

Contributions of the PURE Study to the Definition of a Healthy Diet for the Prevention of Cardiovascular Diseases

Aportes del estudio PURE a la definición de la dieta saludable para la prevención de las enfermedades cardiovasculares

Patricio Lopez-Jaramillo¹  , Natalia Sanchez-López²  , Oscar González³  ,
Cristina López-López¹ 

¹ Masira Research Institute, Universidad de Santander (UDES), Bucaramanga, Colombia

² College of Agricultural and Life Sciences, University of Florida, Gainesville, FL, USA

³ College of Medicine, University of Florida, Gainesville, FL, USA



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Correspondence

Patricio Lopez-Jaramillo.
Email: jplopezj@gmail.com

Editors

Fraidy-Alonso Alzate-Pamplona, MSc. 
Efrén Murillo-Zamora, Ph.D. 

Declaration of interests

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Ethics statement

Ethical approval was not required for this study because it did not involve human participants, animals, or identifiable personal data.

Abstract

Cardiovascular diseases (CVD) are currently the leading cause of mortality in Latin America and worldwide. The main population-attributable risk factors for CVD are hypertension, obesity, tobacco use, low muscular strength, and diabetes, while for overall mortality they are tobacco use, hypertension, low educational attainment, obesity, and diabetes. Most of these factors are related to diet and nutrition; therefore, this study reviews the evidence supporting the development of the PURE healthy diet, based on an analysis that included data from more than 245,000 individuals across 80 countries with high-, middle-, and low-income levels. Diet quality, with an emphasis on diversifying the intake of different protective food groups, is associated with up to a 30% reduction in the risk of death from any cause and a 20% reduction in the risk of developing cardiovascular diseases. The PURE healthy diet recommends adequate consumption of fruits, vegetables, nuts, legumes, fish, and whole-fat dairy products (non-skimmed). The recommendations of the PURE healthy diet should be considered in the development of food policies by governments, academia, the private sector, and civil society, in order to identify solutions that account for the complexity of food systems, as well as to increase the availability, acceptability, and access to and consumption of food groups identified as protective against the risk of developing CVD.

Keywords

Cardiovascular disease; nutrition; healthy diet; PURE study.

Data availability

All data supporting the findings of this study are available within the article. For additional details, please contact the corresponding author.

Author Contributions

Patricio Lopez-Jaramillo:

conceptualization, investigation, methodology, supervision, validation, writing – original draft, writing – review & editing.

Natalia Sanchez-López:

data curation, investigation, writing – review & editing.

Oscar González:

formal analysis, investigation, writing – review & editing.

Cristina López-López:

data curation, visualization, writing – review & editing.

Generative AI declaration

The authors declare that no generative AI tools were used in the writing, editing, data analysis, or any other part of the preparation of this manuscript.

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Resumen

Las enfermedades cardiovasculares (ECV) son actualmente la primera causa de mortalidad en Latinoamérica y a nivel global. Los principales factores de riesgo atribuibles a la población para las ECV son la hipertensión, la obesidad, el tabaquismo, la baja fuerza muscular y la diabetes, mientras que para la mortalidad general son el tabaquismo, la hipertensión, la baja educación, la obesidad y la diabetes. La mayoría de estos factores están relacionados con la dieta y la nutrición, por lo que en este estudio se revisan los datos que soportan la creación de la dieta saludable PURE con base en un análisis que incluyó los datos de más de 245.000 personas de 80 países de ingresos altos, medios y bajos. La calidad de la alimentación, con énfasis en la diversificación del consumo de los diferentes grupos de alimentos protectores, se asocia con una reducción de hasta el 30 % en el riesgo de muerte por cualquier causa y del 20 % en el riesgo de presentar enfermedades cardiovasculares. La dieta saludable PURE recomienda el consumo de cantidades suficientes de frutas, verduras, frutos secos, legumbres, pescado y productos lácteos enteros (no descremados). Las recomendaciones de la dieta saludable PURE deben ser consideradas para el establecimiento de políticas alimentarias por parte de los gobiernos, la academia, el sector privado y la sociedad civil, que permitan encontrar soluciones considerando la complejidad de los sistemas alimentarios, así como aumentar la disponibilidad, la aceptabilidad y el acceso y consumo de los grupos de alimentos identificados como protectores del riesgo de desarrollar ECV.

