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Association between the EAT-Lancet Diet, Incidence of Cardiovascular Events, and All-Cause Mortality: Results from a Swiss Cohort

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ABSTRACT

Background: An unhealthy diet is a major contributor to several noncommunicable diseases, including cardiovascular diseases, the leading cause of death worldwide. Additionally, our food system has significant impacts on the environment. The EAT-Lancet Commission has recommended a healthy diet that preserves global environmental resources.
Objectives: This prospective study aimed to evaluate the associations between adherence to the EAT-Lancet diet and the incidence of cardiovascular events and all-cause mortality in a Swiss cohort.
Methods: We analyzed data from the CoLaus/PsyCoLaus cohort study ($N = 3866$). Dietary intake was assessed using a semiquantitative food frequency questionnaire. The EAT-Lancet adherence score was calculated based on the recommended intake and reference intervals of 12 food components, ranging from 0 to 39 points. Participants were categorized into low-, medium-, and high-adherence groups according to score tertiles. We used Cox Proportional Hazards regressions to assess the association among diet adherence, incident cardiovascular events, and all-cause mortality.
Results: During a mean follow-up of 7.9 y (SD: ±2.0 y), 294 individuals (7.6%) from our initial sample experienced a first cardiovascular event, and 264 (6.8%) died. Compared with the low-adherence group, the adjusted hazard ratios for all-cause mortality were 0.88 (95% CI: 0.66, 1.17) and 0.70 (95% CI: 0.49, 0.98) for the medium-adherence and high-adherence groups, respectively (P-trend = 0.04). We observed no association between adherence groups and cardiovascular events.
Conclusions: In a Swiss cohort, high adherence to the EAT-Lancet diet is associated with a potential 30% lower risk of overall mortality. However, it is not associated with cardiovascular events.

Keywords: EAT-Lancet diet, sustainable diets, nutrition, mortality, cardiovascular disease, cardiometabolic health

Introduction

Noncommunicable diseases, particularly cardiovascular diseases (CVD), stand as the leading cause of death worldwide and are significant contributors to disability [1]. Diet plays a pivotal role as a key risk factor for noncommunicable diseases. An unhealthy diet is estimated to contribute to more deaths globally (11 million) than any other factor [2].

In parallel, food production and consumption have a major impact on the environment, biodiversity, and climate change [3]. Sustainable dietary choices, alongside improved food production practices and reduced food loss and waste, can mitigate

Abbreviations: CVD, cardiovascular disease; T2D, type 2 diabetes mellitus; FFQ, food frequency questionnaire; WHR, waist-to-hip ratio; WC, waist circumference.

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greenhouse gas emissions and climate change, reduce land and water resource use, and limit biodiversity loss [4–6]. For example, reducing the consumption of animal-source foods has been identified as a particularly effective solution for reducing greenhouse gas emissions, with estimated reductions of ≤84% [4].

Therefore, an ideal diet should be healthy and environmentally sustainable. To achieve this goal, in 2019, the EAT-Lancet Commission established recommendations for a healthy and sustainable diet. The EAT-Lancet diet consists largely of diverse plant-based foods, minimal animal-source foods, unsaturated rather than saturated fats, and limited refined grains and added sugars. Shifting from current diets toward the EAT-Lancet diet has the potential to impact health outcomes. For instance, as estimated by Laine et al. [7], this change could potentially prevent ≤63% of deaths and ≤39% of cancers in Europe in the next 20 y and reduce food-associated greenhouse gas emissions and land use by ≤50% and≤62%, respectively.

Despite the reported potential preventive effect of the EAT-Lancet diet on chronic noncommunicable diseases, the findings regarding the associations between adherence to this diet and CVD prevention are inconsistent. Although some observational studies have shown an association between adherence to the EAT-Lancet diet and a lower risk of cardiovascular events and mortality [8–13], others have failed to find associations [14–16]. Therefore, considering these inconsistencies in the literature, this study aimed to answer the following research question: What are the associations among adherence to the EAT-Lancet diet, the incidence of cardiovascular events, CVD-related mortality, and all-cause mortality in a Swiss cohort?

Methods

Participants

The CoLaus/PsyCoLaus study is a closed cohort study based in Lausanne, Switzerland. This study investigated cardiovascular disease risk factors in individuals aged 35 to 75 y [17]. Participant enrollment occurred between 2003 and 2006, involving 6733 participants who underwent comprehensive examinations and interviews and completed questionnaires. Dietary and physical activity data were initially collected during the first follow-up among 5064 participants between 2009 and 2012. Participants then had a second (2014–2017) and a third (2018–2021) follow-up. This study used data from the first (baseline) and third (last) follow-ups. In addition, incident cardiovascular events (including fatal and nonfatal cases) and deaths were collected prospectively until 30 June, 2021.

