Distributional impact of elevated CO_2 on the deficiency of zinc, iron, and protein

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Observations show that CO_2 concentration is very likely to surpass 400 ppm in recent years. Without mitigation efforts, it will probably reach 550 ppm by 2050, unless in the most optimistic scenario.

Climatic change brings huge threat to the food system and human health. Both experimental and modelling studies show that global warming will harm food security by reducing agricultural production, such as heat wave, insect damage, and the decrease in precipitation. Recent Free-air CO2 enrichment (FACE) field experiment has shown another potential impact on nutrition quality: the decrease of nutrients under elevated CO_2. The content of zinc, iron, and protein will decrease by 3-17% under 550 ppm (Smith and Myers 2018). In specific, protein content may be lost by up to 15% for C3 crops, such as wheat and rice (Myers et al. 2014). Iron contents may decrease by 4-10% when growing under elevated CO_2 of 550 ppm (Smith et al. 2017). Zinc may decrease by 3-14% in several major crops including wheat, rice, barley, soya, and field peas (Myers et al. 2015).

Such effect will exacerbate the nutrition deficiency globally. Modelling studies suggest that the global population in zinc, protein, and iron deficiency will increase by 175 million, 122 million, and 1.4 billion, respectively. Lack of these nutrients can result in illness or death. Deficiency in protein constraints growth, tissue repair, and turnover. Deficiency in micronutrients such as zinc and iron will also impair human health.

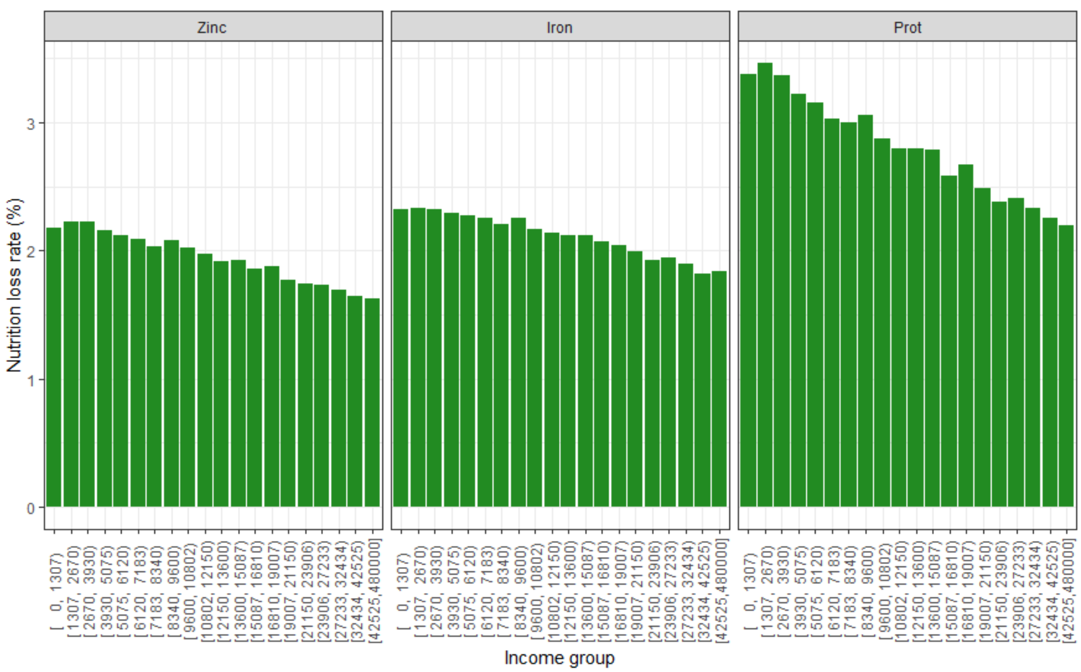

Figure 1. Income and nutrition loss rate

While existing studies so far have evaluated the global impact of elevated CO_2 on nutrients intake and the difference of impacts among countries, further detailed analysis, which focuses on the impact on different socioeconomic groups, is desired. As noted by (Hallegatte and Rozenberg 2017), most of existing impact studies show that poor countries are more vulnerable than rich countries—the differences between the poor and the rich in the same country have not been discussed thoroughly. Therefore, the purpose of this study is to investigate the distributional impact of elevated CO_2 on human nutrition using the Chinese population as an example. We integrate diet data from CHNS (China Health and Nutrition Survey), food nutrients from China FCT (Food Content Table 2004/2009), and nutrients impact for food crops from the literature. We construct a nutrient intake distribution curve before and after the impact on each socioeconomic group.

Results imply that low income population will lose higher percentage of zinc, iron and protein in their diet due to elevated CO_2 (Figure 1). Low income population also have higher deficiency risks (Figure 2). The gap is particularly significant for protein. Such distinction is mainly due to the difference in diet composition: low income population take more nutrients (zinc, iron and protein) from plant-based food.

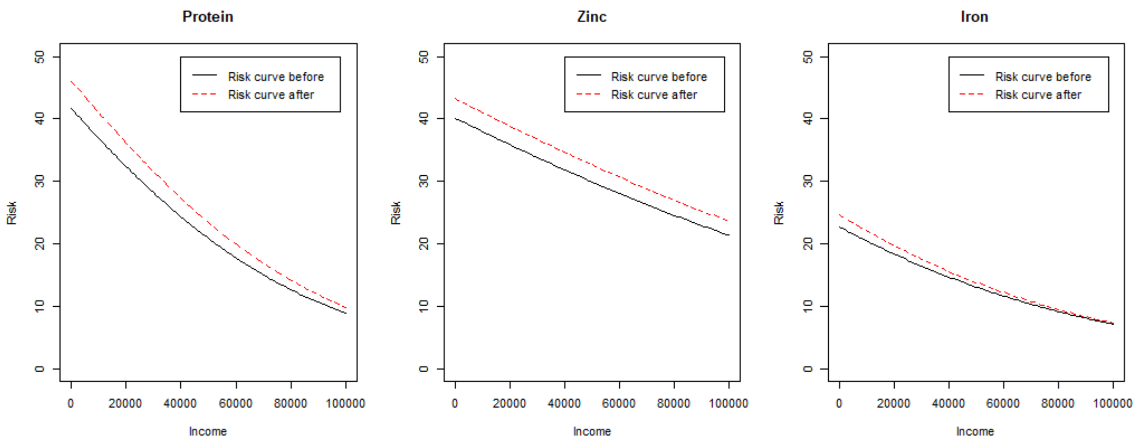

Figure 2. Income and nutrient deficiency risk under elevated CO_2 (550 ppm)

Elevated CO_2 is projected to cause additional nutrient deficiency. This highlights the importance of adaption measures and health intervention policies. Results also suggest that the low-income population have the lowest carbon food print in their diet, while they are the mostly affect by the consequence of CO_2 emission.

References:

Hallegatte S, Rozenberg J (2017) Climate change through a poverty lens. Nat Clim Change 7:250–256. doi: 10.1038/nclimate3253

Myers SS, Wessells KR, Kloog I, et al (2015) Effect of increased concentrations of atmospheric carbon dioxide on the global threat of zinc deficiency: a modelling study. Lancet Glob Health 3:e639–e645. doi: 10.1016/S2214-109X(15)00093-5

Smith MR, Golden CD, Myers SS (2017) Potential rise in iron deficiency due to future anthropogenic carbon dioxide emissions. GeoHealth 1:248–257. doi: 10.1002/2016GH000018

Smith MR, Myers SS (2018) Impact of anthropogenic CO2 emissions on global human nutrition. Nat Clim Change 8:834. doi: 10.1038/s41558-018-0253-3