Palabras clave

Enfermedad cardiovascular; alimentación; dieta saludable; estudio PURE.

Introduction

At the end of the last century, cardiovascular diseases (CVD) had become the leading cause of morbidity and mortality worldwide and emerged as a true epidemic in low- and middle-income countries (LMICs), exerting a major impact on their fragile health systems [1]. The epidemiological transition required a significant effort from the health sector to address the unprecedented rise in CVD, not only through curative actions but primarily through preventive strategies, identifying—within the specific social, cultural, and economic contexts of these countries—those risk factors that could be modified. Thus, the role of academia and of science and technology systems was of paramount importance [2–5].

The need to define priorities in order to optimize the limited resources available for research led us, in 2008, to propose [3] a possible causal pathway that would explain the increase in CVD in LMICs, and to suggest the areas in which research efforts in Latin America should be deepened (Figure 1).

The proposition that in LMICs social variables determine the behavior of biological variables, and that overweight, obesity, type 2 diabetes mellitus, and CVD are the normal biological response to abnormal societal development [5–9], was evidenced through the Prospective Urban Rural Epidemiology (PURE) study. This study was designed to determine the biological, environmental, and socioeconomic factors associated with the epidemiological patterns of chronic non-communicable diseases in adults over 35 years of age living in high-, middle-, or low-income countries, according to the World Bank's 2005 classification [10] (Figure 2).

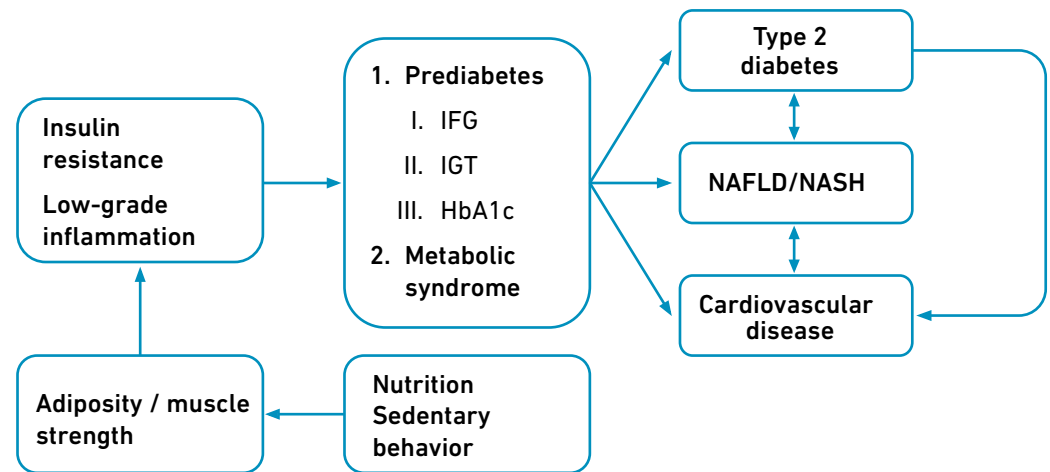


Figure 1. Nutrition and sedentary behavior as initial factors in the development of cardiometabolic diseases.

