# Vegetarian (V*) Diets

Edwin Cox, M.D.
OLLI

# Pros and Cons of V*

+ Possible health benefits
+ Environmental benefits
- Cost increased
- Variety reduced
- Fuss and bother
- Limited data to evaluate objectively

# "Flavors" of V* Diets

**Table 1.** Classification of dietary patterns *.

| Dietary Pattern | Definition | Beef | Poultry/Fish | Dairy/Eggs |
|---|---|---|---|---|
| **Non-vegetarian** | Eat red meat, poultry, fish, milk, and eggs more than once a week |  |  |  |
| **Semi-vegetarian** | Eat red meat, poultry, and fish less than once per week and more than once per month |  |  |  |
| **Vegetarian** | | | | |
| **Pesco-** | Eat fish, milk, and eggs but no red meat nor poultry |  |  |  |
| **Lacto-ovo-** | Eat eggs, milk, or both but no red meat, fish, nor poultry |  |  |  |
| **Vegan** | Eat no red meat, fish, poultry, dairy, and eggs |  |  |  |

* Adapted from Gary E. Fraser [15].

# Adventist Health Studies

**Table 2.** Characteristics of Adventist Mortality Study (AMS), Adventist Health Study-1 (AHS-1), and Adventist Health Study-2 (AHS-2).

| Sources | Location | Number of Subjects (*n*) | Age Range (years) | Years of Follow-Up (years) | Outcomes of Interest | Study Design |
|---|---|---|---|---|---|---|
| **Adventist Mortality Study (AMS) [16]** | California | 22,940<br>64.6% Female | 35–90 | 1960–1976 | Disease Mortality | Prospective |
| **Adventist Health Study-1 (AHS-1) [17]** | California | 34,198<br>60.1% Female | 25–90 | 1976–1982 (incidence)<br>1976–1988 (mortality) | Disease incidence & mortality | Prospective |
| **Adventist Health Study-2 (AHS-2) [14]** | 50 U.S. States & Canada | 96,194<br>65.1% Female | 30–112 | 2002–(ongoing) | Disease Incidence & morality | Prospective |

# Cardiometabolic factors - AHS

**Table 3.** Cardiometabolic factors among vegetarian and non-vegetarian Adventists.

| Cardiometabolic Factor | Person at-Risk | No. of Events | Parameter Estimates | Non-Vegetarian | Vegetarian | Cohort(s) & References |
|---|---|---|---|---|---|---|
| | | | | Mean or OR (95% CI) | | |
| **BMI** [a],* | | | | | | |
| *Men* | 34,192 | - | Mean, kg/m$^2$ | 26.2 (26.1, 26.4) | 24.3 (24.1, 24.4) | AHS-1 [21] |
| *Women* | | | | 25.9 (25.8, 26.0) | 23.7 (23.6, 23.9) | |
| **BMI** [a],* | 773 | - | Mean, kg/m$^2$ | 29.6 (29.0, 30.3) | 25.9 (25.2, 26.6) | AHS-2 [22] |
| **Hypertension** [b],‡ | | | | | | |
| *Men* | 34,192 | - | OR | 1 [*referent*] | 0.45 (0.40, 0.51) | AHS-1 [21] |
| *Women* | | | | | 0.45 (0.41, 0.49) | |
| **Diabetes** [b], ‡ | | | | | | |
| *Men* | 34,192 | - | OR | 1 [*referent*] | 0.51 (0.40, 0.64) | AHS-1 [21] |
| *Women* | | | | | 0.52 (0.44, 0.64) | |
| **Diabetes Mellitus** [c],♠ | 8401 | 543 | OR | 1 [*referent*] | 0.75 (0.57, 0.97) | AMS & AHS-1 [23] |
| **Metabolic Syndrome** [d],† | 773 | - | OR | 1 [*referent*] | 0.44 (0.30, 0.64) | AHS-2 [22] |