Exclusion criteria applied in this study were as follows: *1*) missing dietary information or implausible total energy intake (<500 kcal/d or >3500 kcal/d for females and <800 kcal/d or >4000 kcal/d for males) [18]; *2*) missing covariates (except for physical activity); and *3*) a history of CVD (Supplemental Figure 1). We did not exclude participants with missing data on secondary outcomes. We included 3866 individuals in our analysis, 76.3% of the initial sample (n = 5064).

Dietary assessment and EAT-Lancet score calculation

Dietary intake was assessed using a self-administered, semi-quantitative food frequency questionnaire (FFQ), which has been evaluated for validity [19–21]. The FFQ assessed the dietary intake of the previous 4 wk and included 97 food items, accounting for 90% of the energy intake. For each item, consumption frequencies range from never to ≥2×/d. Participants also indicated their average serving size compared with a reference size (smaller, equal, or larger). The EAT-Lancet adherence score was computed following the method developed by Stubbendorff et al., as described elsewhere [12]. In brief, the score was based on the targeted intake (in grams per day) for each food group constituting the EAT-Lancet diet [6]. These food groups were categorized as emphasized foods (i.e. vegetables, fruits, unsaturated oils, legumes, whole grains, and fish) or limited foods (i.e. red meat, poultry, eggs, dairy, potatoes, and added sugar) according to EAT-Lancet recommendations. Conversion factors were applied to determine the raw/-dry/uncooked weights of all food items because the consumed quantities (based on the FFQ) were estimated for ready-to-eat or cooked foods. This approach follows the EAT-Lancet Commission recommendations and scoring system method by Stubbendorff et al. [12]. The conversion factors were defined using published databases [22–24].

The score calculated for this study comprised only 12 food groups due to the absence of items from the nuts food group in the FFQ. As done in previous studies [11,25–27], we combined the beef and lamb group and the pork group to represent red meat. The scoring system for each food group ranged from 0 to 3, with 0 representing low adherence to the diet and 3 representing high adherence. The red meat group was scored from 0 to 6 as a combination of 2 food groups. Therefore, the total score ranged from 0 to 39 ($11 \times 3 + 1 \times 6$). A higher score indicated greater adherence to the EAT-Lancet diet, that is, high intake of emphasized foods and low intake of limited foods. Participants were then categorized into 3 adherence groups based on tertiles of the EAT-Lancet score: low (score: ≤18), medium (score: 19–21), and high (score: ≥22). Supplemental Table 1 lists the food items included in each food group and related cut-offs used for the scoring.

Primary outcomes

Information on CVD was obtained through a stepwise process, including participant self-reports verified by medical records, a search of the University Hospital of Lausanne's medical database, and crosschecking with administrative data and ICD-10 codes. Coronary-related events were adjudicated by 2 cardiologists according to an international expert consensus document [28]. Major coronary events for this study were defined as a composite outcome comprising *1*) acute coronary syndromes (acute myocardial infarction or unstable angina) and *2*) symptomatic stable angina followed by a revascularization procedure. Events resulting from medical procedures (angioplasty, stenting, or coronary artery bypass surgery) were not considered. Fatal and nonfatal strokes were adjudicated by a neurologist for participants exhibiting nontraumatic and rapidly progressing focal or global disturbances of cerebral function lasting ≥24 h.

Mortality data were gathered from the population register in cases of returned mail, lack of response, or notification from a relative. Information on the cause of death was collected sequentially from various sources, including general practitioners, hospital records, and official death certificates. Deaths were adjudicated by 2 internists and classified as cardiovascular or noncardiovascular. More information about the adjunction procedures can be found elsewhere [29].

Secondary outcomes

Body weight (kilograms) and height (meters) were measured using a Seca scale and height gage, respectively, and BMI (kg/m^2) was calculated from these data [17]. Waist circumference (WC) and hip circumference were measured as recommended by Lean et al. [30], and the waist-to-hip ratio (WHR) was calculated from these data. Blood pressure was measured using an Omron HEM-907 automated oscillometric sphygmomanometer (Matsusaka, Japan). Measurements were taken 3 times on the left arm, using an appropriately sized cuff, after the participant had rested for ≥10 min in a seated position. The mean of the last 2 measurements was used for analysis [17].

Blood samples were collected after overnight fasting. The Clinical Laboratory at Lausanne University Hospital conducted assays on these fresh samples to determine the serum lipid concentrations [total cholesterol (mmol/L), HDL cholesterol (mmol/L), LDL cholesterol (mmol/L), and triglycerides (mmol/L)] [17].