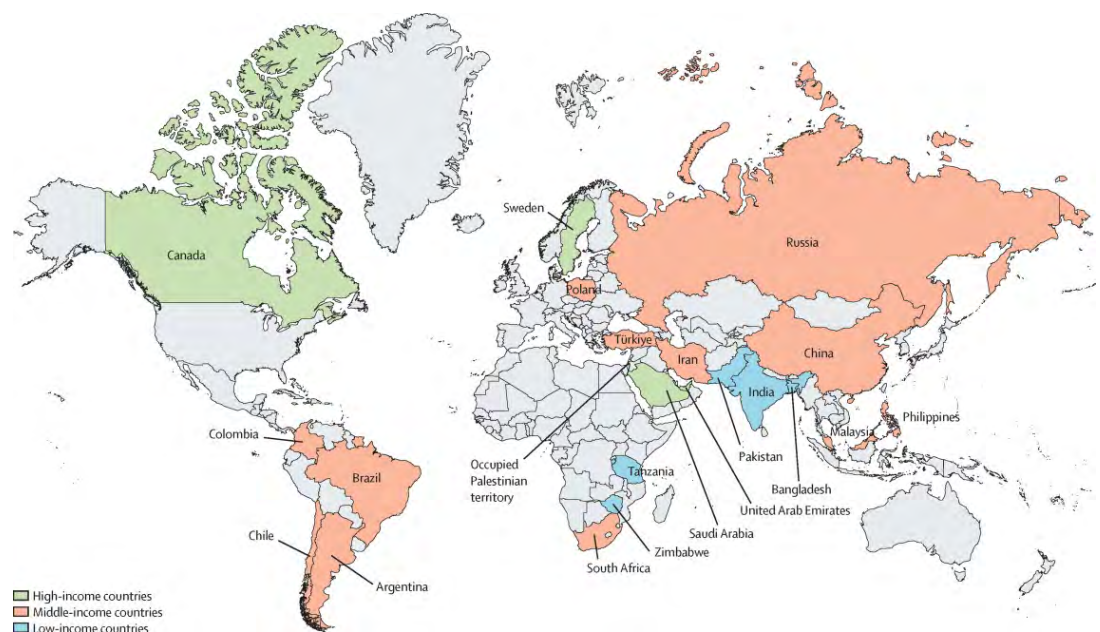


Figure 2. Map of countries participating in the PURE study, according to the 2005 World Bank classification.

Note. Adapted from Lopez-Jaramillo et al. [16].

The PURE study, currently ongoing, is a prospective cohort study that was initially conducted in 18 countries across five continents with different socioeconomic, geographic, and cultural contexts, and it is enabling the identification of the social determinants of health and disease [11–16]. The results obtained over 20 years of cohort follow-up demonstrate that knowledge generated from studies conducted in populations with different social determinants is not necessarily valid or universally applicable. This becomes evident when analyzing the leading causes of mortality across countries according to their income levels, as shown in Figure 3.

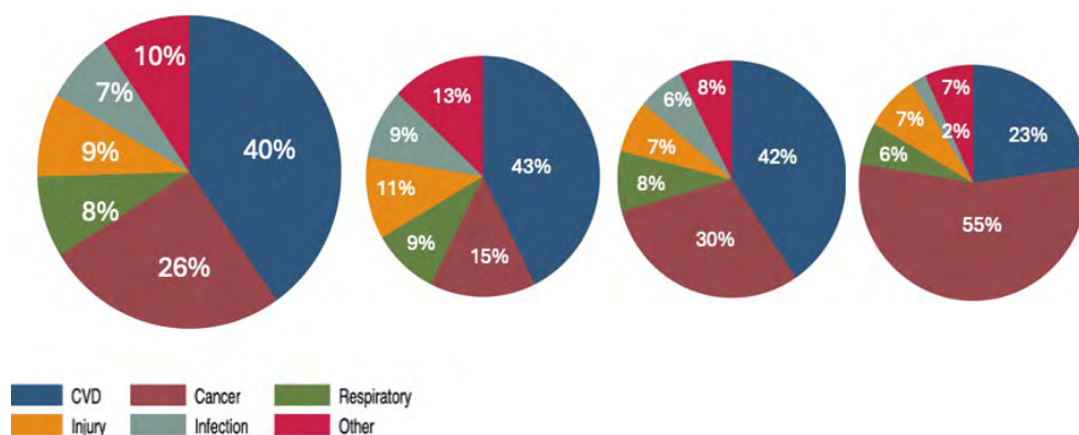


Figure 3. Causes of death among 162,000 adult participants in the PURE study, globally and by socioeconomic status across the 21 participating countries.

