

## Is Meat Killing Us?

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Patients commonly ask physicians about the diet's role in health, including preventing disease and decreasing mortality. Primary care physicians must navigate nutrition evidence to answer these questions, but the science is commonly flawed in study design or bias. Currently, low-carbohydrate/high animal protein diets are popular, and many people in the United States consider "meat and potatoes" to be culinary staples. Yet, concern exists that meat consumption is harmful. How should physicians apply the evidence to offer advice about inclusion and quantity of meat in a diet when patients ask about their food choices?

In this brief review, we identified 6 articles that evaluated the effects of meat and vegetarian diets on mortality (*Table 1*). We discuss some of the pertinent available evidence regarding whether primary care physicians should discourage some or all consumption of meat.

### The Evidence

*Table 2* summarizes the effects of meat consumption on mortality, and *Table 3* summarizes the effect of the vegetarian diet on mortality.

#### Does Meat Consumption Increase Mortality?

In a 2014 meta-analysis and systematic review, Larsson and Orsini<sup>1</sup> reviewed 9 prospective cohort studies conducted in the United States, Europe, and China. They evaluated the association of processed meat (eg, bacon, sausage, salami, hot dogs, ham), unprocessed red meat (eg, uncured, unsalted beef; pork; lamb; game), and total red meat with all-cause mortality in more than 1 million people over follow-up periods ranging from 5.5 to 28 years.<sup>1</sup> All-cause mortality for the highest vs lowest category of processed meat and total red meat intake was statistically significant (RR, 1.23 [95% CI, 1.17-1.28] and RR, 1.29 [95% CI, 1.21-1.35],

#### Clinical Question:

Does meat consumption affect mortality?

**Evidence:** All-cause mortality is higher for increased daily consumption of red meat, especially processed meat. However, the compiled evidence does not link other meat products to all-cause mortality.

**Recommendation:** Physicians should encourage patients to limit animal products when possible, and substitute red meat and processed red meat with plant-based foods. Patients may supplement a plant-based diet with moderate amounts of fish, poultry, eggs, and dairy if desired.

respectively). Unprocessed red meat consumption increased all-cause mortality in the US cohorts (RR, 1.23 [95% CI, 1.17-1.30]) but not in the European cohorts (RR, 0.90 [95% CI, 0.59-1.38]). In addition, the steepest increase in mortality was found at the smallest increases of intake from the reference ranges of 0.6 g/d (0.02 oz/d) of processed meat and 13.9 g/d (0.49 oz/d) of total red meat, indicating that even a small amount of meat may have an impact on mortality risk.

Another 2014 meta-analysis, by Abete et al,<sup>2</sup> encompassed 6 of the same cohort studies included by Larsson and Orsini,<sup>1</sup> along with 7 other studies, for a total of 13 studies and more than 1.5 million people. The analysis not only looked at all-cause mortality but also examined associations with mortality from cardiovascular disease (CVD) and ischemic heart disease (IHD). Abete et al<sup>2</sup> included white meat (poultry or rabbit) in addition to processed and red meats. In comparing highest vs lowest consumption of meats, only processed meat significantly increased risk for all-cause mortality (RR, 1.22 [95% CI, 1.16-1.29]).<sup>2</sup> Both processed meat and red meat were positively associated with CVD mortality (RR, 1.18 [95% CI, 1.05-1.32] and RR, 1.16 [95% CI, 1.03-1.32], respectively). However, total meat (white meat, processed meat, and unprocessed red meat) (RR, 1.08 [95% CI, 0.85-1.36]) and white meat

**Table 1.**  
**Studies Evaluating the Effects of Meat and Vegetarian Diets on Mortality**

Source	Year	Study Design	Location	No. of Studies	No. of Participants
<b>Meat</b>					
Larsson and Orsini <sup>1</sup>	2014	Meta-analysis	US, China, EU	9	1,330,352
Abete et al <sup>2</sup>	2014	Meta-analysis	US, WA, EU, Asia	13	1,674,272
Singh et al <sup>3</sup>	2003	Review	US, EU	6	>50,000 <sup>a</sup>
<b>Vegetarian</b>					
Key et al <sup>4</sup>	1998	Prospective collaborative analysis	US, EU	5	76,172
Huang et al <sup>5</sup>	2012	Meta-analysis/systematic review	US, EU, Japan	7	124,706
Le and Sabaté <sup>6</sup>	2014	Review	US	3	96,000 <sup>b</sup>

<sup>a</sup> Singh et al<sup>3</sup> did not report exact total No. of participants.

<sup>b</sup> Some participants were included in multiple cohorts.