Covariates

Demographic characteristics and lifestyle data were obtained through self-administered questionnaires. Continuous variables included age (in years), total daily energy intake (kilocalories per day, calculated from the FFQ using the French and/or Swiss Food Composition Database), and alcohol consumption (units per week, where 1 unit corresponds to ~10–12 g of ethanol) [31]. Categorical variables included sex (male or female), educational level (university, high school, apprenticeship, or mandatory), physical activity level (assessed by the self-administered Physical Activity Frequency Questionnaire [32] and categorized as sedentary or nonsedentary [33], and smoking habits (never, former, or current). The presence of type 2 diabetes mellitus (T2D) was defined as a fasting plasma glucose concentration of ≥7 mmol or reported use of glucose-lowering medications. Hypertension was defined as a systolic blood pressure of ≥140 mm Hg, a diastolic blood pressure of ≥90 mm Hg, or reported use of antihypertensive drug treatment. Hypercholesterolemia was defined as LDL cholesterol levels >3.0 mmol/L or reported use of hypolipidemic drug treatment [34,35].

Ethics

The CoLaus/PsyCoLaus study was approved by the Institutional Ethics Committee of the University of Lausanne, which subsequently became the Ethics Commission of Canton Vaud (www.cer-vd.ch) (reference PB_2018-00038, 239/09). This study was performed in accordance with the Helsinki Declaration and its amendments. All participants provided written informed consent after receiving a detailed study description [17].

Statistics: descriptive analyses

Statistical analyses were performed using R version 4.3.2 (R Foundation for Statistical Computing). The significance level was set at the probability threshold of $P < 0.05$. We performed single imputation using a random forest algorithm to impute missing values for physical activity, given the large number of missing entries ($n = 372$) and the variable importance in further analyses [36]. The normal distribution of continuous variables was assessed using the Shapiro–Wilk test and visually via histograms. Continuous variables are presented as medians with interquartile ranges (IQRs) or means (±SDs), whereas categorical variables are presented as counts and percentages.

We evaluated differences in sociodemographic characteristics and lifestyle characteristics among the 3 adherence groups using the Kruskal–Wallis test for numeric variables and the χ^2 test for categorical variables. To complement this analysis, we also evaluated how different levels of adherence were associated with participants' characteristics using ordinal regressions, where the EAT-Lancet adherence groups were the dependent variable. Identified characteristics (i.e. $P < 0.20$ in the comparative analysis between diet adherence groups) were subsequently used to adjust further analyses [37]. To compare participants excluded from and included in the study sample, χ^2 tests were used for categorical variables, and Mann–Whitney tests were applied for continuous nonparametric variables. Differences in nutritional status, clinical measures, and cardiometabolic markers between the 3 adherence groups at baseline were evaluated using simple and multiple linear regressions.

Statistics: longitudinal analyses

We explored the relationships between EAT-Lancet adherence and changes in anthropometric and cardiovascular markers, that is, systolic and diastolic blood pressure; total, LDL, and HDL cholesterol; and triglycerides, between the first and last follow-ups. Differences in cardiovascular outcomes among the 3 adherence groups were evaluated using simple and multiple linear regressions. We then assessed risk of cardiovascular events, CVD-related mortality, and all-cause mortality. Age (in years) was used to scale time, with person-years calculated from baseline to the earliest of a CVD event, death, or the last follow-up. Multivariable Cox proportional hazards regression models were used to estimate hazard ratios (HRs) and 95% CIs for the associations of EAT-Lancet adherence groups (reference category: low-adherence) with cardiovascular events and overall mortality. The proportionality of hazards was verified by examining Schoenfeld residuals. For CVD-related mortality, we used Fine–Gray subdistribution proportional hazards models to account for competing risks. We tested for linear trends across tertiles, treating the EAT-Lancet adherence group as a continuous variable.

Statistics: model adjustments

Models were adjusted for age, sex, education level, physical activity level, smoking habits, alcohol consumption, total energy intake, and, when relevant, hypercholesterolemia or lipid-lowering medication use, hypertension, or antihypertensive medication use, T2D or glucose-lowering medications use, and BMI. With BMI and cardiometabolic disorders being on the causal pathway (therefore a mediator rather than a confounder), we also presented a model without adjusting for these variables.

Results

Study participants

Compared with the excluded participants, those included in our study ($N = 3866$) were younger, had a higher level of education, were more physically active, were more likely to smoke, had a lower BMI, WC, and WHR, and had a lower prevalence of T2D and hypertension (Supplemental Table 2).

