

## « F&V consumption and life expectancy in Europe »

### Editorial

#### Increase availability, affordability and consumption of fruit and vegetables

*Fruits and vegetables are key elements of a healthy diet, and intakes vary considerably between countries, reflecting diverse economic, cultural and agricultural environments*

#### Fruit and vegetable and noncommunicable diseases

Low fruit and vegetable intake is among the 10 risk factors contributing to mortality and morbidity, according to the [Global Action Plan for the prevention and control of noncommunicable diseases 2013-2020](#). The health benefits of fruit and vegetable (F&V) consumption are significant and widely documented. According to [reports from the World Health Organization and the Food and Agriculture Organization](#), daily consumption of five servings, or a minimum of 400 grams (excluding potatoes and other starchy tubers), of F&V helps in the prevention of NCD, as well as for the prevention and alleviation of several micronutrient deficiencies.

Alarming data of the European Prospective Investigation into Cancer and Nutrition –EPIC study (<http://epic.iarc.fr/>) show that this recommendation is not achieved in many countries. The data also display a south–north gradient in the mean intake of fruit and vegetables in both genders, ranging from an intake below recommendations in the northern countries (below 250 g per day for Swedish men) to a high intake in the Mediterranean countries (over 700 g per day for men from Murcia, Spain). Of particular concern are unhealthy diets including low fruit and vegetable consumption, inadequate physical activity and energy imbalances in children and adolescents.

#### Key policies

The Global Action Plan for the prevention and control of noncommunicable diseases (2013-2020) as well as the Vienna Declaration on Nutrition and Noncommunicable Diseases in the Context of Health 2020 emphasize an increase in the availability, affordability, sustainability and consumption of fruit and vegetables. These framework documents address the main public health challenges in the area of nutrition, dealing with diet-related noncommunicable diseases. They underline the importance of ensuring a safe, healthy and sustainable food supply by specific actions such as improving the availability and affordability of fruit and vegetables through the revision of agricultural policies; providing technical advice and market incentives for local horticulture, including urban horticulture; reducing trade barriers to imports; and ensuring a reduced risk of pesticide residues. In addition to the above priority areas, the special needs of vulnerable groups in society, including elderly, children and immigrants, must not be forgotten. Also, the need for workforce development in the public health workforce by including NCD prevention in the set of core competencies of the professional public health training is vitally important.

These key actions will facilitate an increase in the availability, affordability, sustainability and consumption of fruit and vegetables.

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# A diet rich in fruits and vegetables reduces mortality

## Study from EPIC

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The large size of European Prospective Investigation Into Cancer and Nutrition (EPIC) cohort, combined with its long follow-up, the large number of deaths, and wide range of fruit and vegetable consumption provides an ideal setting to this study.

The cohort included 451,151 participants from 10 European countries, aged 25-70 years. The participants had no history of non-communicable disease (cancer, stroke, diabetes) and were recruited between 1992 and 2000 and followed until 2010.

This study focuses on consumption of total fruits (fresh fruits, dried or canned fruits), total vegetables and fruit and vegetable (F&V) combined. Legumes, potatoes, and other tubers were not included as vegetables. Consumption of F&V juices was excluded because these differ nutritionally (e.g. - added sugars and vitamins).

The aim of this study is:

1. To investigate the association of F&V consumption with mortality of all causes, cancer, and cardiovascular disease within the EPIC.
2. To estimate the time period by which the risk of death was postponed among participants with a high consumption of fruits and vegetables.

Associations with mortality for vegetables has also been compared according to preparation (i.e. cooked versus raw).

Hazard ratios, rate advancement periods, and preventable proportions to respectively compare risk of death between quartiles of consumption, to estimate the period by which the risk of death was postponed among high consumers, and to estimate proportions of deaths that could be prevented if all participants would shift their consumption one quartile upward.

### Additional support to the evidence that F&V consumption is associated with a lower risk of death

#### Median observed of F&V intake in Europe - 387.9 g/day

In the total study population, the observed median value consumption of fruits and vegetables combined was 387.9 g/day and seemed to increase according to a North-to-South gradient.