**Abbreviations:** EU, Europe; US, United States; WA, West Australia.

(RR, 1.01 [95% CI, 0.96-1.07]) were not associated with CVD mortality. Neither processed meat, total meat, nor white meat were associated with IHD mortality (RR, 1.52 [95% CI, 0.50-4.66]; RR, 1.52 [95% CI, 0.68-3.40]; and RR, 1.00 [95% CI, 0.82-1.21], respectively); however, CIs were broad for processed meat and total meat. Of note, both of these analyses demonstrated statistically significant heterogeneity.

These recent large meta-analyses are consistent with a 2003 review by Singh et al<sup>3</sup> of 6 cohort studies. Singh et al<sup>3</sup> found a decreased risk (25% to nearly 50%) of all-cause mortality for very low meat intake compared with higher meat intake in 5 of the studies. They also found a 3.6-year increase in life expectancy when comparing long-term ( $\geq 17$  years) vs short-term vegetarians.<sup>3</sup>

### Does a Vegetarian Diet Decrease Mortality?

Should patients, then, avoid all meat and eat a strictly vegetarian diet? In a 1998 collaborative investigation<sup>4</sup> of 5 prospective cohort studies comprising more than 76,000 people, vegetarians had a 24% RR reduction in mortality from ischemic cardiac disease. However, no significant differences between vegetarians and non-vegetarians were found in other causes of mortality.

These findings were confirmed by Huang et al<sup>5</sup> in a 2012 meta-analysis and systematic review of vegetarianism and associated cancer incidence and CVD mortality. This review<sup>5</sup> included 7 observational studies with a total of 124,706 participants (including a longer follow-up of the aforementioned investigation). Results showed that vegetarians had a significant decrease in IHD mortality (RR, 0.71 [95% CI, 0.56-0.87]) and reduction in cancer incidence (RR, 0.82 [95% CI, 0.67-0.97]), but the study did not reveal a statistically significant reduction in all-cause mortality (pooled RR, 0.91 [95% CI, 0.66-1.16]).<sup>5</sup>

In 2014, Le and Sabaté<sup>6</sup> published a review of 3 large prospective cohort studies of Adventists in North America.<sup>6</sup> Adventists who were vegetarians had a 10% to 20% decrease in all-cause mortality compared with nonvegetarian-matched Adventist cohorts, and a 26% to 68% decreased risk of mortality from IHD, CVD, and cerebrovascular disease.<sup>6</sup> Vegetarians also had an 8% risk reduction for overall cancer.

The study defined a nonvegetarian diet as containing red meat or poultry and allowed the vegetarian diet to contain fish, milk, and eggs. Yet, in this review,<sup>6</sup> the vegan diet (void of fish, milk, eggs, and all animal products) extended further protection for obesity, hyperten-

**Table 2.**  
**Statistically Significant Increase in Mortality**  
**With Increased Meat Intake**

Increased Mortality	Meat Category			
	Red	Processed	White	Total <sup>a</sup>
<b>All Cause</b>				
Larsson and Orsini <sup>1</sup>	Yes	Yes	NA	NA
Abete et al <sup>2</sup>	No	Yes	No	No
Singh et al <sup>3</sup>	Yes	Yes	No	NA
<b>Cardiovascular Disease</b>				
Abete et al <sup>2</sup>	Yes	Yes	No	No
Singh et al <sup>3</sup>	Yes	Yes	Yes <sup>b</sup>	NA
<b>Ischemic Heart Disease</b>				
Abete et al <sup>2</sup>	No	No	No	No
<b>Cancer</b>				
Singh et al <sup>3</sup>	Yes	Yes	No	NA

<sup>a</sup> Only the article by Abete et al<sup>2</sup> evaluated the effects of total meat defined as white processed and unprocessed red meat. The other studies combined red and processed meat at times, but these combinations are not reflected in this table.

<sup>b</sup> Singh et al<sup>3</sup> reported a statistically significant increase in cardiovascular disease mortality among men but not among women.

**Abbreviation:** NA, not applicable.

sion, type 2 diabetes mellitus, and CVD mortality in comparison with the lacto-ovo-vegetarian diet. Seventh Day Adventists participate in additional aspects of healthy lifestyles, such as abstinence from tobacco and alcohol, and thus may have other independent factors lending to overall decreased CVD. However, these studies used nonvegetarian Adventists as controls, thus mitigating this potential confounding effect.