Diet adherence

The EAT-Lancet adherence score ranged between 7 and 32, with a mean of 19.6 (SD: ±3.7). Women had a greater mean EAT-Lancet adherence score than men (20.6 [SD: ±3.5] compared with 18.4 [SD: ±3.5]) (Supplemental Figure 2). Older individuals, women, those with higher education levels, and nonsmokers, were more likely to be classified into the high-adherence group. Conversely, sedentary individuals, those who consumed greater amounts of alcohol or had higher daily energy intake, and those with hypertension or hypercholesterolemia were less likely to be classified into the high-adherence group (Table 1).

The food groups in which most participants scored the best adherence (i.e. 3 or 6 for red meat) were fruits, fish, poultry, eggs, and potatoes. In contrast, most participants were classified as having the lowest adherence score (i.e. 0) for unsaturated oils, legumes, whole grains, and red meat (Figure 1).

Associations between diet and cardiovascular markers

At baseline, individuals with high adherence to the EAT-Lancet diet had lower BMI, WC, and WHR values than those with low and medium adherence (cross-sectional analyses) (Supplemental Table 3). However, we found no clear associations between adherence to the EAT-Lancet diet and changes in anthropometric measures, blood pressure, or lipid markers between baseline (2009–2012) and the last follow-up (2018–2021) (longitudinal analyses) (Table 2).

Associations among diet, cardiovascular events, and mortality

During a mean follow-up of 7.9 y (SD: ±2.0 y), 294 individuals (7.6%) from our initial sample experienced a first cardiovascular event. The incidence of cardiovascular events per 1000 person-years was 10.5 for the low-adherence group, 8.3 for the medium-adherence group, and 9.8 for the high-adherence group. Compared with the low-adherence group, the multivariable-adjusted HRs for the medium- and high-adherence groups were 0.85 (95% CI: 0.63, 1.13) and 1.09 (95% CI: 0.81, 1.46), respectively, suggesting no significant association between the risk of diet adherence and cardiovascular events (Table 3).

Among participants, 264 (6.8%) died. For all-cause mortality, the incidence per 1000 person-years was 10.4 for the low-adherence group, 8.5 for the medium-adherence group, and 6.5 for the high-adherence group. The HRs for the medium-

TABLE 1
Characteristics of the sample according to adherence groups at baseline, CoLaus/PsyCoLaus study, 2009–2012.

Characteristics	EAT-Lancet diet adherence groups			P value	
	Low (score: ≤18)	Medium (score: 19–21)	High (score: ≥22)	Difference[1]	Association[2]
n	1522	1215	1129	—	—
Score EAT-Lancet	17 (15–18)	20 (19–21)	24 (22–25)	—	—
Sociodemographics					
Age (y)	55.1 (47.7–65.0)	56.8 (48.9–65.8)	58.2 (49.8–66.5)	<0.001	<0.001
Female	576 (38)	759 (62)	817 (72)	<0.001	<0.001
Education					
University education	335 (22)	243 (20)	305 (27)	—	—
High school	394 (26)	341 (28)	317 (28)	—	—
Apprenticeship	572 (38)	439 (36)	525 (32)	—	—
Mandatory education	221 (15)	192 (16)	151 (13)	<0.001	0.004
Lifestyle					
Sedentary	882 (58)	687 (57)	609 (54)	0.119	0.043
Smoking					
Never	575 (38)	522 (43)	524 (46)	—	—
Forme	577 (38)	460 (38)	425 (38)	—	—
Current	370 (24)	233 (19)	180 (16)	<0.001	<0.001
Alcohol consumption (units/wk)[3]	5 (2–11)	4 (1–8)	3 (0–7)	<0.001	<0.001
Dietary intake					
Intake of key food groups (target/d)					
Vegetables (>300 g)	136.7 (92.0–191.4)	165.5 (113.5–234.6)	207.5 (136.2–283.5)	<0.001	<0.001
Fruits (>200 g)	130.7 (61.9–271.2)	232.0 (123.8–392.9)	289.8 (184.5–490.0)	<0.001	<0.001
Unsaturated oils (>40 g)	9.6 (5.7–15.1)	10.7 (6.9–17.3)	12.2 (7.6–19.9)	<0.001	<0.001
Fish (>28 g)	33.5 (17.0–56.0)	39.8 (22.3–61.4)	41.1 (25.1–63.6)	<0.001	<0.001
Beef, lamb, pork (<14 g)	85.3 (61.7–122.7)	62.6 (39.9–94.5)	29.2 (15.7–50.6)	<0.001	<0.001
Dairy foods (<250 milk equivalent)	537.9 (339.4–757.1)	407.3 (264.3–606.1)	331.6 (209.1–504.2)	<0.001	<0.001
Added sugars (<31 g)	53.7 (33.9–78.4)	38.3 (23.3–59.6)	30.6 (19.2–48.6)	<0.001	<0.001
Total energy intake (kcal)	1759 (1408–2190)	1606 (1263–2031)	1516 (1182–1901)	<0.001	<0.001
Presence of diseases					
Type 2 diabetes	146 (10)	108 (9)	93 (8)	0.479	0.200
Hypertension	608 (40)	455 (37)	407 (36)	0.109	0.036
Hypercholesterolemia	1161 (76)	936 (77)	819 (73)	0.025	0.045