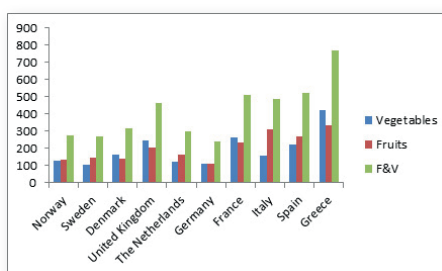


Figure: Median observed for fruit, vegetables and F&V intake in each country studied European Prospective Investigation Into Cancer and Nutrition, 1992-2010

### Older participants, women, and never smokers consumed more F&V than others

Parallel to a high consumption of fruits and vegetables, participants seemed to consume less processed meat and alcohol.

### A higher consumption of F&V combined was inversely associated with all-cause mortality

An 11% lower risk of death was found for the highest quartile of fruit and vegetable consumption (>569 g/day) when compared with the lowest (<249g/day), and have the risk of death postponed by 1.12 years. For every 200-g/day higher intake of F&V combined, the risk of death was 3-6% lower. The fully adjusted model with spline terms for combined consumption of F&V showed a threshold around 400 g/day of consumption, after which the

risk of death did not decrease further.

### F&V intake inversely associated with cardiovascular disease mortality

F&V intake were inversely associated with cardiovascular disease mortality, rate advancement period of 1.37, and preventable proportion of 4.24%. However, no clear inverse association with cancer mortality was observed. It should be noted that the lack of significant inverse associations for cancer mortality may be explained by the longer induction periods that exist for cancers than for cardiovascular disease.

### Fruit consumption was inversely associated with risk of death for women

All participants with high fruit consumption had slightly lower risk of death when analyzed overall, but after stratification by gender, the association was observed only in women. The preventable proportion for women was 2.13%.

### Vegetable consumption was inversely associated with risk of death for all

The risk of death was inversely associated with vegetable consumption, with a hazard ratio of 0.90 and a rate advancement period of 1.17 for participants in the highest versus the lowest quartile (>312.1 vs. <106.8 g/day). No notable differences between genders were observed. Mortality was 3%-5% lower for every 100-g/day higher intake of vegetables.

### A stronger inverse association for raw vegetable than for cooked vegetable

When stratifying vegetable consumption by mode of preparation, a stronger inverse associations in the highest quartile was observed for raw vegetables than for cooked vegetables for all-cause, CVD and cancer mortality. Additionally, no threshold appeared in the inverse association between raw vegetables and all-cause mortality. The relation between raw vegetables and a lower risk of death has been observed previously. Possible mechanisms by which cooking affects the association between vegetables and mortality include changes in the availability of nutrients, destruction of digestive enzymes, and alteration of the structure and digestibility of vegetables.

### Stronger inverse associations for participants with high alcohol consumption or high body mass index

The inverse association between fruit and vegetable consumption and mortality seemed stronger for participants with a body mass index over 30 and participants with high alcohol consumption (>30 g/day in women and >60 g/day in men) and was suggested for smokers. This seems consistent with the antioxidant properties of fruits and vegetables, as a higher alcohol consumption, a higher body mass index, and smoking all have been shown to increase oxidative stress. However, residual confounding cannot be excluded here, because participants that consume more fruits and vegetables may be healthier considering factors that were not included in the analysis.

Table: Number of Participants and Deaths European Prospective Investigation Into Cancer and Nutrition, 1992-2010

Country	No. of Participants		No. of Participants
	Men	Women	
Norway		35,523	899 52 (2,5%)
Sweden	20,991	27,089	4,323 (9,0%)
Denmark	23,862	27,098	4,306 (8,4%)
United Kingdom	20,768	50,25	5,529 (7,8%)
The Netherlands	9,229	25,569	1,819 (5,2%)
Germany	19,234	26,286	1,84 (4%)
France		64,406	2,773 (4,3%)
Italy	13,274	29,136	1,381 (3,1%)
Spain	13,732	22,918	1,527 (4,2%)
Greece	8,792	12,994	1,285 (5,9%)
<b>Overall</b>	<b>129,88</b>	<b>321,269</b>	<b>25,682</b>

# Eating fruit and vegetables daily and living longer

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It was found that daily consumption of fruit and vegetables (F&V) was associated with a substantially longer survival and lower rate of overall mortality.

This study was conducted in a large cohort of Swedish population from 1998 to 2010, with the aim to examine the dose-response relation between F&V consumption and mortality, in terms of both time to death and mortality rate.

