

## Health benefits of a vegetarian diet

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Compared with non-vegetarians, Western vegetarians have a lower mean BMI (by about 1 kg/m<sup>2</sup>), a lower mean plasma total cholesterol concentration (by about 0.5 mmol/l), and a lower mortality from IHD (by about 25%). They may also have a lower risk for some other diseases such as constipation, diverticular disease, gallstones and appendicitis. No differences in mortality from common cancers have been established. There is no evidence of adverse effects on mortality. Much more information is needed, particularly on other causes of death, other morbidity including osteoporosis, and long-term health in vegans. The evidence available suggests that widespread adoption of a vegetarian diet could prevent approximately 40 000 deaths from IHD in Britain each year.

### Vegetarians: Vegan: Mortality: IHD: Cancer

Vegetarian diets are based on cereals, pulses, nuts, vegetables and fruits, and may also include dairy products and eggs. Lacto-ovo-vegetarians do not consume any meat, poultry or fish, but do include dairy products and eggs in their diet; vegans do not consume any foods of animal origin. Unless otherwise specified, reference to vegetarians means lacto-ovo-vegetarians, because relatively little information is available for vegans. In general, a vegetarian diet is lower in saturated fat and higher in starch, NSP, fruits and vegetables than a non-vegetarian diet.

In the present short overview we describe first the relationships between vegetarian diets and BMI and plasma cholesterol concentrations, and then the relationships between vegetarian diets and mortality from the commonest causes of death. The present paper concentrates on major findings from studies of Caucasian Western vegetarians. More extensive reviews have been published by Dwyer (1988, 1991), Sanders & Reddy (1994) and Thorogood (1995).

### BMI and obesity

Numerous studies have consistently found that vegetarians are on average thinner than comparable non-vegetarians (Dwyer, 1988; Thorogood, 1995; Key & Davey, 1996; Key *et al.* 1998). The data from four large cohorts are shown in Fig. 1. The average BMI varies substantially between cohorts (higher in the Seventh-day Adventist cohorts in California, USA (Snowdon *et al.* 1984; Fraser *et al.* 1992)

than in the European cohorts (Chang-Claude *et al.* 1992; Thorogood *et al.* 1994)), but on average vegetarians in each cohort have a BMI about 1 kg/m<sup>2</sup> lower than that of non-vegetarians within the same cohort. The difference is similar in men and women, and is seen in all age-groups (Fig. 2). The lower mean BMI of vegetarians leads to a substantially lower prevalence of obesity (Fig. 3; Key & Davey, 1996).

The reasons for this association have not been established. An analysis of data from 5000 men and women

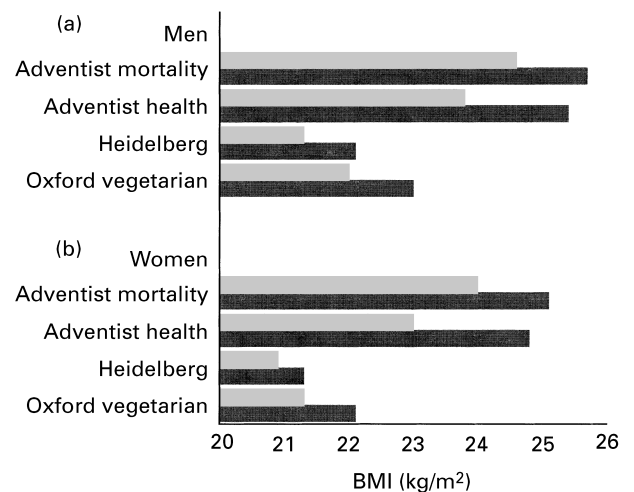
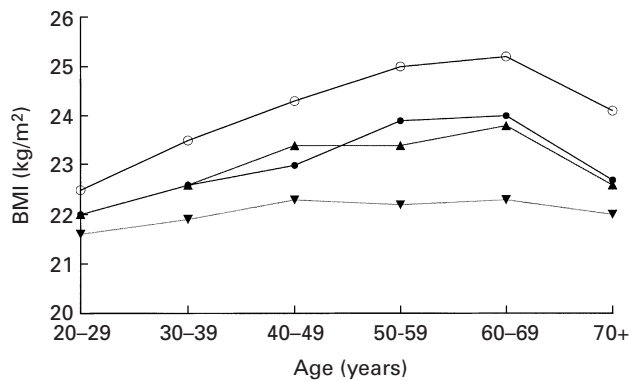


Fig. 1. Mean BMI in vegetarians (■) and non-vegetarians (■) in four large cohort studies. (Adapted from Key *et al.* 1998.)