**Additional Evidence**

Past clinical trials have shown substantial benefits of a vegetarian or vegan diet in reduced body mass index (BMI), reversal of CVD, and improved hypertension and type 2 diabetes mellitus.<sup>7-10</sup> Limitations of these studies include a small number of participants and a short duration. In addition, many studies included confounding dietary variables in the intervention group, such as the elimination of added oils, avocado, nuts, dairy, processed foods, and sugary foods; avoidance of caffeine and al-

cohol; and a reduction in sodium intake.<sup>7,9,11</sup> One study included moderate aerobic exercise, stress management training, tobacco cessation, and group support in its intervention group.<sup>11</sup> However, another study,<sup>12</sup> which included 60,903 Adventists, compared different types of vegetarian diets and their associations with type 2 diabetes mellitus and elevated BMI. Vegan and lacto-ovo-vegetarian diets decreased the risk for type 2 diabetes mellitus by half compared with an omnivorous diet. Pesco-vegetarian and semi-vegetarian (meat consumption less than once per week but more than once per month) diets also decreased this risk by one-fourth to one-third.<sup>12</sup> The study<sup>12</sup> found that only the vegan diet was associated with a BMI in the optimal range. In addition to mortality effects, the topic of plant-based diets in chronic disease has been reviewed and found to be potentially beneficial in weight management, CVD, and metabolic disorders.<sup>13</sup>

The aforementioned studies<sup>1-13</sup> suggest that perhaps complete avoidance of meat could be best for improved health. However, several of the cohorts in these reviews examined the effects of white meat separately and revealed opposing results. In a 2009 cohort study,<sup>14</sup> those who consumed the highest quintile of white meat had a statistically significant decrease in all-cause mortality (hazard ratio [HR], 0.92 [95% CI, 0.88-0.96]) and cancer mortality (HR, 0.89 [95% CI, 0.83-0.95]) compared with the cohort of the lowest quintile of white meat. Another cohort showed no significant effect on all-cause mortality with daily poultry consumption and noted a J curve in which the lowest HR for all-cause mortality was in people with low to moderate red meat consumption (10.0-19.9 g/d) with an HR of 1.00 (set at reference) rather than no red meat (0-9.9 g/d) at an HR of 1.07 (95% CI, 1.01-1.13).<sup>15</sup> In a review<sup>16</sup> of 2 US cohort studies, a substitution analysis estimated the effect of replacing 1 serving of red meat with 1 serving of either fish, poultry, nuts, legumes, low-fat dairy products, or whole grains. It showed a statistically significant lower risk of all-cause mortality with every type of substitution.<sup>16</sup> In the 2014 meta-analysis, when stratified by sex, white meat was associated with a lower risk of all-cause mortality in women

**Table 3.**  
**Statistically Significant Decrease in Mortality With Vegetarian Diet**

Source	Decreased Mortality			
	All Cause	Cardiovascular Disease	Ischemic Heart Disease	Cancer
Key et al <sup>4</sup>	No	NA	Yes	Sometimes <sup>a</sup>
Huang et al <sup>5</sup>	Yes	No	Yes	Yes
Le and Sabaté <sup>6</sup>	Yes	Yes	Yes	Yes

<sup>a</sup> The study by Key et al<sup>4</sup> was a collaborative analysis of 5 large cohorts. It separated cancer into categories of cancer of the stomach, colon, lung, female breast, and prostate without combining these results. The results were fairly heterogenous, so none of the cancers had a consistent statistically significant decrease in mortality in all 5 cohorts.

**Abbreviation:** NA, not applicable.

(RR, 0.95 [95% CI, 0.91-0.99]).<sup>2</sup> A pooled analysis of Asian cohorts revealed an inverse association with poultry intake for all-cause mortality in men and women ( $P=.02$  and  $.03$ , respectively) and cancer mortality in women ( $P<.01$ ).<sup>17</sup> In addition, all-cause and CVD mortality in women were inversely associated with seafood intake ( $P=.05$  and  $.04$ , respectively). The associations of different types of vegetarian diets with all-cause mortality in a cohort from the previously described review<sup>6</sup> found the most benefit in the pesco-vegetarian diet (HR, 0.81 [95% CI, 0.69-0.94]).<sup>18</sup>

## Conclusion

Despite variability in the data, the evidence is consistent that increased intake of red meat, especially processed red meat, is associated with increased all-cause mortality. Red meat also increases CVD and cancer mortality in Western cohorts. A vegan diet has been shown to improve several parameters of health, including reversal of CVD, decreased BMI, decreased risk of diabetes, and decreased blood pressure in smaller studies. Data regarding inclusion of some fish and white meat are conflicted—although fish and white meat consumption are not clearly associated with increased mortality, they do decrease mortality when they replace red meat in the diet.