Continuous variables are presented as medians and interquartile ranges and binary variables as numbers and percentages.
[1] Differences between groups were tested with Kruskal–Wallis for numeric variables and χ^2 for categorical variables.
[2] Associations between groups were tested with ordinal regressions.
[3] A unit of alcohol corresponds to ~10–12 g of ethanol.

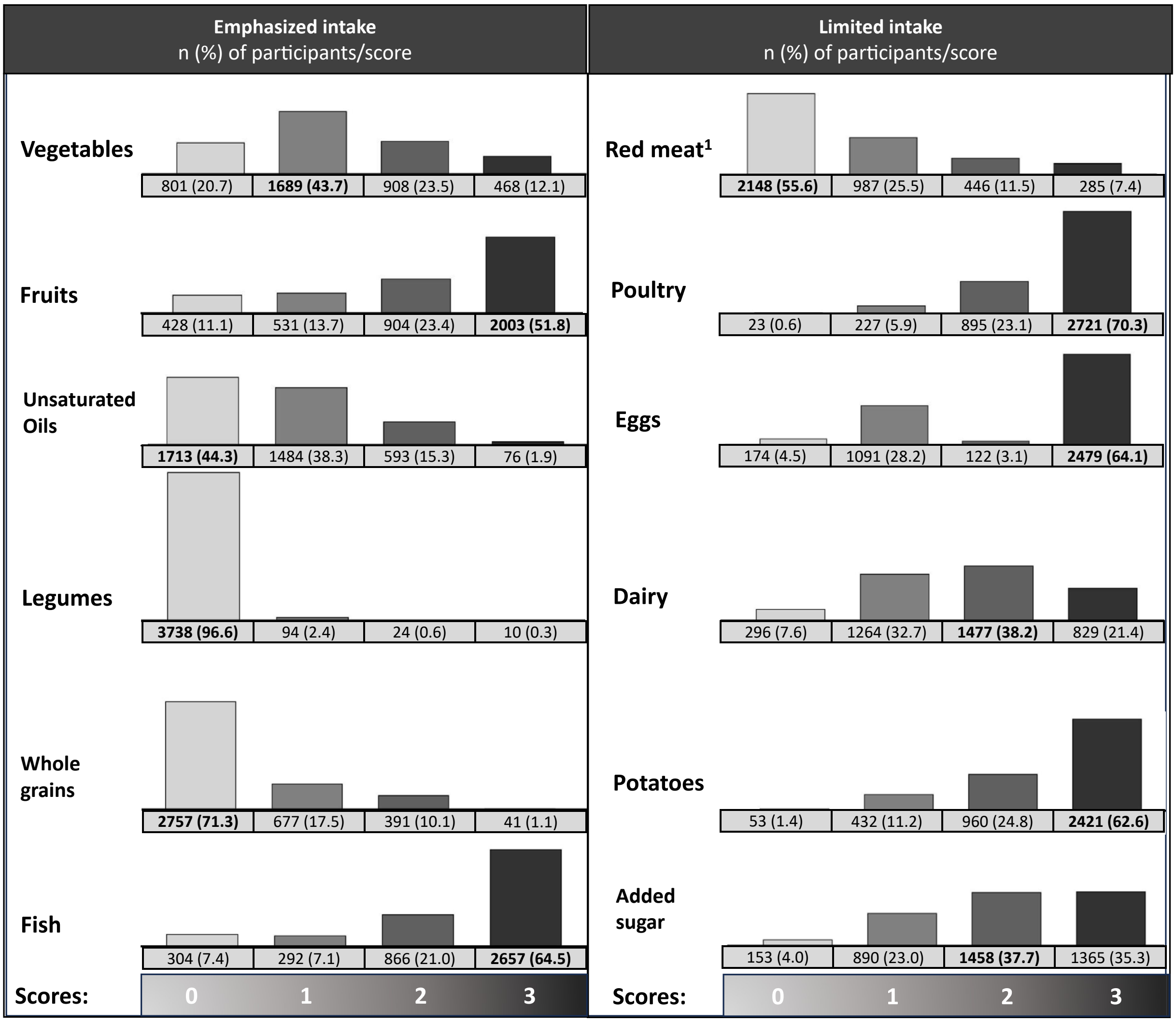

FIGURE 1. Distribution of EAT-Lancet score points for 12 food groups in 3866 participants from the CoLaus/PsyCoLaus study. The data are presented as the number of participants per score category (% of the sample).[1] The red meat group scored 0, 2, 4, or 6 instead of 0, 1, 2, or 3 because it represents a combination of the beef and lamb group and the pork group.