The risk factors associated with causes of death are similar across world regions where LMICs are grouped, with social determinants predominating. Thus, the three main risk factors for mortality in South America are smoking, hypertension, and low educational level, accounting for 61% of the population attributable risk (PAR). In Southeast Asia (India, Pakistan, Bangladesh), the three main factors are low educational level, low muscular strength, and poor nutrition, representing 69% of PAR. In China, the three most important factors are hypertension, low educational level, and poor diet, with a PAR of 56% [17].

The specific analysis of data obtained from the four Latin American countries participating in the PURE study is shown in Figure 4 [18]. The sample included 24,718 participants at baseline, with a mean age of 51.4 years; 61.4% were women, 57.4% lived in urban areas, and 59.5% had a primary level of education or less. A history of smoking was reported in 43.4% of participants, alcohol consumption in 52.0%, and low levels of physical activity in 13.8%. The prevalence of hypertension was 46.5% and diabetes 9.4%; the average body mass index (BMI) was 28.2 kg/m², and 65.9% met the criteria for abdominal obesity based on the waist-to-hip ratio. Mean handgrip strength was 31.5 kg, and 11.4% were exposed to indoor air pollution due to the use of solid fuels for cooking. Recently, we reviewed the importance of indoor air pollution with PM_{2.5} microparticles—resulting from the use of solid fuels such as wood and coal for cooking—as a risk factor for cardiovascular outcomes [19].