# Mortality by Cause and V*

**Table 8.** All-cause and cause-specific mortality among lacto-ovo-vegetarians and vegan Adventists.

| Cause-Specific Mortality | Person at-Risk | No. of Events | Parameter Estimates | Lacto-ovo-Vegetarian | Vegan | Cohort(s) & References |
|---|---|---|---|---|---|---|
| | | | | HR (95% CI) | | |
| **All-cause mortality** [a],[b],‡ | 73,308 | 2560 | HR | 0.91 (0.82, 1.00) | 0.85 (0.73, 1.01) | AHS-2 [19] |
| *Males* [a],* | 25,105 | 1031 | HR | 0.86 (0.74, 1.01) | 0.72 (0.56, 0.92) | |
| *Females* [c] | 48,203 | 1529 | HR | 0.94 (0.83, 1.07) | 0.97 (0.78, 1.20) | |
| **All-Cancer** [a],[b] | 73,308 | 706 | HR | 0.90 (0.75, 1.09) | 0.92 (0.68, 1.24) | |
| *Males* [a] | 25,105 | 273 | HR | 1.01 (0.75, 1.37) | 0.81 (0.48, 1.36) | |
| *Females* | 48,203 | 433 | HR | 0.85 (0.67, 1.09) | 0.99 (0.69, 1.44) | |
| **Ischemic Heart Disease** [a],[b] | 73,308 | 372 | HR | 0.82 (0.62, 1.06) | 0.90 (0.60, 1.33) | |
| *Males* [a],* | 25,105 | 159 | HR | 0.76 (0.52, 1.12) | 0.45 (0.21, 0.94) | |
| *Females* [c] | 48,203 | 203 | HR | 0.85 (0.59, 1.22) | 1.39 (0.87, 2.24) | |
| **Cardiovascular Disease** [a], [b] | 73,308 | 987 | HR | 0.90 (0.76, 1.06) | 0.91 (0.71, 1.16) | |
| *Males* [a],* | 25,105 | 390 | HR | 0.77 (0.59, 0.99) | 0.58 (0.38, 0.89) | |
| *Females* [c] | 48,203 | 597 | HR | 0.99 (0.81, 1.22) | 1.18 (0.88, 1.60) | |
| **Other-cause** [a],[b],‡ | 73,308 | 867 | HR | 0.91 (0.77–1.07) | 0.74 (0.56–0.99) | |
| *Males* [a] | 25,105 | 368 | HR | 0.89 (0.69–1.15) | 0.81 (0.53–1.22) | |
| *Females* [c] | 48,203 | 499 | HR | 0.93 (0.75–1.17) | 0.70 (0.47–1.05) | |

Non-vegetarian is the referent group. HR = hazard ratio; [a] Adjusted by age (*i.e.*, attained age as time variable), race, smoking, exercise, personal income, educational level, marital status, alcohol, region, and. Other-cause includes non-CVD and non-cancer; $*p < 0.05$; [b] Also adjusted by sex, menopause, and hormone therapy; $‡p < 0.05$; [c] Also adjusted by menopause and hormone therapy.

# Cancer Mortality - AHS

**Table 4.** All-cancer and cancer-specific sites among vegetarian and non-vegetarian Adventists.

| Cancer Sites | Person at-Risk | No. of Events | Parameter Estimates | Non-vegetarian | Vegetarian | Cohort(s) & References |
|---|---|---|---|---|---|---|
| | | | | RR or HR (95% CI) | | |
| **Colon** [a],* | 34,198 | 107 | RR | 1 [*referent*] | 0.55 (0.35, 0.81) | AHS-1 [21] |
| **Colon** [b],† | 34,198 | 166 | RR | 1 [*referent*] | 0.39 (0.19, 0.83) | AHS-1 [24] |
| **Gastrointestinal Tract** [c],♦ | 69,120 | 495 | HR | 1 [*referent*] | 0.77 (0.63, 0.93) | AHS-2 [20] |
| **Urinary Tract** [c] | 69,120 | 194 | HR | 1 [*referent*] | 1.21 (0.89, 1.65) | AHS-2 [20] |
| **All-male Cancer** [d] | 24,446 | 553 | HR | 1 [*referent*] | 0.94 (0.42, 2.07) | |
| **Prostate** [a] | 34,198 | 127 | RR | 1 [*referent*] | 0.65 (0.44, 0.95) | AHS-1 [21] |
| **All-female Cancer** [e] | 44,674 | 801 | HR | 1 [*referent*] | 0.97 (0.84, 1.13) | AHS-2 [20] |
| **Breast** [a] | 34,198 | 128 | RR | 1 [*referent*] | 0.80 (0.56, 1.15) | AHS-1 [21] |
| **Uterine** [a] | 34,198 | 1.16 | RR | 1 [*referent*] | 0.85 (0.58, 1.23) | |
| **Overall-Cancer** [f],‡ | 69,120 | 2939 | HR | 1 [*referent*] | 0.92 (0.85, 1.00) | AHS-2 [20] |
| *Males* [g] | 24,446 | 1235 | HR | 1 [*referent*] | 0.92 (0.81, 1.03) | |
| *Females* [f] | 44,674 | 1704 | HR | 1 [*referent*] | 0.93 (0.84, 1.03) | |

