

## Original Article

**Legumes: the most important dietary predictor of survival in older people of different ethnicities**

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To identify protective dietary predictors amongst long-lived elderly people ( $N=785$ ), the "Food Habits in Later Life" (FHILL) study was undertaken among five cohorts in Japan, Sweden, Greece and Australia. Between 1988 and 1991, baseline data on food intakes were collected. There were 785 participants aged 70 and over that were followed up to seven years. Based on an alternative Cox Proportional Hazard model adjusted to age at enrolment (in 5-year intervals), gender and smoking, the legume food group showed 7-8% reduction in mortality hazard ratio for every 20g increase in daily intake with or without controlling for ethnicity (RR 0.92; 95% CI 0.85-0.99 and RR 0.93; 95% CI 0.87-0.99, respectively). Other food groups were not found to be consistently significant in predicting survival amongst the FHILL cohorts.

**Key words:** legumes, diet, survival, FHILL, mortality, food intake, elderly, Australia, Greece, Japan, Sweden, fish, fat ratio

**Introduction**

It is becoming apparent that people of various nations with different food cultures can have comparable life expectancy and morbidity rates.<sup>1</sup> The 'Food Habits in Later Life' (FHILL)<sup>2</sup> is a cross-cultural study conducted under the auspices of the International Union of Nutritional Sciences (IUNS) and the World Health Organization (WHO). The FHILL studies have concentrated on food intake and food intake patterns as differentiators and common denominators in health susceptibility and for survival within and between cultures (people of different ethnicity living in different localities). It has been suggested that the dietary patterns in the early 1960s best characterise what is known today as the "Traditional Greek Food Pattern or Traditional Medi-terranean Diet".<sup>3,4</sup> The Greek variant of the Traditional Mediterranean Diet has been documented in the "Seven Countries Study" by Keys *et al.*<sup>5-7</sup> This diet was characterised by:

1. Plentiful fruits, vegetables, legumes, grains;
2. Olive oil as the principal fat;
3. Lean red meat consumed only a few times per month or in very small portions;
4. Low to moderate daily consumption of dairy products;
5. Poultry, fish and eggs consumed a couple of times per week; and
6. Moderate consumption of wine.

We have previously demonstrated that a plant based diet (similar to the traditional mediterranean diet) which includes fish is the most important predictor of survival amongst FHILL cohorts (*in press*). This result was significant after accounting for other non-nutritional variables such as smoking status, gender, exercise, health status, social activity, activities of daily living and memory status in one Cox Proportional Hazard model. Details of this analysis are discussed elsewhere (*in press*). The current article will investigate in greater detail what aspects of the plant-fish diet contributes to longevity between and within disparate food cultures. The objectives of this article include:

- Describing cross-cultural comparisons on average food consumption amongst FHILL cohorts (grams/day adjusted to 2500 kcal for men and 2000 kcal for women)
- Examining individual food groups as predictors of mortality amongst FHILL cohorts (adjusted and non-adjusted for ethnic backgrounds)

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## Methods

Baseline data on food habits, health status and social variables were collected from five cohorts aged 70 and over (Japanese in Japan, Swedes in Sweden, Anglo-Celtic in Australia, Greeks in Australia and Greece). The validated Food Frequency Questionnaire (FFQ) were used to collect data on food intakes in all cohorts except Japanese where the 3-day weighed food record method was employed. Intakes in gram/week were calculated by multiplying the serving size by the weekly frequency of intake. These values were further translated into gram/day and were adjusted to 2500 kcal (10,460 kJ) for men and 2000 kcal (8,368 kJ) for women for comparison purposes. Furthermore, these food items were grouped into eight major food groups based on the Mediterranean diet.<sup>8-12</sup> To acknowledge the emerging evidence of beneficial effects of fish consumption in health and survival,<sup>13-15</sup> the fish and shellfish group was added. Thus the nine major food groups included vegetables, legumes, fruits and nuts, milk and dairy products, cereals and potatoes, meat and meat products, ethanol, monounsaturated to saturated fats ratio, and fish groups.

All-cause mortality data were obtained from up to seven years follow-up. Out of the 785 participants in the baseline, 169 people died during the follow-up period. An alternative Cox Proportional Hazard model, adjusted to age at enrolment (in 5-year intervals), gender, and smoking, was developed to analyse the survival data. Each Cox model was tested against controlling for cohorts' location and ethnicity.