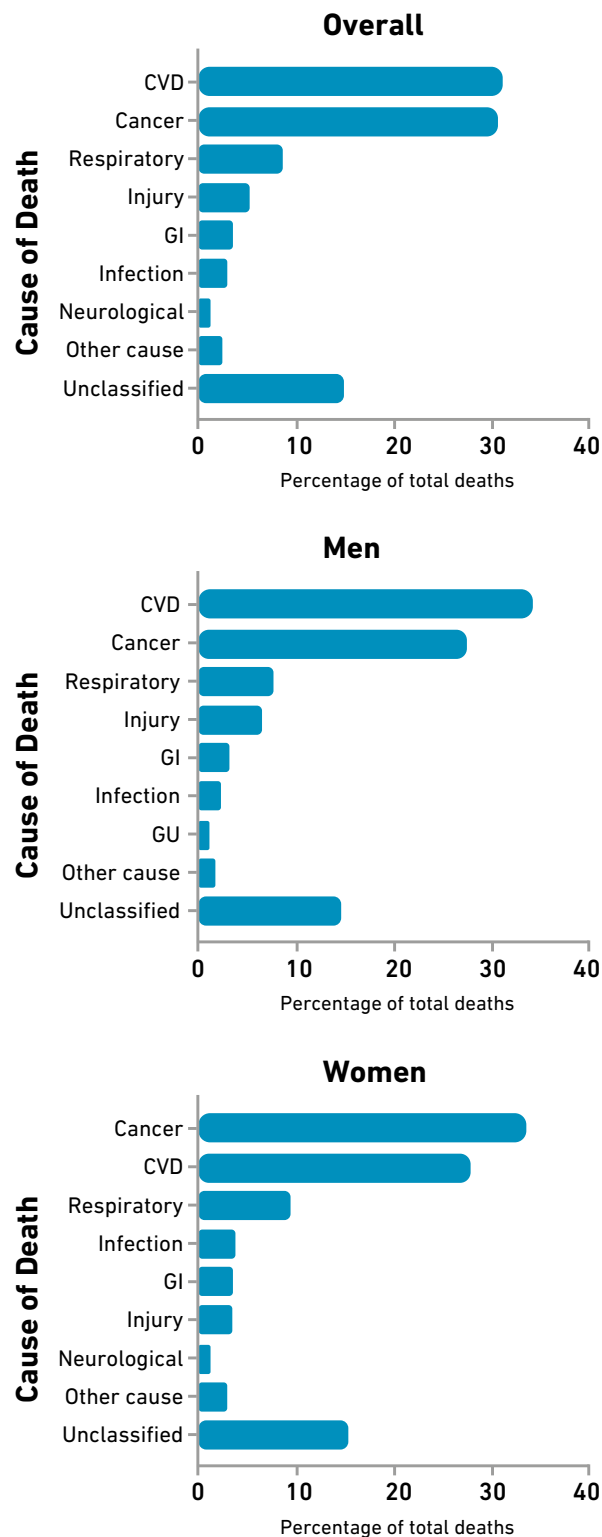


Figure 4. Global causes of death and causes by sex in the countries participating in the PURE–South America study: Argentina, Brazil, Chile, and Colombia.

Note. Adapted from Lopez-Jaramillo et al. [18].

The leading cause of mortality was CVD at 31.1%, closely followed by cancer at 30.6%. It is important to highlight that both the prevalence of CVD and mortality from CVD are higher in men than in women, and in rural areas compared to urban areas. Among women, the leading cause of mortality was cancer, mostly of preventable types such as breast and cervical cancer (Figure 4).

The main population-attributable risk factors for CVD were hypertension, obesity, smoking, low muscular strength, and diabetes, while for overall mortality they were smoking, hypertension, low educational level, obesity, and diabetes.

Most of these factors are related to diet and nutrition. Therefore, the data supporting the development of the PURE healthy diet and our recommendation for its global implementation—particularly in LMICs such as Latin American countries—are reviewed below.

The PURE Healthy Diet

Human nutrition and a healthy diet are influenced by socioeconomic and cultural factors that are part of the complex food system. The PURE study has contributed to clarifying the role that nutrition plays in the risk of developing chronic non-communicable diseases, particularly cardiovascular diseases and cancer. It has also provided rigorous evidence obtained in countries with differences in food availability and access, as well as diverse cultural traditions in food preparation and preferences, independent of the commercial and financial interests of the transnational food industry, which have had a negative impact on both human health and the health of the planet. The results of the PURE study on the effects of diet and nutrition on CVD risk have been published in various articles and have served as the basis for the development of the PURE healthy diet [20–35], based on an analysis that included data from more than 245,000 individuals from 80 high-, middle-, and low-income countries. We observed that diet quality, with an emphasis on diversification across different food groups, is associated with up to a 30% reduction in the risk of death from any cause and a 20% reduction in the risk of cardiovascular disease [36].

The consumption of a diet composed of sufficient amounts of fruits, vegetables, nuts, legumes, fish, and whole-fat dairy products (not low-fat) is associated with a lower risk of cardiovascular disease and all-cause mortality across all regions of the world, especially in lower-income countries where the consumption of these foods is low. This highlights the benefit of consuming protective foods to prevent the risk of diet-related chronic diseases. It was shown that moderate consumption of unprocessed red meat and whole grains does not increase the risk of developing CVD; therefore, their intake in recommended amounts is compatible with a healthy diet. Figure 5 summarizes the recommendations for a healthy diet. In developing the PURE healthy diet score, we used published results on dietary habits and morbidity and mortality in more than 148,000 individuals living in 21 high-, middle-, and low-income countries. The score is based on the consumption of six food groups: fruits, vegetables, nuts, legumes, fish, and whole-fat dairy. For each component, one point was assigned if intake was above the average consumption level, allowing us to create a scale ranging from 0 to 6, where 0 is the least healthy and 6 the most healthy. Table 1 details the average consumption expressed in grams per day for each food across different quintiles.