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**Fig. 2.** BMI by age and diet group in 17 158 women in the European Prospective Investigation into Cancer and Nutrition (Key & Davey, 1996). (○), Meat eaters; (●), fish eaters; (▲), vegetarians; (▼), vegans.

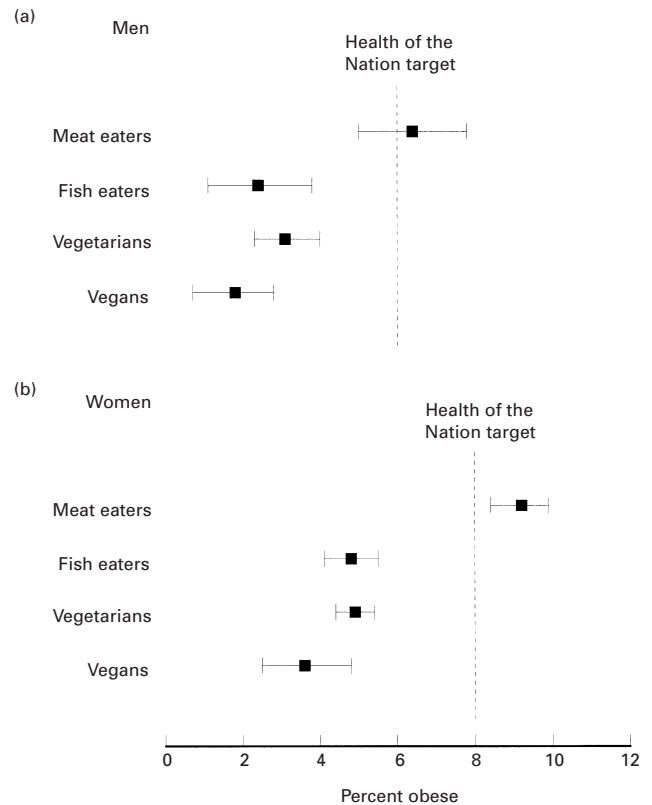
in the Oxford Vegetarian study (Appleby *et al.* 1998) suggested that the lower BMI of non-meat eaters than meat eaters is partly due to a higher intake of dietary fibre and a lower intake of animal fat, and in men only, a lower intake of alcohol. These factors, however, accounted for only one-third of the difference in BMI observed.

### Plasma cholesterol concentration

Studies have consistently reported that vegetarians have lower mean plasma total cholesterol concentrations than comparable non-vegetarians (Dwyer, 1988, 1991; Sanders & Reddy, 1994; Thorogood, 1995). In an analysis of data from 3000 men and women, Thorogood *et al.* (1987) reported that mean total cholesterol concentrations (mmol/l), adjusted for age and sex, were 4.29 in vegans, 4.88 in vegetarians, 5.01 in fish eaters and 5.31 in meat eaters (Table 1). Mean concentrations of HDL-cholesterol were higher in the fish eaters, but otherwise did not differ between the groups.

### Mortality

The relatively low plasma cholesterol concentrations of vegetarians would be expected to reduce the risk of IHD. Thorogood *et al.* (1987), for example, estimated that the 0.4 mmol/l lower plasma cholesterol concentration of vegetarians compared with meat eaters which they observed might lead to a 24% reduction in the incidence of IHD. It is also possible that vegetarian diets might protect against



**Fig. 3.** Percentage of obese subjects in different dietary groups. Data for 3947 men and 17 158 women in the European Prospective Investigation into Cancer and Nutrition. Health of the Nation targets are that the percentages of men and women who are obese should be reduced to 6 and 8 respectively by 2005 (Department of Health, 1992). (Adapted from Key & Davey, 1996.)

cancers of the colo-rectum, breast and prostate, since these cancers are common in rich countries but rare in poor countries with predominantly plant-based diets.

