and collaborative efforts by the scientific and public health communities, working together with stakeholders and policy makers.

Our comprehensive evaluation of seven different diet scores did not suggest that a single score is better than the rest for our chosen parameters. Given the complexities of estimating the environmental impact of food systems, separate scores, or even separate approaches for assessing health and environmental impact, should be considered. However, the scores by Stubbendorff and Colizzi had high to moderate consistency in reflecting adherence to the EAT–*Lancet* recommendations. These scores grouped individuals reasonably well according to high and low adherence to the EAT–*Lancet* reference diet, and had health and climate indicator associations across cohorts. However, an association with health outcomes is not in itself an indication of the usefulness of the diet score. As we observed differences in the health and climate indicator estimates across these scores, we recommend using more than one score to evaluate health and environmental impacts. We also recommend investigating whether the score can group participants according to expected intakes of the EAT–*Lancet* reference diet in the target population, as some scores might perform better than others in different populations and geographical regions. This aspect is important, as some scores might be more adapted to population and regional contexts. Most of the scores were developed in the context of high-income countries and although our study included a Latin American cohort, increased data on greenhouse gas emissions and other environmental indicators such as land use, water use, and impact on biodiversity from low-income and middle-income countries could provide further insights into which score to use and the potential refinement of scores to specific contexts.

Conclusions

This systematic evaluation of seven diet scores reflecting adherence to the EAT–*Lancet* reference diet found substantial differences in score construction and interpretation, and in performance in terms of estimating human health and climate impact. No single score was

superior, but the scores by Stubbendorff and Colizzi performed reasonably well across our chosen parameters. Future studies should carefully consider which score to use, given that use of different scores might have different implications for future food policy.

Contributors

All authors contributed to reviewing and editing the manuscript, to the interpretation of statistics and findings, and to critically revising the manuscript for content. All authors approved the final version. AS, DS, and DBI accessed and verified the underlying data, conducted the analysis, and contributed to the review conceptualisation and methodology, data visualisation, and writing of the original draft of the manuscript. DBI additionally provided supervision. UE, ES, EH, YB, NGF, CCD, and ML were responsible for at least one of the following: data curation, project administration, and resource provision. All authors had full access to all the data in the Review and had final responsibility for the decision to submit for publication.

Declaration of interests

AS, UE, and ES were all involved in constructing one of the EAT–*Lancet* diet scores investigated (Stubbendorff et al[8]). All other authors declare no competing interests.

Data sharing

Data are available for investigators who seek to answer questions on health and disease in the context of research projects that are consistent with the legal and ethical standard practices of the Danish Cancer Society, Swedish Research Council, and the National Institute of Public Health in Mexico. Data access requests can be submitted to dchdata@cancer.dk (Danish Diet Cancer and Health Cohort [DCH]), olle.melander@med.lu.se (Malmö Diet and Cancer Cohort [MDC]), and martin.lajous@insp.mx (Mexican Teachers' Cohort [MTC]). The requests will then be passed on to the respective steering committees for deliberation and approval.

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References

1 Willett W, Rockström J, Loken B, et al. Food in the Anthropocene: the EAT–*Lancet* Commission on healthy diets from sustainable food systems. *Lancet* 2019; **393:** 447–92.

2 Ibsen DB, Christiansen AH, Olsen A, et al. Adherence to the EAT–*Lancet* diet and risk of stroke and stroke subtypes: a cohort study. *Stroke* 2022; **53:** 154–63.

3 Langmann F, Ibsen DB, Tjønneland A, Olsen A, Overvad K, Dahm CC. Adherence to the EAT–*Lancet* diet and risk of incident type 2 diabetes: the Danish Diet, Cancer and Health Cohort. *medRxiv* 2021; published online Dec 16. https://doi.org/10.1101/2021.12.16.21267887 (preprint).

4 Tepper S, Kissinger M, Avital K, Shahar DR. The environmental footprint associated with the Mediterranean diet, EAT–*Lancet* diet, and the Sustainable Healthy Diet Index: a population-based study. *Front Nutr* 2022; **9:** 870883.

5 Laine JE, Huybrechts I, Gunter MJ, et al. Co-benefits from sustainable dietary shifts for population and environmental health: an assessment from a large European cohort study. *Lancet Planet Health* 2021; **5:** e786–96.

6 Knuppel A, Papier K, Key TJ, Travis RC. EAT–*Lancet* score and major health outcomes: the EPIC–Oxford study. *Lancet* 2019; **394:** 213–14.

7 Hanley-Cook GT, Argaw AA, de Kok BP, et al. EAT–*Lancet* diet score requires minimum intake values to predict higher micronutrient adequacy of diets in rural women of reproductive age from five low- and middle-income countries. *Br J Nutr* 2021; **126:** 92–100.

8 Stubbendorff A, Sonestedt E, Ramne S, Drake I, Hallström E, Ericson U. Development of an EAT–*Lancet* index and its relation to mortality in a Swedish population. *Am J Clin Nutr* 2022; **115:** 705–16.

9 Cacau LT, De Carli E, de Carvalho AM, et al. Development and validation of an index based on EAT–*Lancet* recommendations: the Planetary Health Diet Index. *Nutrients* 2021; **13:** 1698.

