adverse effects: other constituents, such as heme iron, likely play an important role, as does the isocaloric displacement of beneficial nutrients from other foods. Importantly, the authors did not consider consumption of alternatives to beef such as fish and nuts, which they and many others have shown to be beneficial for cardiovascular health.

Furthermore, direct effects on health are important considerations for dietary recommendations, but the effects on land degradation, climate change, air pollution, water shortage, water pollution, loss of biodiversity (6), and global food sustainability (7) should also be considered. By these criteria, cattle production is by far the most adverse.

Although the study of Roussel et al (1) represents a useful scientific contribution, the conclusions are not supported by their evidence. Indeed, the overall evidence suggests strongly that replacement of beef with alternative sources of protein would have both direct health benefits and fewer adverse environmental impacts.

Neither of the authors had a conflict of interest to declare.

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Replay to AM Bernstein and WC Willett

Dear Sir:

We thank Bernstein and Willett for their comments on the Beef in an Optimal Lean Diet (BOLD) Study and for sharing their perspectives on beef consumption. We appreciate their scientific contributions that have had an important public health impact.

Food-based dietary recommendations rely on a robust evidence base derived from many studies that span the spectrum from epidemiology to basic science. Randomized controlled clinical trials (RCTs) are essential for establishing cause-and-effect relations. Relative to the perspective presented by Bernstein and Willett, current food-based recommendations have evolved from many RCTs that have evaluated the effects of various nutrient profiles on risk factors for chronic disease. In more recent years, healthy nutrient profiles have been translated to food-based dietary guidance. With respect to cardiovascular disease (CVD), we have an excellent understanding of what the optimal nutrient profile should be for risk reduction. On the basis of this understanding, there are many heart-healthy dietary patterns that include a variety of foods. Moreover, all healthy dietary patterns can include lean beef (except for a vegetarian dietary pattern), meet nutrient targets, and thereby reduce risk of CVD and other chronic diseases.

Several prospective studies have found an association between increased red meat intake and chronic disease risk and mortality. However, a systematic review of dietary factors and CVD risk concluded that there was insufficient evidence regarding the effect of meat on CVD (1). In a separate meta-analysis of 20 studies (17 prospective cohorts and 3 case-control studies), Micha et al (2) reported that consumption of processed meat, but not red meat, was associated with an increase in coronary heart disease (CHD) risk. In the prospective studies that did report an association, the type of red meat associated with increased risk of chronic disease and mortality is described as “hamburger, beef hot dog, processed meat and processed meat sandwich, bacon, beef/pork/lamb as a mixed and main dish” (3). As is apparent, these “meats” do not distinguish lean beef from an array of meats and processed meat products that vary greatly in their nutrient profile compared with the lean beef used in the BOLD Study, which was described as <10 g total fat, <4.5 g SFA, and <95 mg cholesterol per 3.5-oz serving. Whereas the nutrients in fish and nuts (as well as poultry, legumes, and other animal protein foods) can play an important role in a heart-healthy diet, lean beef also provides a unique nutritional profile with a 3.0-oz (28-g) portion containing high biological value protein (50% of the Daily Value), zinc (39%), vitamin B-12 (37%), selenium (24%), niacin (18%), iron (14%), and potassium (6%) (4). This is why a variety of protein foods have an important place in a heart-healthy diet.

It has been hypothesized that heme iron may lead to an increased risk of coronary disease due to an increase in oxidative load. However, Ascherio et al (5) showed that the association between heme iron intake and myocardial infarction was present only in men not taking a vitamin E or multivitamin supplement. A nutrient-rich heart-healthy diet (eg, DASH (Dietary Approaches to Stop Hypertension), BOLD (DASH-like diet containing 4.0 oz lean beef/d), BOLD+ (DASH-like diet containing 5.4 oz lean beef/d and 28% of energy from protein)) provides vitamin E and other nutrients to protect against added oxidative stress (6). Qi et al (7) reported an association between heme iron and CHD. However, heme iron intake was also correlated with saturated fat intake; thus, a clear association between heme iron and CHD cannot be made. Finally, the Upper Tolerable Intake for iron as set by the Institute of Medicine’s Food and Nutrition Board is 45 mg/d. Iron intake in the DASH, BOLD, and BOLD+ diets ranged from 20 to 25 mg/d (8).

The authors state that beef production is associated with environmental consequences. The reality is that all food production systems have an associated environmental impact, some more than others. Questions remain about the quantitative contribution of livestock production to the global carbon footprint (9). Moreover, according to a report from the FAO, livestock production is important to the food security of populations worldwide today and will be in the future...
Of note is that significant progress has been made in reducing the environmental burden of beef production (11). The absence of animal protein in the diet would come with a significant health cost because complete protein sources would be less available to some populations globally (especially those at highest risk of malnutrition), and, as a result, nutrient adequacy would be more difficult to achieve.

The findings from the BOLD Study must be viewed in the context of the total body of evidence and the evidentiary standards such as those of Food and Drug Administration (FDA), which recognizes intervention studies as the highest possible evidence. Specifically, in guidance on substantiating health claims the FDA notes, “intervention studies provide the strongest evidence for the claimed effect, regardless of existing observational studies on the same relationship.” The BOLD Study was a rigorous RCT designed to evaluate cause and effect and met the criteria set forth by the FDA for evidence needed to substantiate a health claim, including a treatment duration of $\geq 3$ wk as a minimum for evaluating diet-related LDL-cholesterol effects (12).

Although our understanding and recommendations on diet and health evolve from both intervention and observational studies, it is important to note that observational studies generally cannot be used to rule out the findings from more reliable intervention studies (13). The scientific literature has examined several classic cases in which RCTs ultimately did not prove hypotheses generated from prospective studies. The BOLD Study, a well-controlled RCT, we believe reinforces the need to revisit recommendations on the role of lean beef in a heart-healthy diet.

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Erratum


A second corresponding author was inadvertently omitted from footnote 3 on the title page of the article (page 249). Footnote 3 should read as follows: “Address correspondence and reprint requests to M Bulló (e-mail: monica.bullo@urv.cat) or J Salas-Salvadó (e-mail: jordi.salas@urv.cat) at the Human Nutrition Unit, Faculty of Medicine and Healthy Scienes, Universitat Rovira i Virgili, C/Sant Llorenç 21, 43201 Reus, Spain.”

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