

Manuscript Title: Effects of Diets Containing Beef Compared with Poultry on Pancreatic β -Cell Function and Other Cardiometabolic Health Indicators in Males and Females with Prediabetes: A Randomized, Crossover Trial

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Study Headline: Eating 6-7 ounces of beef per day does not impact risk factors for type 2 diabetes, including pancreatic β -cell function and measures of blood sugar regulation or inflammation, or other cardiometabolic health markers in adults with prediabetes.

Background: The development of type 2 diabetes mellitus (T2D) typically results from insulin resistance that occurs over an extended period and is worsened with the progressive deterioration of pancreatic β -cell function. The body has the ability to compensate for insulin resistance through increased insulin production by the pancreas, but over time, this can lead to pancreatic β -cell exhaustion and loss of β -cell function, resulting in insufficient insulin secretion to maintain normal blood glucose levels.

Observational studies have reported associations between higher red meat intake and increased T2D risk, whereas poultry intake has generally not been associated, or was inversely associated, with T2D risk. These findings may be confounded by lifestyle and behavioral differences often seen in individuals who consume greater amounts of red meat. In contrast, clinical research from randomized controlled trials generally show that red meat intake, including beef, does not significantly affect insulin sensitivity; however, there is limited clinical research evaluating the impact of red meat on pancreatic β -cell function. In a previous study¹, Dr. Maki and his research team demonstrated that consuming a USDA Healthy Eating Pattern that included 150 g/d of lean beef substituted in place of refined starches did not significantly alter measures of pancreatic β -cell function, compared to the USDA Healthy Eating Pattern control diet that included <40 g/d of red meat. However, the methodology to measure β -cell function was limited and unable to assess the effects of glucoregulatory hormones stimulated in response to food consumption. To better understand the mechanisms underlying the associations in observational studies, the team conducted a clinical study to assess pancreatic β -cell function in response to the consumption of red meat (beef specifically) compared to the consumption of poultry.

Objective: To examine the effects of beef intake compared with poultry intake on pancreatic β -cell function, other indicators of glucose homeostasis, glucoregulatory hormone responses, lipoprotein lipids, and biomarkers of inflammation in adults with prediabetes.

¹ Maki et al, 2020. <https://doi.org/10.1093/jn/nxaa116>

Study Design: In a randomized, controlled, crossover trial, 24 adults (17 males and 7 females; ages 18-74 yr) with overweight or obesity and prediabetes, who were otherwise generally healthy, completed two 28-day dietary intervention periods, separated by a 28-day washout period. During both dietary intervention periods, study participants were instructed to maintain their usual diets, with the exception of avoiding meat, eggs, seafood, and poultry (other than that provided in the study entrées). Participants were instructed to consume two premade entrées each day as part of their usual diets, for the duration of the 28-day intervention period, and to return any unused portions to the clinic. Entrées contained 3.0-3.5 ounces of cooked beef or poultry and were prepared by a catering service and provided in accordance with the assigned diet condition. During the washout period, participants were instructed to maintain their usual diets.

Participants were encouraged to maintain their weight and normal levels of physical activity throughout the duration of the study. Additionally, participants were asked not to change their tobacco or nicotine use, except to abstain from nicotine, caffeine, recreational marijuana, and alcohol, 24 hours prior to each clinic visit.

The primary outcome, pancreatic β -cell function, is a common assessment to determine the pancreas' insulin-producing capacity. Pancreatic β -cell function and the following measures were collected at baseline, conclusion of the washout period, and at the end of each dietary intervention period:

- Body weight, waist circumference, blood pressure, and heart rate
- 3-d diet record (not collected during washout period)
- Lipoprotein lipids (total cholesterol, calculated LDL cholesterol, HDL cholesterol, calculated non-HDL cholesterol, and triglycerides)
- Biomarkers of inflammation (high-sensitivity C-reactive protein [hs-CRP], interleukin-6 (IL-6), fibrinogen, and tumor necrosis factor- α (TNF- α))
- Glucoregulatory hormone levels (glucagon, GLP-1, and GIP)
- Glucose, insulin, and C-peptide levels

Intervention Details:

Diet Condition	Intervention/Treatment	Food (Amount, Frequency)	Length of Intervention
Beef	2 beef-containing entrées per day (fajitas, stew, burgers, burritos, or stir fry) each day, as part of their habitual dietary pattern	3.0-3.5 oz cooked, unprocessed beef chuck roll or 80/20 ground beef per entrée	28 days
Poultry	2 poultry-containing entrées per day (fajitas, stew, burgers, burritos, or stir fry) each day, as part of their habitual dietary pattern	3.0-3.5 oz cooked, unprocessed chicken breast or ground chicken per entrée	28 days

Key Findings:

- No statistically significant differences were observed for any of the pancreatic β -cell function parameters or insulin sensitivity after 28-days of consuming 6-7 oz per day of unprocessed beef or poultry, when incorporated into participants' habitual dietary patterns.
- Beef consumption did not impact other measures of cardiometabolic health, including indicators of glucose homeostasis, glucoregulatory hormones, lipoprotein lipids, or biomarkers of inflammation.

Additional Result:

- There were some significant differences the nutrient intake of the beef and poultry dietary intervention periods. During the poultry dietary intervention period, participants had higher intakes of calories from carbohydrates and proteins, whereas during the beef dietary intervention period, participants had higher intakes of calories from sugars, dietary fats, and saturated fatty acids. This is likely due to the differences in fatty acids composition in the beef and poultry entree ingredients as well as the other foods in the individuals' usual diets.

Study Implications:

- Results from this gold standard randomized, crossover, controlled feeding trial build on the available scientific evidence that demonstrates eating beef does not adversely impact glycemic control or inflammation biomarkers, which are measures of cardiometabolic health.
- Beef can be included in a healthy diet without increasing risk factors for type 2 diabetes or cardiovascular disease, contrary to associations seen in observational studies (likely due to confounding lifestyle factors).
- There is no clear evidence from intervention studies that support dietary recommendations to replace red meat (including beef) with poultry to improve cardiometabolic and heart health outcomes.

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