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Re: Nomination of Meat-Related Exposures to the National Toxicology Program for the Report on Carcinogens

Dear Dr. Lunn

On October 7, 2016 The Beef Checkoff commented (reference number 13336) to the Office of the Report on Carcinogens (RoC) regarding terminology used in the estimation of dietary intake of red meat, processed meat, and meat cooked at high temperatures as part of an RoC request for data related to the nomination of meat-related exposures. Since our earlier comment, the American Meat Science Association (AMSA), in cooperation with the scientific journal *Animal Frontiers*, has published a perspective regarding meat categorization terminology. In addition, updated evidence regarding the estimated intake of red meat, processed meat, and meat cooked at high temperature has become available. The following comment summarizes this newly available information.

### ***Standardized Meat Categorization Terminology***

The October 2017 issue of *Animal Frontiers* compiles a series of publications regarding the categorization of meat entitled, "*What is meat? Perspective of the American Meat Science Association and the international community.*" A complete table of contents for this issue can be found at <https://www.animalsciencepublications.org/publications/af/tocs/7/4>. The following are highlights from this series:

- Keeton and Dikeman (2017) provide the following assessment, "The use of precise terminology to categorize meat, meat products, and meat groupings is needed to improve the accuracy of scientific studies, ensure communication of sound dietary policy, and enable a more accurate assessment of meat's impact on nutrition and health."
- On behalf of AMSA, Boler and Woerner (2017) define meat as "skeletal muscle and its associated tissues derived from mammalian, avian, reptilian, amphibian, and aquatic species commonly harvested for human consumption. Edible offal consisting of organs and non-skeletal muscle tissues also are considered meat. Even though bones are not independently considered meat, when they are associated with a bone-in portion of meat such as a steak or chop, bones would be considered meat. Further, land dwelling and/or aquatic animals intended for human consumption are included in the definition of meat. This definition is broader than some used by regulatory agencies. For example, the USDA omits fish, poultry, and wild game from its definition of meat (USDA FSIS, 2017)." This definition is relevant when estimating meat exposure.
- Keeton and Dikeman (2017) note that use of the terms "red meat" or "white meat" as a proxy for nutritional or quality characteristics is misleading and recommend avoiding the use of these terms altogether in favor of identifying meat derived from a specific species. For example, defining ground beef as red meat, while failing to do the same for dark turkey meat (e.g. turkey

leg), is misleading as the heme iron content of these is nearly identical (Keeton and Dikeman, 2017).

- “Persistent discrepancies between the definitions of meat considered by nutrition versus meat scientists complicate the interpretation of meat intake data from epidemiologic studies and the subsequent determination of dietary guidance.” (McNeill et al., 2017) This situation is further complicated by cultural variations in meat categorization, as detailed in an international survey of red and processed meat definitions in observational cohorts, and government issued dietary guidance (McNeill et al., 2017).
- Keeton and Dikeman (2017) further identify limitations of using epidemiologic studies to assess dietary effects of meat and meat product consumption to include: dietary survey groupings that are too broad or inaccurate to study specific meat effects; nutrient composition within a meat category that is too diverse to draw specific conclusions; lack of meat cooking method/preparation information despite the fact that these have a direct effect on diet; and overlapping and thus duplicative inclusion of meat and meat products in multiple categories such as bacon in both red meat and processed meat groupings in the same study.

### ***Estimated U.S. intake of red meat and processed meat***

Despite well-acknowledged limitations, survey data are still the primary source of information on consumption/food intake patterns in the United States diet (McNeill et al., 2017). In the United States, the National Health and Nutrition Examination Survey (NHANES) is designed to assess the health and nutritional status of adults and children (CDC, 2017). What We Eat in America (WWEIA) is the dietary intake component of NHANES and used to estimate per capita average intakes as well as to estimate exposure in the Food Commodity Intake Database (FCID; USDA ARS, 2017; EPA, 2017).

Data from the most recent WWEIA (2013–2014) show that total meat intake is roughly only one-tenth of an ounce above current 2015 Dietary Guidelines for Americans (DGA) recommendations and meat typically considered “red” (i.e. beef and pork) is below DGA recommendations (Table 1; McNeill et al., 2017). The DGA makes no specific recommendation for processed meat, but on average, U.S. intake of all processed meat (sources include beef, pork, poultry, etc.) is less than 1 oz equivalent per day (i.e., 0.96 oz equivalents; Table 1; McNeill et al., 2017; USDA ARS FSRG, 2017).

In addition to average consumption, it is also important to consider the range of consumption within the population. For example, the FCID was designed to complement WWEIA data for use in estimating population exposure levels across a broad range of commodities. Figure 1 indicates the FCID (2005-2010) mean consumption of beef and pork (fresh and processed) is 2.8 oz and that 40% of the U.S. population consumes less total “red” and processed meat than the DGA recommends for fresh “red meat” alone (McNeill et al., 2017; EPA, 2017).