## Results

Table 1 describes the average amount of foods consumed per person daily amongst FHILL cohorts. Most cohorts consumed vegetables between 283 and 353 g/d. However, the Swedes in Sweden ate far less vegetables. The Japanese in Japan, along with both Greek cohorts in Australia and Greece, consumed more legumes (63-86g/d) compared to other cohorts. Fruit and nut intakes were low for Japanese in Japan (140g/d) compared to the rest of the cohorts (252-330g/d). On the other hand the intake of cereals (which was mainly rice), as expected, was high for Japanese in Japan (366g/d). Other cohorts consumed between 102-280 grams of cereals daily.

Milk and dairy consumption varied between cohorts. It was noted that Swedes consumed more than 400g/d whilst Japanese consumed as little as 165g/d. The variation in meat consumption was enormous. In Japan, the Japanese ate very little meat (less than 50g/d). In contrast, the Greeks in Australia ate about 190g of meat and meat products daily. Little fish and shellfish were eaten by the Anglo-Celts in Australia (21g/d). However, the Japanese in Japan consumed five times more than the Anglo-Celts in Australia (more than 100g daily).

Ethanol consumption appeared to be varied between cohorts. While most cohorts consumed between 5 and 10 grams of ethanol daily, the Japanese (mainly men) drank about 15 grams of ethanol per day. The Swedes and Anglo-Celtic seemed to consume more saturated fats than the rest of the cohorts. This result was reflected in low monounsaturated:saturated fat ratio (less than 1). Finally, there was considerable variation between the cohorts in energy intakes. The Japanese in Japan reported a very low energy intake (about 1600 kcal daily). On the other hand, the Swedes in Sweden consumed around 2500 kcal per day. Other cohorts reported energy intakes between 2060-2118 kcal daily.

Results from the overall FHILL cohorts suggested that higher intakes of legumes, fish and shellfish, and olive oil (reflected in monounsaturated:saturated fat ratio) were significant predictors of survival in the elderly (Table 2). There was a reduction in risk of death by up to 8% for every 20 grams increase in legumes intake. The result remained significant with or without controlling for ethnic backgrounds. With every 20 grams increase in fish and shellfish intake, there was a 6% decrease in the hazard of death (95% CI 1%-12%), after adjusting for age, gender, and smoking status only. For every unit increase in the mono-unsaturated:saturated fat ratio there was a 46% decrease in the hazard of death (95% CI 9%-68%). However, this ratio was a significant predictor of mortality only when ethnic background was included as a confounding factor in addition to age at enrolment (in 5-year intervals), gender, and smoking status.

Only for legume intake was the result plausible, consistent and statistically significant across collective FHILL cohorts' data. There is a 7% - 8% reduction in

**Table 1.** Average amount of foods consumed (grams) per person daily in FHILL cohorts

Variables	Japanese in Japan			Swedes in Sweden			Anglo-Celts in Australia			Greeks in Australia			Greeks in Greece		
	Mean	±	SD	Mean	±	SD	Mean	±	SD	Mean	±	SD	Mean	±	SD
	N	=	89	N	=	184	N	=	141	N	=	189	N	=	182
Vegetables	283	±	152	165	±	117	346	±	180	353	±	143	295	±	152
Legumes	85	±	68	21	±	18	14	±	19	86	±	58	63	±	47
Fruits and nuts	140	±	99	298	±	179	330	±	188	252	±	135	261	±	179
Cereals	366	±	102	102	±	54	204	±	104	261	±	97	280	±	112
Dairy products	165	±	150	404	±	205	346	±	173	245	±	172	243	±	184
Meat & meat products	43	±	38	73	±	49	151	±	84	190	±	79	110	±	58
Fish and shellfish	102	±	69	73	±	49	21	±	20	73	±	51	42	±	38
Ethanol	15	±	30	5	±	9	8	±	14	7	±	12	10	±	15
Monounsaturated:saturated ratio	1.3	±	0.3	0.7	±	0.2	0.8	±	0.2	1.7	±	0.4	1.8	±	0.5
Energy (kcal)	1599	±	414	2501	±	689	2096	±	503	2118	±	537	2060	±	671

Food groups were adjusted to 2500 kcal for men and 2000 kcal for women

**Table 2.** Mortality risk ratio estimates (and 95%CI) deprived from alternative Cox's models with each of nine major food groups\*