F&V consumption was assessed through a self-administrated questionnaire in a population-based cohort of 71,706 participants aged 45–83 years, from the population-based Cohort of Swedish Men and the Swedish Mammography Cohort. Information on F&V consumption was collected by using 14 questions on vegetables (carrot, beetroot, lettuce, cabbage, cauliflower, broccoli, tomato, pepper, spinach, peas, onion, garlic, and other vegetables), five questions on fruit (orange, apple, banana, berry, and other fruit), and one question on orange juice. Participants were asked to indicate how often on average in the previous year they had consumed each food. Our main variables for F&V, fruit, and vegetable consumption were calculated as the average servings per day and were obtained by converting the questionnaire responses to average daily intake of each item and adding the intake of all items.

During 13 years of follow-up, 16% of deaths occurred (11,439 deaths). Therefore, the analysis was focused on the 10th percentile of survival, expressed in months, that being the time by which 10% of participants in the current study died.

## Characteristics of the study population by categories of F&V consumption (Table1)

- On average, women tended to consume more F&V than did men.
- Participants with a low F&V intake were more likely :
  - to be current smokers,
  - to have a lower educational level,
  - to have a higher consumption of non-recommended foods.
- An increase in F&V consumption corresponded to a higher total energy intake.
- Age, BMI, physical activity, and alcohol consumption were similar, overall, across categories of FV consumption. The overall 10th survival percentile was 116 months, which meant that 90% of the cohort was still alive after 9.6 years of follow-up.

Table 1: Characteristics of this study population by categories of F&V consumption

Characteristics	Categories of daily F&V consumption (median)			
	≤ 2 (1,5)	2,1-4 (3,5)	4,1-6 (5)	>6 (8)
No. of subjects	11,922	24,812	19,139	15,833
Female (%)	29	40	52	64
Mean BMI (kg/m <sup>2</sup> )	25.6	25.3	25.2	25.1
Total physical activity (MET-h/d)	41.8	41.9	42.1	42.6
Current smoking status (%)	34	24	20	18
Current alcohol consumption (%)	84	87	88	87
High consumption of non-recommended food (%)	70	69	67	66
High school/university (%)	17	25	31	35
Energy (kcal/d)	2058	2201	2260	2413

## People consuming five or more servings of F&V lived longer than those who ate less

Compared with an F&V consumption of five servings/day, lower levels of consumption were progressively associated with shorter survival up to three years for those who never consumed F&V daily. The mortality rate for those who did not consume F&Vs was 53% higher than the rate for those who consumed the recommended dose of five servings/day. Compared with an F&V consumption of five servings/day, higher levels of consumption were not associated with longer survival or a decreased rate of mortality.

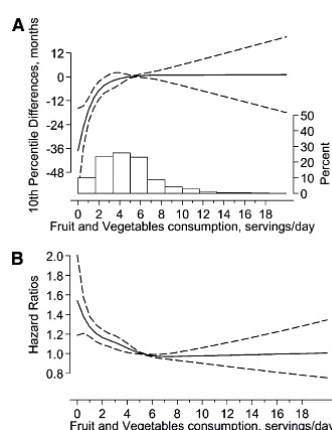


Figure: Tenth percentile differences (differences in months by which 10% of the cohort has died; A) and HRs (ratios of hazards of death; B) as a function of fruit and vegetable consumption. Data were fitted by using Laplace regression (A) and Cox proportional hazard regression (B). Models were adjusted for age at baseline, sex, BMI, total physical activity, alcohol consumption, smoking status and pack-years, education level, and total energy intake. Dashed lines represent 95% CIs. The reference value is 5 servings/day, and the histogram (A) shows the distribution of fruit and vegetable consumption in the cohort.

Benefits from eating fruit were observed at a consumption of merely one serving/day, whereas vegetable consumption was associated with a progressively longer survival up to three servings/day. People who never consumed fruit lived 19 months less than those who consumed one fruit per day. Participants who consumed three vegetables a day lived 32 months longer than those who ate no vegetables.

The study next evaluated possible interactions between F&V and sex, smoking status, BMI, and education level in predicting mortality. The shape of the dose-response relation between F&V and the 10th survival percentile did not substantially change according to sex (P-interaction = 0.31), smoking status (P-interaction = 0.53), BMI (P-interaction = 0.82), and education level (P-interaction = 0.35).



