Fruit, vegetable, and legume intake, and cardiovascular disease and deaths in 18 countries (PURE): a prospective cohort study

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BACKGROUND

- The association between intake of fruits, vegetables, and legumes with cardiovascular disease (CVD) and deaths has been investigated extensively in Europe, the USA, Japan, and China, but little or no data are available from the Middle East, South America, Africa, or south Asia.
- Several guidelines recommend the consumption of five or more servings per day of fruits, vegetables, and legumes.
- Little information is available on any potential associations of lower levels of consumption of fruit and vegetables with cardiovascular disease or deaths outside European or US populations.
- Currently, most dietary guidelines do not differentiate between raw and cooked vegetable intake, despite potential differences in nutritional composition and digestibility.

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AIM

The aim of this study was to investigate the association of fruit, vegetable and legume consumption with cardiovascular outcomes and total mortality in a prospective cohort study from 18 countries from seven geographical regions.

Different patterns including very low consumption of fruit and vegetables and high consumption of legumes, or raw and cooked vegetable intake and their association with CVD events and total mortality were also investigated.

METHODS

- Prospective cohort study in 135 335 individuals aged 35 to 70 years without CVD from 613 communities in 18 low-income, middle-income, and high-income countries in seven geographical regions: North America and Europe, South America, the Middle East, south Asia, China, southeast Asia, and Africa.
- At baseline, participants completed dietary assessments using country-specific, validated food frequency questionnaires (FFQs).
  - Potatoes, other tubers, and legumes were not included as vegetables. Fruit and vegetable juices were excluded.
  - One serving was defined as 125 g of fruits or vegetables and 150 g of cooked legumes in accordance with USDA serving sizes.
- Standardized questionnaires were used to collect information about demographic factors, socioeconomic status (education, income, and employment), lifestyle (smoking, physical activity, and alcohol intake), health history and medication use, and family history of cardiovascular disease.
- The main clinical outcomes were major cardiovascular disease (defined as death from cardiovascular causes and non-fatal myocardial infarction, stroke, and heart failure), fatal and non-fatal myocardial infarction, fatal and non-fatal strokes, cardiovascular mortality, non-cardiovascular mortality, and total mortality.
- Case-report forms, death certificates, medical records and verbal autopsies were used to capture data about major cardiovascular events, and death during follow-up.
- Follow-up contact was made with every participant at least every 3 years either by telephone or by a face-to-face visit by the local research team.

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METHODS

Two models applied for analysis of data:

- **Minimally adjusted model**

  Adjusted for:

  – Age

  – Sex

  – Study center (as a random effect)

- **Fully adjusted model**

  Adjusted for:

  – Age

  – Sex

  – Energy intake

  – Current smoking status

  – Urban or rural location

  – Physical activity

  – Baseline diabetes

  – Education

  – Other dietary variables (white meat, red meat, bread, and cereal intake)

  – Study center (as a random effect)

- For the analyses of fruit intake, vegetable intake was adjusted for and vice versa. Furthermore, adjustments were made for socioeconomic status by using education, household income or wealth index.

- Analyses did not adjust for obesity, hypertension, or hypercholesterolaemia, as these factors might mediate the effects of fruits, vegetables, and legumes on the risk of cardiovascular disease and mortality.

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RESULTS

- Overall, combined mean fruit, vegetable and legume intake was 3·91 (SD 2·77) servings per day (for fruit, vegetables and legumes: 1·51 (SD 1·77), 2·01 (1·55), and 0·40 (0·48) servings per day, respectively).
- People who consumed more fruits, vegetables, and legumes had higher education, higher levels of physical activity, lower rates of smoking, and higher energy, red meat and white meat intake, and were more likely to live in urban areas.
- During a median 7·4 years of follow up, 4784 major cardiovascular disease events, 1649 cardiovascular deaths, and 5796 total deaths were documented.
- Higher total fruit, vegetable, and legume intake was inversely associated with major cardiovascular disease, myocardial infarction, cardiovascular mortality, non-cardiovascular mortality, and total mortality in the minimally adjusted model.
- The HR for total mortality was lowest for three to four servings per day, with no further apparent decrease in HR with higher consumption.