Variables	P value	Risk Ratio† (95% CI)	P value	Risk Ratio‡ (95% CI)
Vegetable intake (20g)	0.70	1.00 (0.98 to 1.02)	0.97	1.00 (0.98 to 1.02)
Legume intake (20g)	0.02	0.92 (0.85 to 0.99)	0.02	0.93 (0.87 to 0.99)
Fruit and nut intake (20g)	0.38	0.99 (0.97 to 1.01)	0.29	0.99 (0.97 to 1.01)
Cereal intake (20g)	0.75	0.99 (0.97 to 1.02)	0.89	1.00 (0.98 to 1.03)
Dairy intake (20g)	0.29	1.01 (0.99 to 1.03)	0.58	0.99 (0.98 to 1.01)
Meat intake (20g)	0.42	1.02 (0.97 to 1.08)	0.34	0.98 (0.94 to 1.02)
Fish intake (20g)	0.23	0.96 (0.89 to 1.03)	0.04	0.94 (0.88 to 0.99)
Monounsaturated : Saturated ratio (1 unit)	0.02	0.54 (0.32 to 0.91)	0.85	0.97 (0.74 to 1.29)
Ethanol intake (10g)	0.83	1.01 (0.92 to 1.10)	0.40	1.04 (0.95 to 1.13)

\*Adjusted to 2500 kcal (10,460 kJ) for men and 2000 kcal (8368 kJ) for women ; †From model including terms of age at enrolment (5-y interval), sex, smoking status, and ethnicity/locality

‡From model including terms of age at enrolment (5-y interval), sex, and smoking status, but not ethnicity/locality

mortality hazard ratio for every 20g increase in daily legume intake with adjustment for location/ethnicity (RR 0.92; 95% CI 0.85 – 0.99) and without adjustment for location/ethnicity (RR 0.93; 95% CI 0.87 – 0.99).

### Discussion

Food intake promises to be, not surprisingly, one of the best measures of nutritional status. Together with body composition and various performance measures such as strength and endurance, it represents the inputs, outputs and the sum total of energy and food component throughput and status or balance in human biology. Biomarkers of food intake offer ways in which its validity can be increased and its perturbations recognised.

There were variations between the five FHILL cohorts on average daily consumption of foods consumed. Taller elderly consumed the most calories whilst the shortest elderly consumed less. These findings about food and survival apply across cultures with a wide range of energy intakes (Japanese 1599kcal - Swedes 2501kcal) and wide range of stature (Japanese 152cm - Swedes 165cm). Results from the current study were compared with the results documented by Keys and his colleagues from the classical international "Seven Countries Study". It was observed in the current study that the average cereal and ethanol consumption were lower whilst the average meat consumption was higher across longevity cultures, in comparison to the intake from the "Seven Countries study" in the 1960s.<sup>5</sup> Overall, the Japanese in the FHILL study consumed more vegetables, fruits, meat and dairy products than the Japanese cohort from the "Seven Countries Study". On the other hand, they consumed less legumes, cereals, fish, and alcohol. On average, both the Greek cohorts in Australia and Greece consumed more vegetables, legumes, fish, meat and dairy products compared to two Greek cohorts from the "Seven Countries Study". However, they consumed less fruits, cereals, and alcohol.

Only for legumes intake was the result plausible, consistent and statistically significant from collective FHILL cohorts data (8% reduction in risk of death for every 20 grams increase in daily legumes intake).

Legumes have long been associated with longevity food cultures. For example, the Japanese eat soy, tofu, natto, miso, the Swedes eat brown beans and peas and the Mediterraneans eat lentils, chickpeas and white beans.<sup>6,16-18</sup> A 6% decrease in the hazard of death (95% CI 1%-12%) for every 20g increase in intake of fish and shellfish was observed when the Cox's model did not include ethnicity/locality as a confounding factor. It appeared that fish and shellfish intakes were shown to prolong survival, but it may be related to certain food cultures that have high intakes of fish such as the Japanese.<sup>19</sup> The monounsaturated:saturated fat ratio was associated with a 46% decrease in the hazard of death (95% CI 9%-68%) for every unit increase. This ratio was a significant predictor of mortality only when ethnic background was included as a confounding factor in the Cox's model. Thus across longevity cultures in the FHILL study, higher monounsaturated: saturated fat ratio (as reflected in intake of olive oil in the Mediterranean cultures) appeared to be protective against premature death irrespective of their ethnic backgrounds. The intake of monounsaturated fat has been shown to be protective against breast cancer in Sweden.<sup>20</sup>

### Conclusions

The FHILL longitudinal study shows that a higher legume intake is the most protective dietary predictor of survival amongst the elderly, regardless of their ethnicity. The significance of legumes persisted even after controlling for age at enrolment (in 5-year intervals), gender, and smoking. Legumes have been associated with long-lived food cultures such as the Japanese (soy, tofu, natto, miso), the Swedes (brown beans, peas), and the Mediterranean people (lentils, chickpeas, white beans).

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