# Modelling the impact of specific food policy options on coronary heart disease and stroke deaths in Ireland

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In Europe, cardiovascular disease (CVD) remains the main cause of premature deaths and disability. It is estimated that 80% of premature coronary heart disease (CHD) and stroke deaths can be prevented<sup>1</sup>. Ireland has seen significant declines in CHD death rates between 1985 and 2000 and more recently until 2006<sup>2,3</sup>. Half of these reduced CHD deaths could be linked to improvements in population risk factors, mainly reductions in smoking, blood pressure and cholesterol levels. Two recent studies in the United Kingdom estimated that approximately 30,000–33,000 premature deaths every year could be averted if UK dietary recommendations were met<sup>4,5</sup>. Poor diet has been consistently linked with increased cardiovascular disease and cancer<sup>1,6</sup>. The evidence on salt and blood pressure, for instance, now overwhelmingly supports action to reduce population exposure to this dietary additive<sup>7</sup>.

It is estimated in the Irish population potential reductions in CHD and stroke mortality are achievable by specific and feasible decreases in consumption of:

- saturated fat,
- trans fat,
- salt; and
- increases in consumption of fruits and vegetables.

This study employed a previously validated CHD epidemiological model, the IMPACT model. Two scenarios were modelled: a conservative scenario and a substantial but politically feasible scenario.

## The IMPACT model

This is a cell-based population model described in detail elsewhere<sup>2,3</sup>. Few assumptions were made in the modelling study. A sensitivity analyses was also conducted to estimate robust estimates with confidence. The conceptual framework is based on a theoretical model relating the consumption of foods and nutrients to adverse health outcomes through biological risk factors for ill health – details of which are available elsewhere<sup>8</sup>.

The main outcomes of interest were CHD and stroke deaths in Ireland for the latest calendar year 2010 for which data were available. Age-specific and sex-specific aggregate data for both CHD and stroke deaths were obtained from the Central Statistics Office of Ireland.

In the current model, available estimates were used of the direct association between the four food components and CHD and stroke deaths, similar to the recent UK studies<sup>4,5</sup>. For example, reducing daily salt intake by 5g would translate into approximately 17% and 23% fewer CHD and stroke deaths in a year, respectively<sup>9</sup>. Details of the two

scenarios (modest versus feasible) and corresponding effect estimates based on meta-analyses from large cohort studies for each of the food components are available elsewhere<sup>8</sup>.

## We estimated that there would be about 1,000 fewer premature deaths from coronary heart disease or stroke in Ireland if better food policy was followed

A total of 4,080 cardiovascular deaths (2,966 CHD deaths; 1,114 Strokes) were reported in the age group of 25–85 years in 2010 in Ireland.

It was estimated that modest changes in food policy could result in approximately 395 (minimum 315; maximum 475) fewer cardiovascular deaths per year, a 10% overall reduction in CVD mortality in Ireland. Approximately 28% of the 395 fewer CVD deaths could be attributable to 0.5% decreased trans fat energy consumption levels; 22–1.0% decreased saturated fat energy consumption levels; 23% to decreased daily salt intake by 1g; and 26% to one portion increased consumption of fruits and vegetables from the current consumption levels.

When this study modelled with more ambitious but feasible food policy options, it was found approximately 1,070 fewer CVD deaths could be prevented per year, representing an overall 26% reduction in annual CVD mortality in Ireland. As regards consumption of fatty acids, a 3% decrease in saturated fat energy consumption has the greatest potential impact on stroke deaths in both sexes, while a 1% decrease in trans fat energy consumption level has a relatively higher benefit on CHD deaths in both sexes. Reducing the average salt intake by 3 g/day would reduce CVD mortality by approximately 270 (minimum 220; maximum 325) deaths per year. Increasing fruits and vegetable portions to 3/day would result in the maximum health benefits—approximately 310 (minimum 250; maximum 370) fewer CVD deaths per year.

## Conclusions

- Coronary heart disease (CHD) mortality in Ireland fell by more than 50% between 1985 and 2006.
- A further 26% overall decline in both CHD and stroke deaths per year could be achieved if more substantial but politically feasible food policy options were adopted in Ireland.
- A total of 1,070 fewer CHD and stroke deaths per year could occur in Ireland by achieving reductions in current dietary salt by 3g/day, trans fat by 1% of current energy intake and saturated fat by 3% of current energy intake and increasing fruit and vegetable intake by three portions/day.

Based on : O’Keeffe C, Kabir Z, O’Flaherty M, Walton J, Capewell S, Perry IJ. Modelling the impact of specific food policy options on coronary heart disease and stroke deaths in Ireland. *BMJ Open* 2013 Jul 3; 3 (7)

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