Data on mortality rates in Western vegetarians are available from five cohort studies. Two of these studies were conducted among Seventh-day Adventists in California, USA (Snowdon *et al.* 1984; Fraser *et al.* 1992), two among members of the Vegetarian Society and other vegetarians and comparable non-vegetarians in Britain (Burr & Butland, 1988; Thorogood *et al.* 1994), and one among the readers of vegetarian magazines in Germany (Chang-Claude *et al.* 1992). We (Key *et al.* 1998) have recently published a pooled analysis of original data from these five cohort studies, including data for 76 000 men and women

**Table 1.** Plasma lipid concentrations in vegetarians and non-vegetarians, adjusted for age and sex (From Thorogood *et al.* 1987) (Mean values with their standard errors)

Diet	n	Total cholesterol (mmol/l)		LDL-cholesterol (mmol/l)		HDL-cholesterol (mmol/l)	
		Mean	SE	Mean	SE	Mean	SE
Vegan	114	4.29	0.140	2.28	0.126	1.49	0.048
Vegetarian	1550	4.88	0.100	2.74	0.090	1.50	0.035
Fish eater	415	5.01	0.109	2.88	0.098	1.56	0.038
Meat eater	1198	5.31	0.101	3.17	0.091	1.49	0.035
Heterogeneity		P < 0.001		P < 0.001		P < 0.01	

among whom there were 8300 deaths before age 90 years after an average 11 years of follow up. In all these cohorts, approximately 40–50% of the subjects recruited were vegetarian and, importantly, the vegetarians and the non-vegetarians in each study had a shared interest in healthy living or a similar social and/or religious background. The results summarized below are for mortality rates among vegetarians compared with non-vegetarians. All results were adjusted for age, sex and smoking, and a random-effects model was used to calculate pooled estimates of effect for all studies combined. Further adjustments for BMI, alcohol consumption, exercise and educational level had little effect on the results. As far as we are aware these are all the data available concerning mortality in Western-style vegetarians.

### IHD

In the pooled analysis of cohort studies (Key *et al.* 1998) there were 2264 deaths from IHD before age 90 years. In comparison with non-vegetarians, vegetarians had a 24% reduction in mortality from this disease (death rate ratio 0.76 (95% CI 0.62, 0.94)). The reduction in mortality was greater at younger ages: death rate ratios were 0.55 (95% CI 0.35, 0.85), 0.69 (95% CI 0.53, 0.90) and 0.92 (95% CI 0.73, 1.16) for deaths from IHD at ages <65, 65–79 and 80–89 years respectively. The reduction in mortality was confined to vegetarians who had followed their current diet for more than 5 years. When the non-vegetarians were divided into regular meat eaters (who ate meat at least once per week) and semi-vegetarians (who ate fish only or ate meat less than once per week), the IHD death rate ratios, when compared with regular meat eaters, were 0.78 (95% CI 0.68, 0.89) in semi-vegetarians and 0.66 (95% CI 0.53, 0.83) in vegetarians (test for trend  $P < 0.001$ ; Fig. 4).

There is thus very strong evidence that vegetarians have a lower risk of dying from IHD than comparable non-Vegetarians. There are currently about 165 000 deaths from IHD each year in Britain, therefore a 24% reduction in the death rate could prevent about 40 000 deaths each year in this country alone.

It is likely that the reduction in IHD among vegetarians is at least partly due to a lower dietary intake of saturated fat and cholesterol. In an analysis of data from the Oxford Vegetarian study (Mann *et al.* 1997), in which vegetarians had a 17% lower mortality from IHD than regular meat eaters, consumption of cheese, eggs, total animal fat and dietary cholesterol were each strongly associated with IHD mortality. Compared with those who ate relatively little of these foods, the death rate ratios in those who ate the most were 2.47 (95% CI 0.97, 6.26) for cheese, 2.68 (95% CI 1.19, 6.02) for eggs, 3.29 (95% CI 1.50, 7.21) for total animal fat and 3.53 (95% CI 1.57, 7.96) for dietary cholesterol (Fig. 5).

### Cancers

The pooled analysis of five prospective studies presented mortality data for the five commonest cancers: lung, colorectal, breast, prostate and stomach (Key *et al.* 1998).