# Cancer Mortality - AHS

Colon cancer

- Significant reduction in AHS1
- Significant reduction in all GI cancers AHS2

Prostate cancer in men

- Significant reduction in AHS1
- AHS2 – longer observation needed

Breast cancer in women

- Non-significant reduction in AHS1
- AHS2 – longer observation needed

Overall cancer

- AHS2 small (8%) reduction, not yet significant

# Mortality by Type of V* Diet

| Characteristic | Deaths, Hazard Ratio (95% CI) | | | | |
|---|---|---|---|---|---|
| | All-Cause | Ischemic Heart Disease | Cardiovascular Disease | Cancer | Other |
| All (N = 73 308), No. of deaths[a,b] | 2560 | 372 | 987 | 706 | 867 |
| Vegetarian | | | | | |
| Vegan | 0.85 (0.73–1.01) | 0.90 (0.60–1.33) | 0.91 (0.71–1.16) | 0.92 (0.68–1.24) | 0.74 (0.56–0.99) |
| Lacto-ovo | 0.91 (0.82–1.00) | 0.82 (0.62–1.06) | 0.90 (0.76–1.06) | 0.90 (0.75–1.09) | 0.91 (0.77–1.07) |
| Pesco | 0.81 (0.69–0.94) | 0.65 (0.43–0.97) | 0.80 (0.62–1.03) | 0.94 (0.72–1.22) | 0.71 (0.54–0.94) |
| Semi | 0.92 (0.75–1.13) | 0.92 (0.57–1.51) | 0.85 (0.63–1.16) | 0.94 (0.66–1.35) | 0.99 (0.72–1.36) |
| Nonvegetarian | 1 [Reference] | 1 [Reference] | 1 [Reference] | 1 [Reference] | 1 [Reference] |
| Men (n = 25 105), No. of deaths[a] | 1031 | 169 | 390 | 273 | 368 |
| Vegetarian | | | | | |
| Vegan | 0.72 (0.56–0.92) | 0.45 (0.21–0.94) | 0.58 (0.38–0.89) | 0.81 (0.48–1.36) | 0.81 (0.53–1.22) |
| Lacto-ovo | 0.86 (0.74–1.01) | 0.76 (0.52–1.12) | 0.77 (0.59–0.99) | 1.01 (0.75–1.37) | 0.89 (0.69–1.15) |
| Pesco | 0.73 (0.57–0.93) | 0.77 (0.45–1.30) | 0.66 (0.44–0.98) | 1.10 (0.73–1.67) | 0.60 (0.39–0.93) |
| Semi | 0.93 (0.68–1.26) | 0.73 (0.33–1.60) | 0.75 (0.43–1.32) | 1.15 (0.65–2.03) | 1.03 (0.62–1.71) |
| Nonvegetarian | 1 [Reference] | 1 [Reference] | 1 [Reference] | 1 [Reference] | 1 [Reference] |
| Women (n = 48 203), No. of deaths[a,c] | 1529 | 203 | 597 | 433 | 499 |
| Vegetarian | | | | | |
| Vegan | 0.97 (0.78–1.20) | 1.39 (0.87–2.24) | 1.18 (0.88–1.60) | 0.99 (0.69–1.44) | 0.70 (0.47–1.05) |
| Lacto-ovo | 0.94 (0.83–1.07) | 0.85 (0.59–1.22) | 0.99 (0.81–1.22) | 0.85 (0.67–1.09) | 0.93 (0.75–1.17) |
| Pesco | 0.88 (0.72–1.07) | 0.51 (0.26–0.99) | 0.90 (0.66–1.23) | 0.86 (0.61–1.21) | 0.81 (0.58–1.15) |
| Semi | 0.92 (0.70–1.22) | 1.09 (0.60–1.98) | 0.93 (0.64–1.34) | 0.85 (0.56–1.30) | 0.97 (0.64–1.47) |
| Nonvegetarian | 1 [Reference] | 1 [Reference] | 1 [Reference] | 1 [Reference] | 1 [Reference] |

# Mortality reduction – AHS2 All causes

| | All | Men | Women |
|---|---|---|---|
| Pesco | 19%* | 27%* | 12% |
| Vegan | 15%± | 28%* | 3% |
| Lacto-ovo | 9%± | 14%± | 6% |
| Semi | 8% | 7% | 8% |

