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<sup>1</sup> Author disclosures: JC King, KJ Reimers, MH Alderman, and DA McCarron, no conflicts of interest.

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## Sustainable Diet Studies Show Co-Benefits for Greenhouse Gas Emissions and Public Health<sup>1</sup>

Dear Editor:

Because agriculture contributes about one-fifth of global greenhouse gas (GHG) emissions, sustainable diets offer an opportunity for climate change mitigation. Many recent studies have assessed the environmental and health impacts of sustainable diets, finding that realistic shifts in intake can reduce GHG emissions and have public health cobenefits. However, the recent review of sustainable diets by Auestad and Fulgoni (1) implies that there is, as of yet, little clear benefit from changing diets.

The authors state that mitigation efforts should not focus on diets, because nonagricultural emissions account for the majority of global emissions. However, nonagricultural emissions are split across several sectors. Agriculture, forestry, and other land use change is the second-largest contributor (24%), behind energy (35%). Industry, transport, and buildings individually contribute 21%, 14%, and 6%, respectively (2). There is no single silver bullet for GHG

mitigation, and deep cuts in emissions will be easier to achieve if each sector implements mitigation strategies.

The review also suggested that results across these studies are inconclusive. Although the authors are correct that methods of comparing diets and measuring environmental outcomes do differ, the emission trends across studies mostly differ in magnitude, not direction. Two out of 37 dietary scenarios across 12 studies calculated higher emissions for healthier diets (3). However, these compared scenarios in which meat intake did not meaningfully change between healthy and unhealthy diets (4), and in which meat was replaced by the caloric equivalent of fruit and vegetables (5). The latter study's other scenarios, which substituted meat with dairy or mixed food groups, produced fewer emissions (5). These few exceptions highlight that convergence of healthy and lower-emission diets is possible, though with careful and realistic substitution of foods (6). The effects on emissions also depend on the type of meat replaced, because poultry and pork have considerably fewer emissions than ruminant meat.

We agree that additional research is required to add precision to the environmental effects of sustainable diets, but this is not an argument for inaction. Particularly, there is a need for emission estimates for a larger variety of foods and their regional variation, especially in low- and middle-income countries. Studies in these countries are also needed to estimate the scope of current and future dietary emissions. Here, mitigation opportunities from recent shifts to Western diets may be countered by rising emissions from undernourished populations who require higher dietary diversity and caloric intakes, and who may benefit from consumption of some animal-based products.

The current body of research, despite methodological differences, generally shows that reducing intake of animal-based products—particularly ruminant meat—proportionally decreases dietary GHG emissions (3). Additionally, increased consumption of fruit and vegetables (but not refined carbohydrates) can improve health in many populations.

The transition to sustainable diets may also not be as problematic as the authors describe. Indeed, the literature has shown that in most settings, even bridging current population-level gaps between current and recommended dietary intakes could alone bring GHG reductions and improve health (3). Adverse economic impacts could be addressed by appropriate policies (6).

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## Reply to L Aleksandrowicz et al.<sup>1</sup>

Dear Editor:

We thank Aleksandrowicz et al. (1) for calling attention to the recent review of studies assessing environmental impacts of dietary patterns by Hallström (2) and to the 2014 report to the Intergovernmental Panel on Climate Change that examined strategies for mitigation of climate change across sectors, including the agriculture, forestry, and other land use sectors (3). These, along with other recent publications (4, 5), add to this rapidly expanding, multifaceted area of research.

We agree that changes in eating patterns could have substantial, but uncertain, potential to mitigate the environmental impacts of food systems (3, 5, 6). The review by Hallström et al. (2) of available, but limited, literature on environmental impacts of current and theoretical dietary scenarios reports that reducing consumption of animal-based products (in particular, ruminant meat) could decrease greenhouse gas (GHG) emissions considerably (2). It was noted also that the choice of methodology to assess dietary impacts can affect the scientific quality and outcome of studies. As noted in our review (6) and by others (2, 4, 7, 8), methodologic differences including the choice of functional unit in life cycle assessments (LCA), the gold standard for evaluating environmental impacts across multiple sectors (8), can lead to different and conflicting conclusions. The study by Vieux et al. (9), for example, reported that high nutritional quality diets that include higher fruit and vegetable consumption were not associated with low GHG emissions, as anticipated. These results were explained in part by whether GHG emissions were reported on the basis of caloric intake (CO<sub>2</sub> equivalents/100 kcal) or food weight (CO<sub>2</sub> equivalents/100 g).

The specific LCA method used also can lead to different and potentially conflicting conclusions. Whereas the studies reviewed by Hallström et al. (2) use attributional LCA methodology to assess impacts of dietary scenarios on GHG emissions, a recent study in Australia used an environmentally extended input-output LCA method to estimate GHG emissions for different food sectors (7). Australian dietary guidelines, as in other developed countries, recommend increased consumption of fruit, vegetables, legumes, and dairy along with reduced consumption of energy-dense foods and drinks that are high in saturated fat, added sugar, salt, or alcohol (referred to as noncore foods) to achieve recommended intakes of dietary essential nutrients. The climate impact of dietary patterns based on Australian Dietary Guidelines was estimated to be about 25% lower than that of the average Australian diet. The impact of dietary scenarios modeled with only a 10% reduction in red meat and eliminating noncore food items was similarly estimated to be 25% lower. Reducing consumption of red meat as a sole dietary strategy to mitigate GHG emissions posed nutritional challenges for obtaining key nutrients, including highly bioavailable iron and zinc. In this study, increased consumption of core foods and lower consumption of noncore foods could have the cobenefits of 25% lower GHG emissions from Australian dietary patterns and enhanced population health. Given the variability in LCA methodologies among researchers, agreement on the appropriate LCA methodology and functional unit is critically needed to inform future guidance on healthy and sustainable diets.

Consumer lifestyle preferences and circumstances also play a major role in shaping environmental impacts associated not only with dietary patterns, but also with food waste, transportation, shelter, and household energy use (3, 10). Barriers to substantive changes in dietary habits include both implications to human health and cultural and societal resistance to behavior change (3). Indeed, concerted efforts to improve public health through recommended changes in dietary patterns to achieve nutrient adequacy have fallen short (3, 11). Similar anomalies in consumer behavior have been observed in relation to household energy use (3).

The report to the Intergovernmental Panel on Climate Change notes that impacts of GHG emissions, energy consumption, and land use varies considerably across regions and countries and that the potential for successful mitigation strategies will be most effective when country-specific approaches for sustainable development are in line with national priorities (3). Others similarly report that both positive and negative environmental impacts and opportunities and barriers to GHG emissions mitigation are region specific; thus, mitigation options should be examined on a case-by-case basis (5). Further, as noted by Aleksandrowicz et al. (1), mitigation opportunities in developed countries differ from those in low- and middle-income countries. Food systems are diverse not only within individual countries but also within the broader economic and sociopolitical context globally (3, 5).

Decision-makers need suitable tools to analyze the intended effects and unintended consequences of potential mitigation strategies while also considering potential trade-offs. A recent committee report from the Institute of Medicine in the United States proposed an analytic framework for researchers,