Even though limitations exist in these studies (eg, lack of large, long-term randomized controlled trials;

large amount of heterogeneity), avoidance of red and processed meats and a diet rich in plant-based whole foods including fruits, vegetables, whole grains, nuts, and legumes is a sound, evidence-based recommendation. If such a recommendation represents a difficult change for a patient, physicians should encourage limited animal products when possible and substituting red meat with plant-based proteins, fish, or poultry. (doi:10.7556/jaoa.2016.059)

## References

- Larsson SC, Orsini N. Red meat and processed meat consumption and all-cause mortality: a meta-analysis. *Am J Epidemiol*. 2014;179(3):282-289. doi:10.1093/aje/kwt261.
- Abete I, Romaguera D, Vieira AR, Lopez de Munain A, Norat T. Association between total, processed, red and white meat consumption and all-cause, CVD and IHD mortality: a meta-analysis of cohort studies. *Br J Nutr*. 2014;112(5):762-775. doi:10.1017/S000711451400124X.
- Singh PN, Sabaté J, Fraser GE. Does low meat consumption increase life expectancy in humans [review]? *Am J Clin Nutr*. 2003;78(3 suppl):526S-532S.
- Key TJ, Fraser GE, Thorogood M, et al. Mortality in vegetarians and non-vegetarians: a collaborative analysis of 8300 deaths among 76,000 men and women in five prospective studies. *Public Health Nutr*. 1998;1(1):33-41.
- Huang T, Yang B, Zheng J, Li G, Wahlqvist ML, Li D. Cardiovascular disease mortality and cancer incidence in vegetarians: a meta-analysis and systematic review. *Ann Nutr Metab*. 2012;60(4):233-240. doi:10.1159/000337301.
- Le LT, Sabaté J. Beyond meatless, the health effects of vegan diets: findings from the Adventist cohorts. *Nutrients*. 2014;6(6):2131-2147. doi:10.3390/nu6062131.

7. Esselstyn CB Jr, Gendy G, Doyle J, Golubic M, Roizen MF. A way to reverse CAD? *J Fam Pract.* 2014;63(7):356-364b.
8. Ornish D, Brown SE, Scherwitz LW, et al. Lifestyle changes and heart disease. *Lancet.* 1990;336(8717):741-742.
9. Barnard ND, Cohen J, Jenkins DJ, et al. A low-fat vegan diet and a conventional diabetes diet in the treatment of type 2 diabetes: a randomized, controlled, 74-wk clinical trial. *Am J Clin Nutr.* 2009;89(5):1588S-1596S. doi:10.3945/ajcn.2009.26736H.
10. Mishra S, Barnard ND, Gonzales J, Xu J, Agarwal U, Levin S. Nutrient intake in the GEICO multicenter trial: the effects of a multicomponent worksite intervention. *Eur J Clin Nutr.* 2013;67(10):1066-1071. doi:10.1038/ejcn.2013.149.
11. Ornish D, Brown SE, Scherwitz LW, et al. Can lifestyle changes reverse coronary heart disease? The Lifestyle Heart Trial. *Lancet.* 1990;336(8708):129-133.
12. Tonstad S, Butler T, Yan R, Fraser GE. Type of vegetarian diet, body weight, and prevalence of type 2 diabetes. *Diabetes Care.* 2009;32(5):791-796. doi:10.2337/dc08-1886.
13. Tusso PJ, Ismail MH, Ha BP, Bartolotto C. Nutritional update for physicians: plant-based diets. *Perm J.* 2013;17(2):61-66. doi:10.7812/TPP/12-085.
14. Sinha R, Cross AJ, Graubard BI, Leitzmann MF, Schatzkin A. Meat intake and mortality: a prospective study of over half a million people. *Arch Intern Med.* 2009;169(6):562-571. doi:10.1001/archinternmed.2009.6.
15. Rohrmann S, Overvad K, Bueno-de-Mesquita HB, et al. Meat consumption and mortality—results from the European Prospective Investigation into Cancer and Nutrition. *BMC Med.* 2013;11:63. doi:10.1186/1741-7015-11-63.
16. Pan A, Sun Q, Bernstein AM, et al. Red meat consumption and mortality: results from 2 prospective cohort studies. *Arch Intern Med.* 2012;172(7):555-563. doi:10.1001/archinternmed.2011.2287.
17. Lee JE, McLerran DF, Rolland B, et al. Meat intake and cause-specific mortality: a pooled analysis of Asian prospective cohort studies. *Am J Clin Nutr.* 2013;98(4):1032-1041. doi:10.3945/ajcn.113.062638.
18. Orlich MJ, Singh PN, Sabaté J, et al. Vegetarian dietary patterns and mortality in Adventist Health Study 2. *JAMA Intern Med.* 2013;173(13):1230-1238. doi:10.1001/jamainternmed.2013.6473.

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