10 Colizzi C, Harbers MC, Vellinga RE, et al. Adherence to the EAT–*Lancet* healthy reference diet in relation to risk of cardiovascular events and environmental impact: results from the EPIC-NL cohort. *J Am Heart Assoc* 2023; **12:** e026318.

11 Trijsburg L, Talsma EF, Crispim SP, et al. Method for the development of WISH, a globally applicable index for healthy diets from sustainable food systems. *Nutrients* 2020; **13:** 93.

12 Kesse-Guyot E, Rebouillat P, Brunin J, et al. Environmental and nutritional analysis of the EAT–*Lancet* diet at the individual level: insights from the NutriNet-Santé study. *J Clean Prod* 2021; **296:** 126555.

13 Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021; **372:** n71.

14 Burggraf C, Teuber R, Brosig S, Meier T. Review of a priori dietary quality indices in relation to their construction criteria. *Nutr Rev* 2018; **76:** 747–64.

15 Cooper AJ, Sharp SJ, Lentjes MA, et al. A prospective study of the association between quantity and variety of fruit and vegetable intake and incident type 2 diabetes. *Diabetes Care* 2012; **35:** 1293–300.

16 Lachat C, Hawwash D, Ocké MC, et al. Strengthening the Reporting of Observational Studies in Epidemiology–Nutritional Epidemiology (STROBE-nut): an extension of the STROBE statement. *PLoS Med* 2016; **13:** e1002036.

17 Tjønneland A, Olsen A, Boll K, et al. Study design, exposure variables, and socioeconomic determinants of participation in Diet, Cancer and Health: a population-based prospective cohort study of 57 053 men and women in Denmark. *Scand J Public Health* 2007; **35:** 432–41.

18 Manjer J, Carlsson S, Elmståhl S, et al. The Malmö Diet and Cancer Study: representativity, cancer incidence and mortality in participants and non-participants. *Eur J Cancer Prev* 2001; **10:** 489–99.

19 Manjer J, Elmståhl S, Janzon L, Berglund G. Invitation to a population-based cohort study: differences between subjects recruited using various strategies. *Scand J Public Health* 2002; **30:** 103–12.

20 Lajous M, Ortiz-Panozo E, Monge A, et al. Cohort profile: the Mexican Teachers' Cohort (MTC). *Int J Epidemiol* 2017; **46:** e10.

21 Willett W. Nutritional epidemiology. New York, NY: Oxford University Press, 2012.

22 Overvad K, Tjønneland A, Haraldsdóttir J, Ewertz M, Jensen OM. Development of a semiquantitative food frequency questionnaire to assess food, energy and nutrient intake in Denmark. *Int J Epidemiol* 1991; **20:** 900–05.

23 Wirfält E, Mattisson I, Johansson U, Gullberg B, Wallström P, Berglund G. A methodological report from the Malmö Diet and Cancer Study: development and evaluation of altered routines in dietary data processing. *Nutr J* 2002; **1:** 3.

24 Pedersen CB. The Danish Civil Registration System. *Scand J Public Health* 2011; **39** (suppl)**:** 22–25.

25 Quezada-Sánchez AD, Espín-Arellano I, Morales-Carmona E, et al. Implementation and validation of a probabilistic linkage method for population databases without identification variables. *Heliyon* 2022; **8:** e12311.

26 Lozano-Esparza S, López-Ridaura R, Ortiz-Panozo E, et al. Diabetes is associated with a higher risk of mortality among women in a middle-income country: results from the Mexican Teacher's cohort study. *Diabetes Metab* 2020; **46:** 304–10.

27 Lühdorf P, Overvad K, Schmidt EB, Johnsen SP, Bach FW. Predictive value of stroke discharge diagnoses in the Danish National Patient Register. *Scand J Public Health* 2017; **45:** 630–36.
28 Hallström E, Bajzelj B, Håkansson N, et al. Dietary climate impact: contribution of foods and dietary patterns by gender and age in a Swedish population. *J Clean Prod* 2021; **306:** 127189.
29 Moberg E, Walker Andersson M, Säll S, Hansson P-A, Röös E. Determining the climate impact of food for use in a climate tax—design of a consistent and transparent model. *Int J Life Cycle Assess* 2019; **24:** 1715–28.
30 Ortiz-Panozo E, Yunes-Díaz E, Lajous M, Romieu I, Monge A, López-Ridaura R. Validity of self-reported anthropometry in adult Mexican women. *Salud Publica Mex* 2017; **59:** 266–75.
31 Poore J, Nemecek T. Reducing food's environmental impacts through producers and consumers. *Science* 2018; **360:** 987–92.
32 Villarreal-Garza C, Aguila C, Magallanes-Hoyos MC, et al. Breast cancer in young women in Latin America: an unmet, growing burden. *Oncologist* 2013; **18:** 1298–306.
33 Zahed H, Feng X, Sheikh M, et al. Age at diagnosis for lung, colon, breast and prostate cancers: an international comparative study. *Int J Cancer* 2024; **154:** 28–40.
34 Hernán MA, Taubman SL. Does obesity shorten life? The importance of well-defined interventions to answer causal questions. *Int J Obes (Lond)* 2008; **32** (suppl 3)**:** S8–14.

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