adherence and high-adherence groups compared with the low-adherence group in the fully adjusted models were 0.88 (95% CI: 0.66, 1.17) and 0.70 (95% CI: 0.49, 0.98), respectively, indicating that a higher adherence to the diet was associated with a lower risk of all-cause mortality (P-trend = 0.04) (Table 3). No interactions between dietary adherence and sex or age were observed across any of the Cox proportional hazards models ($P > .05$). Regarding CVD-related mortality, the HRs in the medium-adherence and high-adherence groups, compared with the low-adherence group, were 1.09 (95% CI: 0.51, 2.30) and 1.17 (95% CI: 0.51, 2.68), respectively (fully adjusted model, data not shown). Owing to the limited number of CVD-related deaths (16 cases in the low-adherence group and 13 cases in each of the medium-adherence and high-adherence groups), no definitive conclusions could be drawn, as the results were affected by limited statistical power and wide 95% CI.

Discussion

This study evaluated the associations between the EAT-Lancet diet and the incidence of cardiovascular events, CVD-related mortality, and all-cause mortality in a middle-aged Swiss population. Survival analyses revealed that high adherence to the EAT-Lancet diet was associated with reduced risk of all-cause mortality compared with low adherence. However, we did not find any associations with the risk of cardiovascular events or CVD-related mortality, probably due to the limited sample size of our study.

The findings of this study align with those of previous studies demonstrating a potential association between the EAT-Lancet diet and reduced all-cause mortality. Notably, the magnitude of the association observed in this study (HR: 0.70; 95% CI: 0.50, 0.98) is consistent with associations from other cohorts in the United States (HR: 0.77; 95% CI: 0.75, 0.80) [13] and Sweden (HR: 0.75; 95% CI: 0.67, 0.85) [12].

Despite the fact that we did not observe an association between EAT-Lancet diet adherence and the risk of cardiovascular events or CVD-related mortality in our cohort, increasing evidence suggests that plant-based diets can reduce risk of cardiovascular outcomes [38,39]. For example, a large prospective cohort study conducted in the United States found that replacing 3% of energy from animal protein with plant-based

TABLE 2
Changes in anthropometric measures and cardiovascular indicators according to EAT-Lancet adherence groups between the baseline and the last follow-up of the CoLaus/PsyCoLaus study.

Characteristic	EAT-Lancet diet adherence groups			P[1]	
	Low (score: ≤18)	Medium (score: 19–21)	High (score: ≥22)	Models	
				Crude	Full[2]
Nutritional status					
ΔBody mass index (kg/m^2)[1]	0.49 ± 2.14	0.52 ± 2.05	0.40 ± 2.24	0.433	0.126
n	1142	903	853		
ΔWaist circumference (cm) [1]	1.59 ± 7.05	0.72 ± 7.31	0.26 ± 7.25	<0.001	0.145
n	1144	906	857		
ΔWaist-to-hip ratio	−0.02 ± 0.06	−0.03 ± 0.07	−0.03 ± 0.08	<0.001	0.392
n	1144	905	857		
Blood pressure (mm Hg)					
ΔSystolic blood pressure	4.10 ± 15.93	4.28 ± 15.84	4.47 ± 14.27	0.591	0.424
n	1147	905	855		
ΔDiastolic blood pressure	−0.15 ± 10.70	0.02 ± 10.36	−0.45 ± 9.66	0.565	0.116
n	1147	905	855		
Lipid concentrations (mmol/L)					
ΔTotal cholesterol	−0.57 ± 0.99	−0.48 ± 0.99	−0.46 ± 1.02	0.014	0.588
n	1138	904	856		
ΔHDL cholesterol	−0.09 ± 0.27	−0.11 ± 0.26	−0.07 ± 0.28	0.283	0.008
n	1138	904	856		
ΔLDL cholesterol	−0.46 ± 0.87	−0.39 ± 0.89	−0.40 ± 0.91	0.107	0.127
n	1121	896	848		
ΔTriglycerides	−0.04 ± 0.88	0.05 ± 0.72	0.03 ± 0.78	0.041	0.874
n	1138	904	856		

All variables are presented as mean ± standard deviation. The Δ for cardiovascular indicators was calculated as the difference between follow-up 3 (2018–2021) and follow-up 1 (2009–2012) measurements. Variables have different sample sizes as we did not exclude missing data on secondary outcomes.