Pescotarians had the largest (and only statistically significant) reduction in all-cause mortality in the combined group

Only men had significant reductions

- Suggests comparison group of men non-vegetarians had some particularly deleterious behaviors, dietary or otherwise

* $p<0.05$ ± Borderline significant

# Mortality reduction – AHS2 Coronary heart disease

| | All | Men | Women |
|---|---|---|---|
| Pesco | 35%* | 23% | 49%* |
| Vegan | 10% | 55%* | -39% |
| Lacto-ovo | 18% | 24% | 15% |
| Semi | 8% | 27% | -9% |

Pescotarians had the largest (and only statistically significant) reduction in coronary heart disease mortality in the combined group

Only pesco women (not men) had significant reductions

Vegan and semi-veg women had increases in mortality!

- Not statistically significant, though

Vegan men had large and significant reduction; all groups had substantial reductions

- Suggests comparison group of men non-vegetarians had some particularly deleterious behaviors, dietary or otherwise

* $p<0.05$ ± Borderline significant

# Mortality reduction – AHS2 "Other" causes of death

| | All | Men | Women |
|---|---|---|---|
| Pesco | 29%* | 40%* | 19% |
| Vegan | 26%* | 19% | 30% |
| Lacto-ovo | 9% | 11% | 7% |
| Semi | 1% | -3% | 3% |

Pescotarians and vegans had large, significant reductions in non-cardiac, non-cancer mortality in the combined group

Only pesco men had significant reductions

* $p<0.05$ ± Borderline significant

# Adventist Health Studies Summary

Earliest study, AHS1, has long-term followup

- Overall cancer mortality shows a small but not statistically significant reduction in vegetarians groups
- Colon cancer and prostate cancer are two types with suggestion of substantial reductions

Recent study, AHS2, followup is short but some interesting results stand out

- Reduced coronary heart disease death rate in pescotarians is striking, especially in women by contrast to increased CHD mortality in vegan women
- Non-vegetarian men seem to be at unusually high risk for CHD, since all vegetarian diet groups in men fared much better by comparison

# But, is it the meat, or something else...?

**Beyond Meatless, the Health Effects of Vegan Diets: Findings from the Adventist Cohorts**

**Lap Tai Le and Joan Sabaté ***

Department of Nutrition, School of Public Health, Loma Linda University, CA 92350, USA;

Specific foods were recorded by diet questionaires in AHS2, but were not analyzed in the foregoing studies. In this study, the specific nutrients were determined for each dietary group. In the next slide, pay particular attention to dietary fiber.