Figure 5. Recommendations of the PURE healthy diet based on six major international studies involving 244,597 participants from 80 countries.

Note. Adapted from Mente et al. [36].

Table 1. Average food intake expressed in grams/day and as a percentage of total daily energy intake for each food group (%E) across quintiles of the PURE healthy diet score.

	≤1 (Least healthy)	2	3	4	≥5 (Most healthy)
Fruit, g per day	45.6	82.4	133.3	185.5	256.8
Vegetables, g per day	85.0	126.1	180.6	232.4	306.3
Legumes, g per day	21.0	31.9	32.9	36.5	48.0
Nuts, g per day	3.9	7.0	13.9	20.2	28.2
Fish, g per day	6.1	16.4	18.0	20.8	26.1
Dairy, g per day	31.2	75.5	94.2	132.0	185.5
Red meat, unprocessed, g per day	24.1	27.2	35.0	43.3	54.5
White meat, g per day	10.3	11.1	13.8	18.0	22.1
Eggs, g per day	9.6	12.7	16.0	17.5	18.0
Whole wheat foods, g per day	42.7	40.8	35.0	32.3	40.9
Refined wheat foods, g per day	101.9	105.8	116.1	124.9	119.4
Rice, g per day	178.4	166.6	139.1	107.8	80.8
Potatoes and tubers, g per day	22.5	20.9	25.0	30.0	34.6
Sweets, g per day	70.4	66.3	78.9	104.2	128.6
Cholesterol, mg per day	187.9	248.0	293.7	344.3	394.6
Alcohol, g per day	76.0	37.8	42.9	49.9	65.2
Carbohydrates, %E	65.8	62.8	61.0	58.7	56.4
Fats, %E	20.1	22.8	23.7	25.2	27.1
Saturated, %E	6.3	7.8	7.9	8.2	8.9
Monounsaturated, %E	6.3	7.0	7.8	8.5	9.5
Polyunsaturated, %E	4.4	4.9	5.0	5.1	5.5
Polyunsaturated-to-saturated fat ratio	0.89	0.76	0.74	0.71	0.68

Note. Adapted from Mente et al. [36].

We then evaluated the risk of mortality and CVD associated with this healthy diet score, first among participants in the PURE study and then in approximately 97,000 adults from five other international studies. We compared our results with those obtained using other dietary indices such as the Healthy Eating Index (HEI) [37,38], the Mediterranean Diet Score [39], the DASH Diet Score [40], and the Planetary Diet Score [41]. Multivariable adjusted analysis in the PURE cohort showed that each quintile (approximately one point higher on the scale) was associated with a lower risk of all-cause mortality [hazard ratio (HR) = 0.91; confidence interval (CI) = 0.89–0.93], a lower risk of major cardiovascular events (HR = 0.94; CI = 0.92–0.97), and a lower risk of the composite outcome of cardiovascular death and CVD (HR = 0.93; CI = 0.92–0.95). Similar findings were observed in the other international studies analyzed. These results were consistent both in adults with and without a history of CVD and/or diabetes at baseline. When evaluating the PURE score with or without each of its components, all six food groups contributed to the observed protective effect.

When compared with other dietary indices, we found that the association with mortality and CVD was similar to that of the HEI, slightly weaker than the Mediterranean diet, very weak with the DASH diet, and not associated with the Planetary diet. Formal predictive assessment using the area under the curve (AUC) was consistent with the differences in risks observed with the PURE score. In subgroup analyses, the association between the PURE score and death or CVD appeared stronger in low-income countries, as well as in Southeast Asia and China. Consistent with this, the PURE healthy diet score showed a non-linear association, with a stronger effect at lower scores (<4). In contrast, the association of the HEI with death or CVD appeared more linear across the full range of scores.