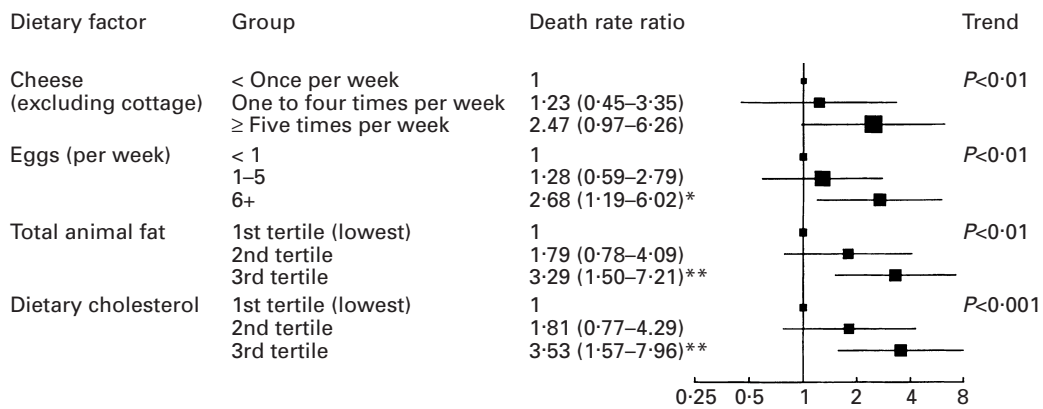


**Fig. 4.** Pooled analysis of mortality in vegetarians and non-vegetarians: death rate ratios for IHD by (a) age at death (vegetarians: non-vegetarians), (b) duration of current diet (vegetarians: non-vegetarians; duration unknown for some vegetarians), and (c) diet group (regular meat eater, meat eaten at least once per week; semi-vegetarian, fish but not meat eaten, or meat eaten less than once per week; vegetarian, no meat or fish eaten; expressed relative to regular meat eaters; subdivision unavailable for one study), adjusted for age, sex, and smoking, and for study using a random-effects model. Values are shown with 95% CI represented by horizontal bars. (Adapted from Key *et al.* 1998.)

Mortality among the vegetarians did not differ significantly from that of the non-vegetarians for any of these cancer sites. Mortality from colo-rectal cancer, for which the hypothesis that vegetarian diets might reduce risk was considered to be strongest, was almost identical in vegetarians and non-vegetarians (death rate ratio 0.99 (95% CI 0.77, 1.27)), and this did not vary according to age at death or according to the length of time for which vegetarians had followed their current diet.

### Other causes of death and all-cause mortality

The pooled analysis of five prospective studies presented mortality data for cerebrovascular disease (Key *et al.* 1998). The death rate ratio in vegetarians compared with non-vegetarians was 0.93 (95% CI 0.74, 1.17). No other individual causes of death were examined because numbers of subjects were small. All-cause mortality was 5% lower in



**Fig. 5.** Analysis of data from the Oxford Vegetarian study. Death rate ratios for IHD by dietary factor, among subjects with no evidence of pre-existing disease at the time of recruitment, adjusted for age, sex, smoking and social class. Values are shown with 95% CI represented by horizontal bars; the area of each square is proportional to the number of deaths in that group. Death rate ratios were significantly different from those for the reference group: \* $P < 0.05$ , \*\* $P < 0.01$ . (Adapted from Mann *et al.* 1997.)

vegetarians than in non-vegetarians; this was not statistically significant (death rate ratio 0.95 (95% CI 0.82, 1.11)), but this is compatible with the 24% reduction in mortality from IHD which was responsible for 27% of all deaths.

### Morbidity

Relatively little information is available concerning morbidity in vegetarians. There is some evidence that vegetarians may have a lower incidence of constipation (Burkitt *et al.* 1972), diabetes (Snowdon & Phillips, 1975), diverticular disease of the colon (Gear *et al.* 1979), gallstones (Pixley *et al.* 1985), hypertension (Beilin, 1993) and emergency appendicectomy (Appleby *et al.* 1995).

### Conclusion

Compared with non-vegetarians, Western vegetarians have a lower BMI (by about 1 kg/m<sup>2</sup>), a lower plasma cholesterol concentration (by about 0.5 mmol/l), and a lower mortality from IHD (by about 25%). They may also have a lower risk for some other diseases such as diverticular disease, gallstones and appendicitis. No differences in mortality from common cancers have been established. There is no evidence of adverse effects on mortality. Much more information is needed, particularly on other causes of death, osteoporosis, and long-term health in vegans. The evidence available suggests that widespread adoption of a vegetarian diet could prevent approximately 40 000 deaths from IHD in Britain each year.

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