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RESULTS

- **Minimally adjusted model:**
  - Fruit consumption was inversely associated with the risk of major cardiovascular disease, stroke, cardiovascular mortality, non-cardiovascular mortality, and total mortality.
  - Vegetable intake was inversely associated with cardiovascular mortality, non-cardiovascular mortality, and total mortality.
  - Legume consumption was inversely associated with cardiovascular mortality, non-cardiovascular mortality, and total mortality.

- **Fully adjusted model:**
  - Fruit intake was associated with significantly lower risk of cardiovascular, non-cardiovascular, and total mortality.
  - For vegetables, raw vegetable intake was strongly associated with a lower risk of total mortality, whereas cooked vegetable intake showed a modest benefit against mortality.
  - Legume intake was inversely associated with non-cardiovascular mortality and total mortality.

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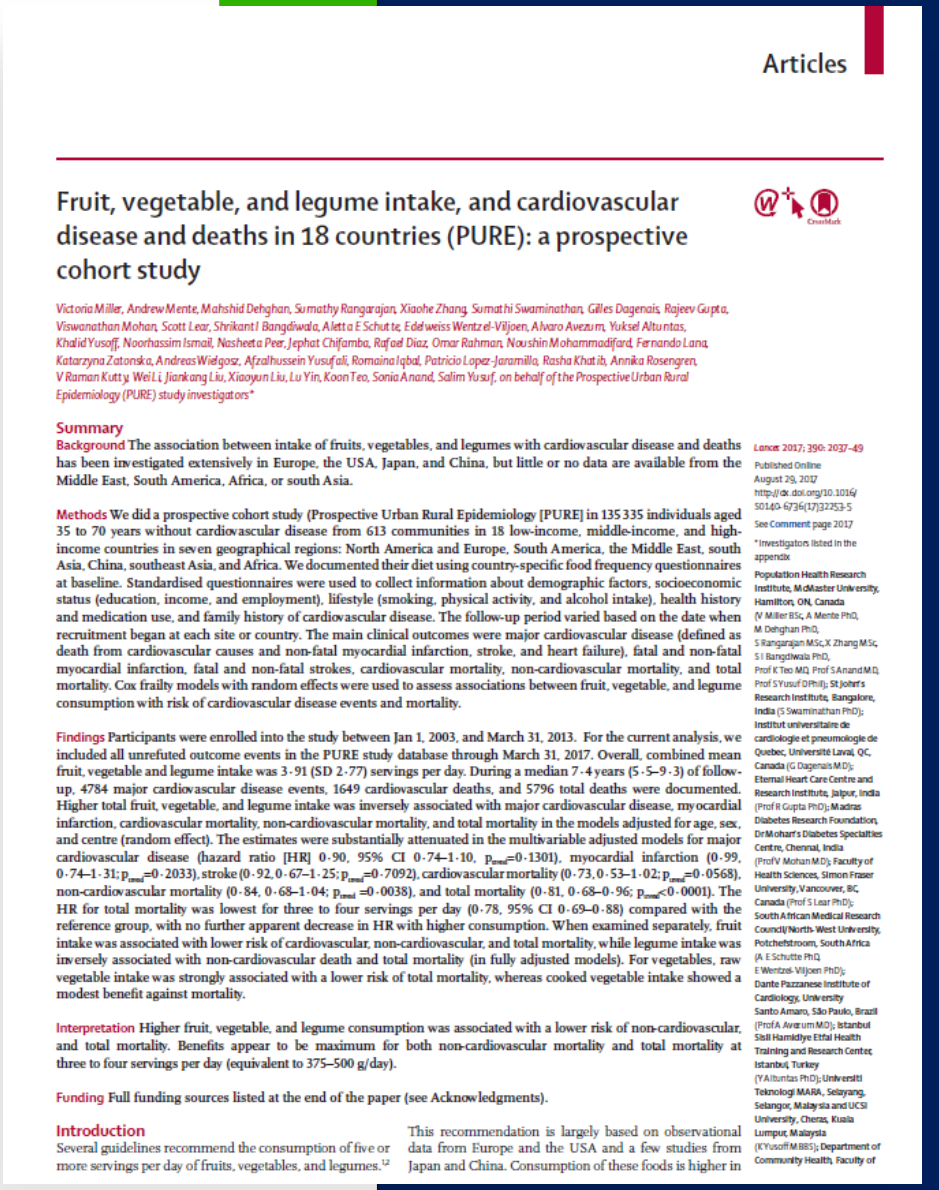
CONCLUSION

"Higher fruit, vegetable, and legume consumption was associated with risk reduction on several investigated end points, including cardiovascular, non-cardiovascular and total mortality."