These results, obtained in populations with different socioeconomic, geographic, and cultural contexts and validated in international studies, confirm previous findings reported in high-income Western countries and demonstrate that low intake of fruits, vegetables, nuts, legumes, and fish are major risk factors for poor health. Moreover, the associations described are not merely confounded but play a causal role in health deterioration [22,24,26,27,33]. Our findings consistently support that the intake of milk and whole-fat dairy products, including their fat content, is a fundamental component of a healthy diet [31]. Previously, we and other groups demonstrated the beneficial effects of consuming whole milk and dairy products on muscle mass and their protective role in the development of diabetes, hypertension, and metabolic syndrome [28]. Studies using more robust biomarkers than self-reported dietary data have shown that the intake of dairy fat has beneficial effects on human health. A large pooled analysis including more than 60,000 adults from 16 cohorts in 12 countries identified a protective association between dairy fat consumption and blood biomarkers of incident diabetes. These findings, together with those from the PURE study, call for a reassessment of guidelines that recommend avoiding whole milk and full-fat dairy products.

A third important implication relates to the consumption of unprocessed red meat, which in our studies did not show a negative effect and did not significantly influence the PURE healthy diet score [21]. In addition, the Planetary Diet Score, which emphasizes reducing the consumption of red meat and other animal products, showed no association with mortality or CVD and, in subgroup analyses, even increased risk in Southeast Asian countries and China. The Planetary diet was developed with the aim of promoting both human and planetary health in alignment with sustainability goals and has been associated with lower disease incidence in some—but not all—prospective cohort studies conducted in high-income Western countries. This highlights the need to improve our understanding and priorities regarding the relationship between diet, human health, and planetary sustainability. Currently, the net

effect of unprocessed red meat consumption on health remains uncertain and represents a high-priority area for future research. However, based on the available evidence, our findings are highly relevant, as they indicate that unprocessed red meat consumption is not a primary target for cardiovascular health in adults and therefore is not central to recommendations to avoid its intake, as emphasized in the EAT-Lancet report.

Conclusions

In conclusion, the results of the PURE study provide us with a healthy diet score whose highest protective level against the development of CVD and mortality can be achieved by consuming daily five servings of fruits and vegetables (563.1 grams), two servings of whole-fat dairy (185.5 grams), half a serving of nuts (26.1 grams), half a serving of legumes (28.2 grams), half a serving of unprocessed red meat (54.5 grams), one-third of a serving of fish (26.1 grams), and one-third of a serving of poultry (22.1 grams). This corresponds to a varied diet, consistent with 56% of daily energy intake coming from natural carbohydrates, 27% from fats (8.9% saturated, 15% unsaturated), and 17.2% from protein. In contrast, the least healthy diet (in the lowest quintile, with less than 1 point on the PURE healthy scale) consists of a carbohydrate-rich diet (66% of daily energy intake), low in fat (20% of energy intake, with 6.3% saturated fat and 10.7% unsaturated fat), and low in protein (13.5% of energy intake), with only 24.1 grams of red meat and 10.3 grams of poultry consumed daily.

The promotion of low-fat foods has occupied a central place among the food industry, the public, and policymakers, who have recommended the implementation of nutritional labeling focused on reducing fat intake, particularly saturated fats. Our findings suggest that the priority should instead be to increase the consumption of foods that have demonstrated a protective effect against the development of CVD, such as nuts (often avoided due to their high energy density), fish, and particularly whole-fat dairy products rather than restricting them to very low amounts, as has been proposed in various guidelines based on studies conducted in high-income Western countries.

The recommendations of the PURE healthy diet should be considered in the development of food policies by governments, academia, the private sector, and civil society. This would allow for the identification of solutions that consider the complexity of food systems and promote the availability, acceptability, access, and consumption of food groups identified as protective against the risk of developing CVD. This is an urgent need, to which our collaborative work within the PURE study has contributed robust and consistent evidence demonstrating the association between higher intake of protective foods and a lower risk of all-cause mortality and CVD morbidity and mortality across diverse regions of the world.

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