[1] *P* values for trend were calculated using linear models, treating the EAT-Lancet adherence groups as a continuous variable.

[2] Adjusted by sex, age, education level, total energy intake, sedentary lifestyle, smoking, alcohol consumption, hypercholesterolemia or lipid-lowering medication use (only for serum lipids), hypertension or antihypertensive medication use (only for blood pressure), and BMI (except for anthropometric measures).

protein was inversely associated with CVD-related mortality, potentially reducing CVD risk by 11% in men and 12% in women [38]. The EAT-Lancet diet, which emphasizes the intake of plant-based foods rich in fiber and limits animal protein, is therefore expected to have benefits for cardiovascular health. Previous studies in Europe, Brazil, and North America reported a reduced risk of cardiovascular events and CVD-related mortality associated with higher adherence to the EAT-Lancet diet [8–13]. However, other sufficiently powered studies testing these relationships in France and Canada did not observe such associations [14,15].

One explanation for the divergence among findings across studies is the lack of consensus on calculating the EAT-Lancet diet adherence score. Several authors have proposed different adherence scoring systems based on the daily recommended intake for each food group in grams [11,12,25,26] or calories [27], as suggested by the EAT-Lancet Commission report [6]. The use of different scoring systems can substantially impact the results of studies [40]. In this study, we adopted the scoring system developed by Stubbendorff et al. [12] because of the cultural and geographical similarities with our sample and the characteristics of our FFQ. Previous studies using the scoring system by Stubbendorff et al. to assess adherence to the EAT-Lancet diet have demonstrated associations between higher diet adherence and lower overall mortality, cancer mortality, CVD-related mortality [12], T2D [41], atrial fibrillation [42], coronary events [8], and heart failure [43] in the Swedish population. The discrepancies between our findings and those of previous studies that used the same diet scoring system may be explained by the characteristics of our sample, the tools used to record food intake in the CoLaus/PsyCoLaus study, and the fact that the diet was only evaluated once at baseline. Notably, the FFQ used in this study lacked information on the consumption of nuts (a food group with well-documented benefits for cardiovascular health) [44,45] and included a limited number of foods in the legume group (rarely consumed in Switzerland), which may lead to measurement differences in estimating the diet adherence score.

We also observed that most participants in our sample were classified as having the lowest scores for unsaturated oils, legumes, and whole grains, indicating insufficient intake, although there was excessive intake of red meat. Optimal consumption of these food groups has also been associated with a reduced risk of CVD [44]. Furthermore, as suggested by Lazarova et al. [14], the benefits of a plant-based diet may only become apparent after a certain level of adherence is achieved, which is challenging to observe due to generally lower adherence to plant-based dietary patterns. Indeed, only 7.4% of our sample were classified as having the highest adherence score (i.e. 3) for red meat. This result aligns with a national nutrition survey showing that the Swiss population consumes an average of 109 g of meat per day, suggesting that the eating habits of most Swiss people largely deviate from a plant-based diet [46].

TABLE 3
Associations between EAT-Lancet diet adherence groups and the incidence of cardiovascular events and all-cause mortality.

	EAT-Lancet diet adherence groups			P-trend[1]
	Low (score: ≤18)	Medium (score: 19–21)	High (score: ≥22)	
Cardiovascular events				
No. participants	1522	1215	1129	—
No. cases	126	80	88	—
Incidence	10.5 (8.70–12.39)	8.3 (6.4–10.1)	9.8 (7.7–11.8)	—
HRs (95% IC)				
Crude	1.00	0.78 (0.59–1.03)	0.92 (0.70–1.21)	0.482
Model 1	1.00	0.87 (0.65–1.16)	1.09 (0.81–1.46)	0.653
Model 2	1.00	0.86 (0.65–1.15)	1.07 (0.80–1.44)	0.722
Model 3	1.00	0.85 (0.63–1.13)	1.09 (0.81–1.46)	0.675
All-cause mortality				
No. participants	1522	1215	1129	—
No. cases	124	82	58	—
Incidence	10.4 (8.5–12.20)	8.5 (6.6–10.3)	6.5 (4.8–8.1)	—
HRs (95% IC)				
Crude	1.00	0.81 (0.61–1.07)	0.62 (0.45–0.85)	0.002
Model 1	1.00	0.89 (0.67–1.20)	0.74 (0.53–1.04)	0.089
Model 2	1.00	0.88 (0.66–1.17)	0.72 (0.52–1.01)	0.057
Model 3	1.00	0.88 (0.66–1.17)	0.70 (0.50–0.98)	0.040