# Dietary Factors in AHS2

| | Non Vegetarian | | Semi Vegetarian | | Pesco Vegetarian | | Lacto Ovo Vegetarian | | Strict Vegetarian | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Mean** | **SE** | **Mean** | **SE** | **Mean** | **SE** | **Mean** | **SE** | **Mean** | **SE** |
| Caloric Intake (kcal/d) | 1890 | 4 | 1713 | 12 | 1937 | 9 | 1899 | 5 | 1894 | 10 |
| Carbohydrate (% Energy) | 53.1 | <0.1 | 56.6 | 0.1 | 56.8 | 0.1 | 57.2 | 0.1 | 61.7 | 0.1 |
| Protein (% Energy) | 15.2 | <0.1 | 14.4 | <0.1 | 14.9 | <0.1 | 14.4 | <0.1 | 14.5 | <0.1 |
| Plant Protein (% Energy) | 8.8 | <0.1 | *10.8 | <0.1 | *11.6 | <0.1 | *11.9 | <0.1 | *13.8 | <0.1 |
| Animal Protein (% Energy) | 6.4 | <0.1 | *3.5 | <0.1 | *3.2 | <0.1 | *2.4 | <0.1 | *0.6 | <0.1 |
| Fat (% Energy) | 35.1 | <0.1 | 33.4 | 0.1 | 33 | 0.1 | 33.1 | 0.1 | 29.8 | 0.1 |
| Total Carbohydrate (g) | 266 | 0.2 | 283 | 0.7 | 284 | 0.5 | 286 | 0.3 | 309 | 0.6 |
| Total Sugar (g) | 110 | 0.2 | 113 | 0.5 | 111 | 0.4 | 110 | 0.2 | 112 | 0.5 |
| Total Fiber (g) | 30.4 | <0.1 | *34.9 | 0.1 | *37.7 | 0.1 | *37.5 | 0.1 | *46.7 | 0.1 |
| Total Protein (g) | 75.8 | 0.1 | 71.8 | 0.2 | 74.3 | 0.2 | 72.0 | 0.1 | 72.3 | 0.2 |
| Plant Protein (g) | 43.9 | 0.1 | *54.1 | 0.2 | *58.2 | 0.2 | *59.7 | 0.1 | *69.2 | 0.2 |
| Animal Protein (g) | 31.8 | 0.1 | *17.6 | 0.2 | *16.0 | 0.2 | *12.2 | 0.1 | *3.1 | 0.2 |
| Dairy Protein (g) | 11.8 | <0.1 | 10.2 | 0.1 | *7.7 | 0.1 | *7.5 | 0.1 | *0.7 | 0.1 |
| Soy Protein (g) | 4.9 | <0.1 | *8.0 | 0.1 | *10.5 | 0.1 | *10.2 | 0.1 | *13.1 | 0.1 |
| Total Fat (g) | 78.1 | 0.1 | 74.2 | 0.3 | 73.4 | 0.2 | 73.6 | 0.1 | 66.1 | 0.2 |
| [b]PUFA (g) | 20.2 | <0.1 | 21.1 | 0.1 | 21.5 | 0.1 | 22.1 | <0.1 | 21.6 | 0.1 |
| [c]MUFA (g) | 32.4 | 0.1 | 30.5 | 0.2 | 30.9 | 0.1 | 30.3 | 0.1 | 28 | 0.1 |
| [d]SFA (g) | 19.9 | <0.1 | 17.4 | 0.1 | *15.8 | 0.1 | 16 | <0.1 | *11.6 | 0.1 |
| [e]TFA (g) | 4.4 | <0.1 | 4 | <0.1 | *3.1 | <0.1 | 3.6 | <0.1 | *2.1 | <0.1 |
| Omega 3 (g) | 2.3 | <0.1 | 2.1 | <0.1 | 2.4 | <0.1 | 2.1 | <0.1 | 2 | <0.1 |
| Linoleic Acid (g) | 17.6 | <0.1 | 18.8 | 0.1 | 19 | 0.1 | 19.9 | <0.1 | 19.5 | 0.1 |
| Arachidonic Acid (mg) | 84.1 | 0.3 | *27.2 | 0.7 | *43.6 | 0.6 | *13.4 | 0.3 | *2.6 | 0.6 |
| [f]DHA (mg) | 182 | 1.2 | *69.8 | 3.6 | 187 | 2.8 | *33.8 | 1.5 | *18.2 | 3 |

# Dietary fiber in AHS2

Daily fiber ranged from 30 g/d in non-vegetarians up to 46 g/d in vegans!

- Compare this to average U.S. intake of about 15 g/d of fiber, and upper decile of 30 g/d in AARP-NIH study
- Given the strong relationship of fiber intake and mortality in various studies, AHS2 vegetarian benefits could be primarily due to differences in fiber intake

# Mortality in British V*

European Prospective Investigation into Cancer and Nutrition (EPIC-Oxford)

- 47,254 subjects (76% women, ages 20-89, 34% vegetarians)
- On-study 1993-1999, followed to 2007
- 1,513 deaths (3%); 213 CHD deaths
- Overall mortality 50% of SMR → healthier overall than standard population

# EPIC-Oxford: Results

| Mortality (RR) | All cause | CHD |
|---|---|---|
| Non-vegetarians | 1.00 (referent) | 1.00 (referent) |
| Vegetarian | 1.03 (0.90,1.16) | 0.81 (0.57, 1.16) |
| Pescatarian | 0.89 (0.75, 1.05) | 0.86 (0.58, 1.38) |

Vegetarians

- Lower BMI
- Less smoking
- Less alcohol
- Younger
-

# Vegetarian diets: Conclusions

Data to support health and longevity benefits of vegetarians diets are scant and limited to relatively homogeneous groups, such as religious communities (e.g., Seventh Day Adventists)

SDA (vegetarian and non-vegetarian) have better overall outcomes than the general population, associated with lower rates of smoking and obesity

Within these groups, certain causes of death (CHD in men) have lower rates in V* vs. non-V*

However, the observed differences could be explained by factors other than meat vs. no meat

- Specifically, variation in amount of fiber between groups could be responsible for observed effects

# Vegetarian diets: Conclusions

Pescotarian observations in AHS2

- The pesco group had the greatest reduction in all-cause mortality, CHD mortality and "other" mortality
- This finding is consistent with the large body of observations wherein higher fish consumption is associated with lower cardiac mortality