### ***Exposure to compounds produced during high temperature cooking***

A comparative dietary exposure assessment of selected heterocyclic amines (HCA) and polycyclic aromatic hydrocarbons (PAH) through meat and bread consumption in the United States was recently conducted via a literature review combined with NHANES intake data. The literature review resulted in a

database of foods, concentrations, and source studies' characteristics related to HCA (n=18) and PAH concentrations (n=9). Estimates of concentration for up to nine different methods of cooking were computed for meat (beef, poultry, pork, and seafood) and wheat-based bread products. Pouzou et al. (2017) report that although cooking method directly impacts the formation of PAH in food, when comparing meat and bread, there is not difference in PAH exposure in the U.S. between these two products due to differences in primary preparation method and consumption level. More specifically, PAH8 concentration was not different among meats (p=0.861, beef: 3.7 ng/g, poultry: 1.1 ng/g, pork: 0.6 ng/g, and seafood: 0.4 ng/g), but was significantly impacted by cooking method (p<0.001), using open flame (p<0.001), and cooking time (p<0.001). The authors conclude that, "This analysis represents an improvement to existing compilations of PAH and HCA concentrations for exposure assessment such as the CHARRED database thanks to the inclusion of additional studies, more PAH compounds, and more cooking methods (such as smoking), as well as estimates for seafood."

**Table 1. Comparison of Usual<sup>1</sup> versus Recommended<sup>2</sup> Mean Daily Meat Intake in the US (oz eq/day)**

	Total Meat, Poultry, and Seafood <sup>3</sup>		Total (Fresh Red) Meat <sup>4</sup>		Total Cured Meat <sup>5</sup>	
	Usual	Rec	Usual	Rec	Usual	Rec
2015 DGA						
FPED 2013-2014	4.54	4.43	1.52 [beef=1.25] <sup>6</sup>  [pork=0.27] <sup>6</sup>	1.79	1.04  [beef=0.25] <sup>6</sup> [pork=0.48] <sup>6</sup> [poultry=0.21] <sup>6</sup> [other=0.10] <sup>6</sup>	No rec provided

<sup>1</sup> From What We Eat in America, NHANES 2013-2014, individuals 2 years and over (excluding breast-fed children), day 1 dietary intake data, weighted. Food Patterns Equivalents Database (FPED) 2013-2014. Available at [https://www.ars.usda.gov/ARSUserFiles/80400530/pdf/fped/Table\\_1\\_FPED\\_GEN\\_1314.pdf](https://www.ars.usda.gov/ARSUserFiles/80400530/pdf/fped/Table_1_FPED_GEN_1314.pdf) Accessed November 10, 2017 (Note: The USDA Food Patterns allows 2.63g solid fat per ounce (28.63g) of lean meat. Any solid fat that are naturally present above the allowable amount is included under the Solid Fats food component column.)

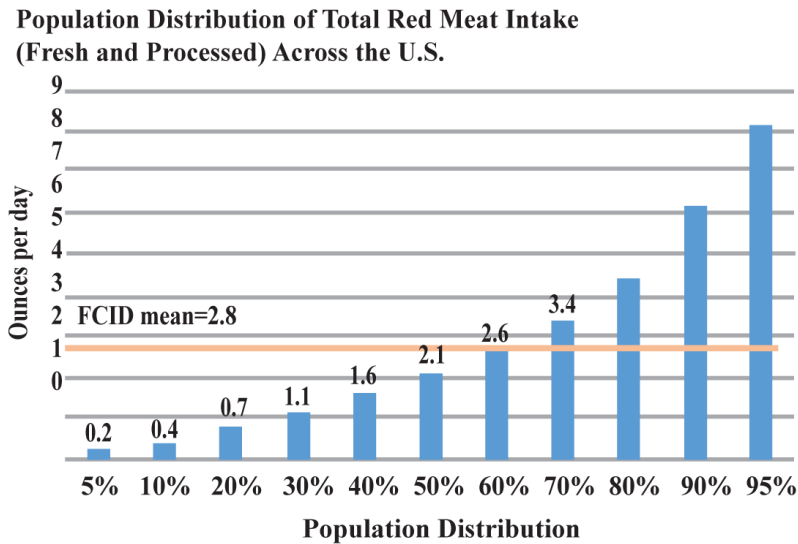
<sup>2</sup> From Healthy US-Style Pattern at 2,000 kcal level, reported in the Scientific Report of the 2015 Dietary Guidelines Advisory Committee (2015 DGAC, Table D1.32) and the 2015 Dietary Guidelines for Americans (2015 DGA, Table A3-1).

<sup>3</sup> Includes lean red meat/poultry, lean seafood, lean cured/processed meat (both red meat and poultry) & organ meat.

<sup>4</sup> Includes lean red meat.

<sup>5</sup> Includes lean cured/processed meat (both red meat and poultry).

<sup>6</sup> Beef, Pork and Cured Meat Intakes calculated from WWEIA FPED 2009-2010 and 2015 DGAC Table E3.1A2.



**Figure 1. Distribution of total red meat intake (fresh and processed) across the population, calculated using the Food Commodity Intake Database (FCID). (Originally published in McNeill et al., 2017; used with permission)**

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