The incidence is expressed as 1000 people per year (95% CI).
[1] P values for trends were calculated by treating the EAT-Lancet adherence group as a continuous variable. Model 1: Adjusted by sex, age, education level, total energy intake, sedentary lifestyle, smoking, and alcohol consumption. Model 2: model 1 + hypercholesterolemia or lipid-lowering medication use, hypertension or antihypertensive medication use, and diabetes or glucose-lowering medication use. Model 3: model 2 + BMI.

Importantly, in our sample, a limited number of individuals died from CVD. Our sample size was smaller than those of studies reporting an association between adherence to the EAT-Lancet diet and cardiovascular outcomes [8–12]. Consequently, we had limited power in our longitudinal analyses, preventing us from identifying associations. In addition, previous studies evaluating the associations between the EAT-Lancet diet and cardiovascular outcomes also vary regarding CVD definitions, statistical approaches, and the range of confounders included in the analyses, which could contribute to the divergence in the results.

In addition to the primary outcome analyses, we observed that individuals with high adherence to the EAT-Lancet diet had lower BMI, WC, and WHR, consistent with other studies reporting a cross-sectional inverse association between EAT-Lancet diet adherence and anthropometric measures. For instance, Knuppel et al. [25] reported that a higher EAT-Lancet diet adherence score was associated with a 1.4 kg/m^2 lower BMI in adults in the United Kingdom. Similarly, a study conducted by Cacau et al. [47] in a sample of Brazilian adults found that individuals who adhered most closely to the EAT-Lancet diet were 24% less likely to be overweight or obese and 14% less likely to have an increased WC. However, in the longitudinal analyses, we found no associations between adherence to the EAT-Lancet diet and changes in anthropometric measures between the baseline and the last follow-up in the full-adjusted model, indicating that the cross-sectional associations observed may not reflect causal relationships. Instead, they could be influenced by residual confounding or reverse causation, where individuals with healthier anthropometric profiles might be more likely to adhere to a diet aligned with the EAT-Lancet recommendations.

Other limitations of this study include the inherent misreporting in self-reported tools for assessing dietary intake. However, to address this bias, we excluded individuals who reported food and beverage consumption with implausible total energy intake [18]. Additionally, there is a selection bias of individuals in our sample, as evidenced by analyses comparing excluded and included individuals. However, this bias is commonly observed in observational studies [48]. Another limitation of our study is the evaluation of the physical activity level (sedentary: yes/no) based on self-reported questionnaire data, potentially leading to residual confounding. Finally, in this study, we did not collect information on the causes of non--cardiovascular deaths. As a result, we were unable to exclude unnatural deaths (e.g. accident, murder, and suicide) from the all-cause mortality analysis. Nonetheless, it is reasonable to assume that such deaths occurred with similar probabilities across diet adherence groups and would not significantly bias the findings. Therefore, further studies involving a larger sample and more accurate tools for assessing dietary intake and physical activity are needed to confirm or confront our findings.

Notably, the EAT-Lancet dietary recommendations have faced criticism regarding adaptation to local contexts and food production, potential nutritional deficiencies it may cause in certain population groups, and its feasibility in low-income countries due to cost [49,50]. Therefore, expanding studies across various countries with different economic conditions and cultural/eating habits is crucial to gain a broader perspective on the real consequences of adopting this dietary pattern, which ultimately aids in developing public policies aimed at simultaneously benefiting health and the environment.

In conclusion, this study found that high adherence to the EAT-Lancet diet in a Swiss population–based cohort was not associated with cardiovascular events. However, it was associated with a lower risk of all-cause mortality. Future studies with larger sample sizes and more accurate tools for assessing dietary intake are needed.

Authors' contributions

The authors' responsibilities were as follows – AC, SV, PM-V: designed the study; LBM, AC: analyzed the data with the assistance of FS, PM-V, MG, and AS; LBM: drafted the manuscript under the supervision of AC, SV, and PM-V; MG, FS, AS, NG, LL, UE: reviewed and edited the manuscript; LBM, AC: had primary responsibility for the final content; and all authors: read and approved the final manuscript.

Conflict of interest

The authors report no conflicts of interest.

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Data availability

Data described in the manuscript, code book, and analytic code will be made available upon request pending. All CoLaus/PsyCoLaus protocols, questionnaires, and data can be found at https://www.colaus-psycolaus.ch/colaus.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.tjnut.2024.12.012.

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