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EDITORIALS

Red and processed meat, and human and planetary health

Contemporary meat consumption harms human health and is equally bad for the planet

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Analyses from the National Institutes of Health (NIH)-AARP study have previously shown that mortality was higher among participants with a high meat intake. With a total of more than 7.5 million person years of observation, further analyses by Etemadi and colleagues (doi:10.1136/bmj.j1957) now show an association between high intakes of red and processed meat and elevated total mortality and mortality from most major causes: cardiovascular disease, diabetes, cancer, and hepatic, renal, and respiratory diseases.[1] They have explored the possible role of meat constituents and established that both haem iron (from red meat) and nitrate/nitrite (from processed meats) provide explanatory power and, perhaps, information on causation. The fact that poultry and fish intake are inversely related to risk and contain little of these agents adds plausibility to their causal interpretation.

The problem is, however, that red and processed meats are likely to be harmful to human health in many different ways, often linked to more than one outcome. Simply choosing one or two from a list of probably highly correlated constituents does not further inform prevention strategies. For instance, evidence shows harm from protein degradation,[2] saturated fat,[3] N-nitroso compounds,[4] cooking related carcinogens,[5] L-carnitine and its interaction with the gut microbiome,[6] feed related contaminants,[7] and reduced plant food intake.[3] It feels like an old fashioned murder mystery with too many suspects. The important conclusion is that the current patterns of consumption of red and processed meat are not good for humans.

Although our closest primate relatives are vegetarian (gorilla, *Gorilla gorilla*) or only occasional consumers of meat (chimpanzee, *Pan troglodytes*, and bonobo, *Pan paniscus*), and although good evidence shows that some of our hominin cousins (*Australopithecus bahrelghazali, Paranthropus robustus,* and *Australopithecus sediba*) were largely plant eaters,[8-10] humans have a long history of meat consumption.[11] By the end of the last ice age, 10 000-12 000 years ago, humans had both highly honed hunting skills and a taste for meat,[12] devastating populations of megafauna and even birds on many islands and across all continents except Africa.

With the transition to a pastoral lifestyle, we began to raise animals for meat and milk in settlements or as nomads. Meat was rare and largely celebratory in ancient Greece,[13] and in traditional European agricultural societies it was eaten once a week or less often, with intake rarely more than 5-10 kg per person per year.[12] Current consumption in rich countries is unprecedented. In the US, Australia, and New Zealand, people now consume about 110-120 kg/person/year (at least an order of magnitude increase).[14] Livestock have colonised more than 30% of the earth's land surface, mostly on permanent pasture, but this total also includes 33% of global arable land that is used to produce feed.[15] Meat and dairy animals account for about 20% of the total terrestrial animal biomass—about four times the biomass of humans.[15]

This shift from animal protein as a modest supplement to a plant based diet to providing up to 15-20% of total energy has consequences for human health, as Etemadi and colleagues describe.[1] Other outcomes include accelerated human sexual development, either as a result of meat and fat consumption itself or arising from naturally occurring or exogenous growth promoting hormones in meat[16 17]; extensive antibiotic resistance following antibiotic use to promote the growth of livestock[18]; a reduction in available human food and consequent hunger, as high value grains and legumes are fed to cattle (more than 97% of global soymeal production is fed to livestock[15]); and higher risks of infected food from animals raised using inappropriate feeding practices or in concentrated animal feeding operations using inappropriate feeding practices.[19 20] Such operations for pigs can act as a point source and "mixing vessel" for recombination of epidemic influenza strains, and use of multiple animal vaccines in a factory farm has been shown to result in the emergence of a virulent strain after recombination of two attenuated strains.[21]

Damage to planetary health includes depletion of aquifers[15] (producing 1 kg of meat protein requires more than 110 000 L of water[22]); production of 37% of anthropogenic methane (with 23 times the global warming potential of CO_2) and 65% of anthropogenic nitrous oxide (almost 300 times the potential of CO_2); groundwater pollution; and 64% of anthropogenic

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ammonia emissions, which contribute significantly to acid rain and acidification of ecosystems.[15] The combination of rainforest destruction for livestock and the production of greenhouse gases by livestock contributes more to climate change than do fossil fuels used for transport.[15]

The research community collectively understands the problem—overconsumption of meat is bad for our health and for the health of our planet; research even provides clear underpinnings for evidence based policy that could limit harm to both,[23] but these underpinnings are not linked to action. As with many contemporary problems of resource overuse and maldistribution, we need to decide whether to act now to reduce human meat consumption or wait until the decay of sufficient parts of the global system tip us into much poorer planetary, societal, and human health.[24]

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