Fruit, vegetable, and legume intake, and cardiovascular disease and deaths in 18 countries (PURE): a prospective cohort study

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Summary

Background The association between intake of fruits, vegetables, and legumes with cardiovascular disease and deaths has been investigated extensively in Europe, the USA, Japan, and China, but little or no data are available from the Middle East, South America, Africa, or south Asia.

Methods We did a prospective cohort study (Prospective Urban Rural Epidemiology [PURE] in 135 335 individuals aged 35 to 70 years without cardiovascular disease from 613 communities in 18 low-income, middle-income, and high-income countries in seven geographical regions: North America and Europe, South America, the Middle East, south Asia, China, southeast Asia, and Africa. We documented their diet using country-specific food frequency questionnaires at baseline. Standardised questionnaires were used to collect information about demographic factors, socioeconomic status (education, income, and employment), lifestyle (smoking, physical activity, and alcohol intake), health history and medication use, and family history of cardiovascular disease. The follow-up period varied based on the date when recruitment began at each site or country. The main clinical outcomes were major cardiovascular disease (defined as death from cardiovascular causes and non-fatal myocardial infarction, stroke, and heart failure), fatal and non-fatal myocardial infarction, fatal and non-fatal strokes, cardiovascular mortality, non-cardiovascular mortality, and total mortality. Cox frailty models with random effects were used to assess associations between fruit, vegetable, and legume consumption with risk of cardiovascular disease events and mortality.

Findings Participants were enrolled into the study between Jan 1, 2003, and March 31, 2013. For the current analysis, we included all unrefuted outcome events in the PURE study database through March 31, 2017. Overall, combined mean fruit, vegetable and legume intake was 3·91 (SD 2·77) servings per day. During a median 7·4 years (5·5–9·3) of follow-up, 4784 major cardiovascular disease events, 1649 cardiovascular deaths, and 5796 total deaths were documented. Higher total fruit, vegetable, and legume intake was inversely associated with major cardiovascular disease, myocardial infarction, cardiovascular mortality, non-cardiovascular mortality, and total mortality in the models adjusted for age, sex, and centre (random effect). The estimates were substantially attenuated in the multivariable adjusted models for major cardiovascular disease (hazard ratio [HR] 0·90, 95% CI 0·74–1·10, p_{trend}=0·1301), myocardial infarction (0·99, 0·74–1·31; p_{trend}=0·2033), stroke (0·92, 0·67–1·25; p_{trend}=0·7092), cardiovascular mortality (0·73, 0·53–1·02; p_{trend}=0·0568), non-cardiovascular mortality (0·84, 0·68–1·04; p_{trend} =0·0038), and total mortality (0·81, 0·68–0·96; p_{trend}<0·0001). The HR for total mortality was lowest for three to four servings per day (0·78, 95% CI 0·69–0·88) compared with the reference group, with no further apparent decrease in HR with higher consumption. When examined separately, fruit intake was associated with lower risk of cardiovascular, non-cardiovascular, and total mortality, while legume intake was inversely associated with non-cardiovascular death and total mortality (in fully adjusted models). For vegetables, raw vegetable intake was strongly associated with a lower risk of total mortality, whereas cooked vegetable intake showed a modest benefit against mortality.

Interpretation Higher fruit, vegetable, and legume consumption was associated with a lower risk of non-cardiovascular, and total mortality. Benefits appear to be maximum for both non-cardiovascular mortality and total mortality at three to four servings per day (equivalent to 375–500 g/day).

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Introduction

Several guidelines recommend the consumption of five or more servings per day of fruits, vegetables, and legumes.[1,2] This recommendation is largely based on observational data from Europe and the USA and a few studies from Japan and China. Consumption of these foods is higher in

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