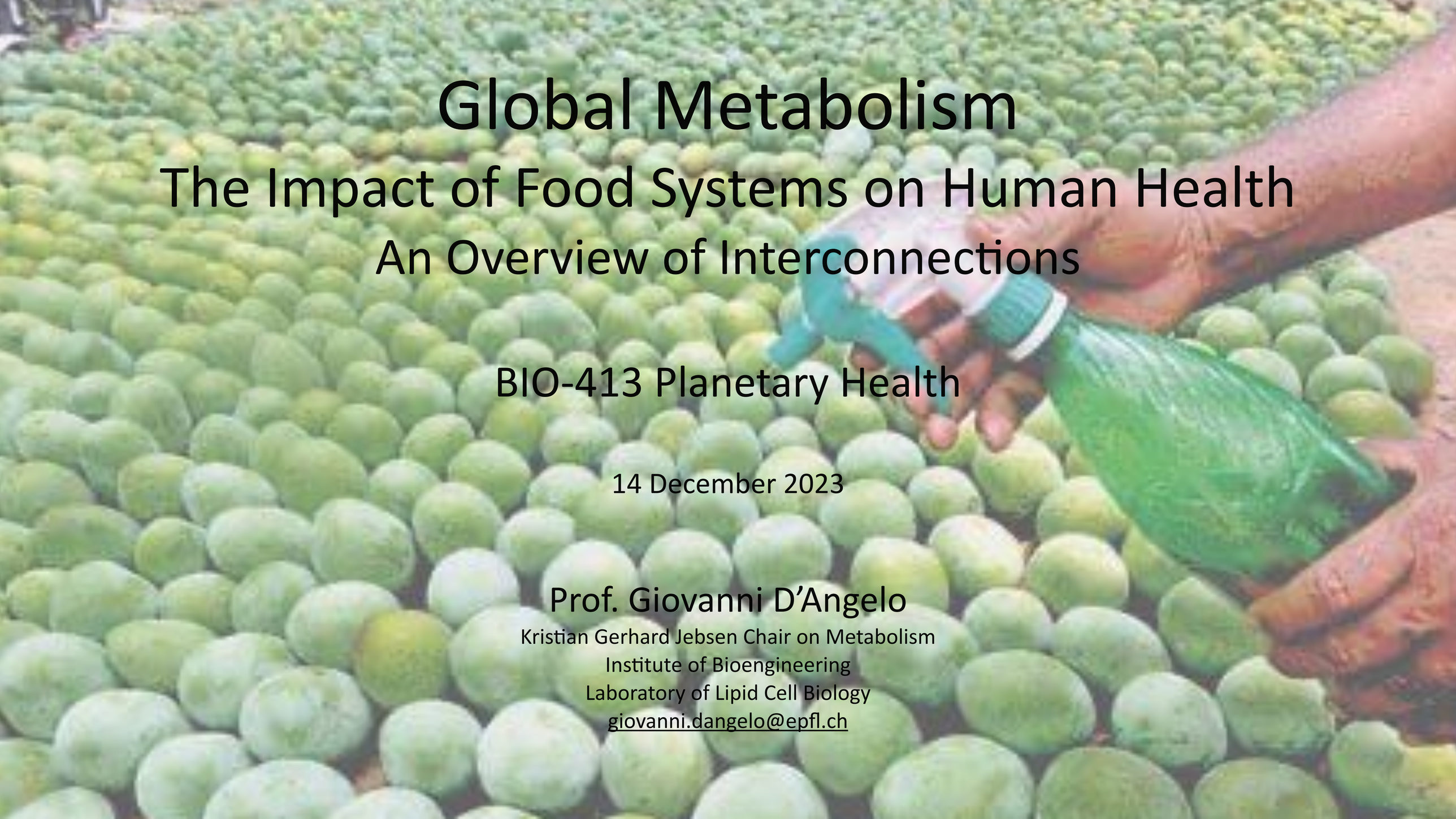

Global Metabolism

The Impact of Food Systems on Human Health

An Overview of Interconnections

BIO-413 Planetary Health

14 December 2023

Prof. Giovanni D'Angelo

Kristian Gerhard Jebsen Chair on Metabolism

Institute of Bioengineering

Laboratory of Lipid Cell Biology

giovanni.dangelo@epfl.ch

Angel Keys

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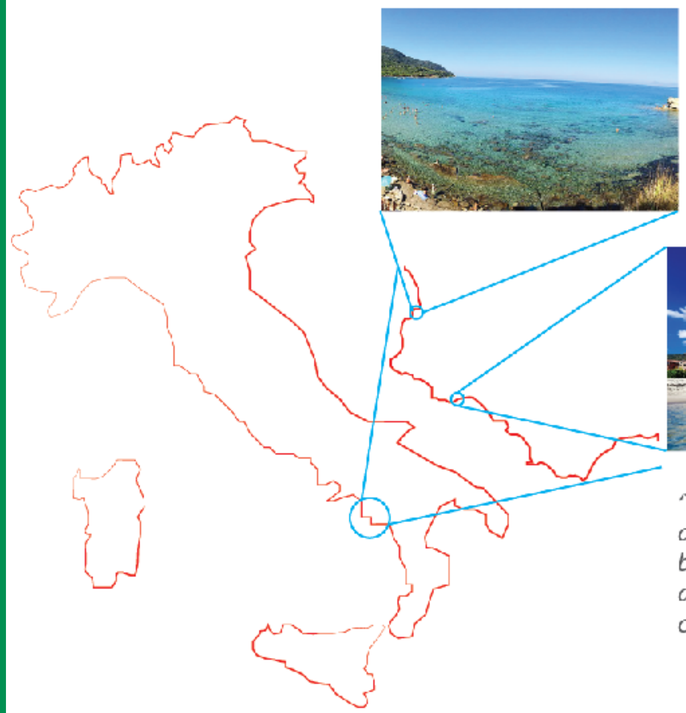
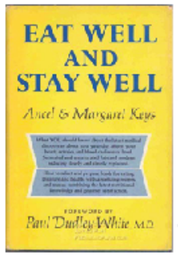
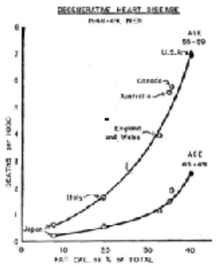


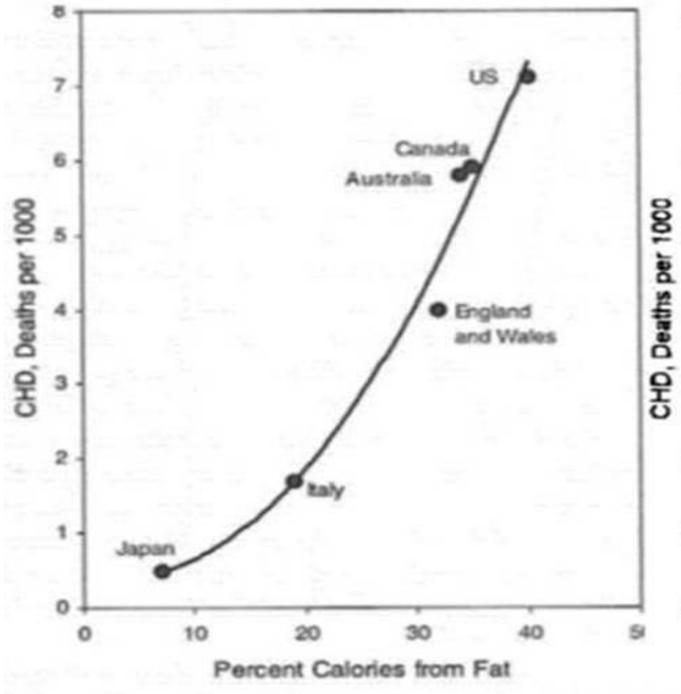


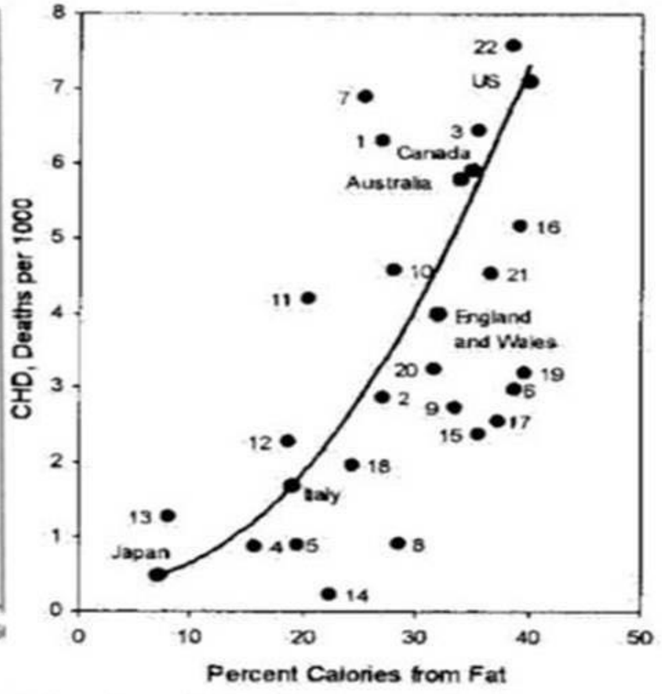


Importance of nutrition for human health

*‘The major findings were (i) there was a close correlation between the percentage of dietary **calories from total fats** and 10-y **coronary deaths** per 10,000 men; (2) median blood **cholesterol** values were highly correlated with **coronary heart disease** deaths, accounting for 64% of the variance in coronary heart disease death rates among the cohorts‘*

Angel Keys





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Goldstein and Brown

1985

Goldstein and Brown

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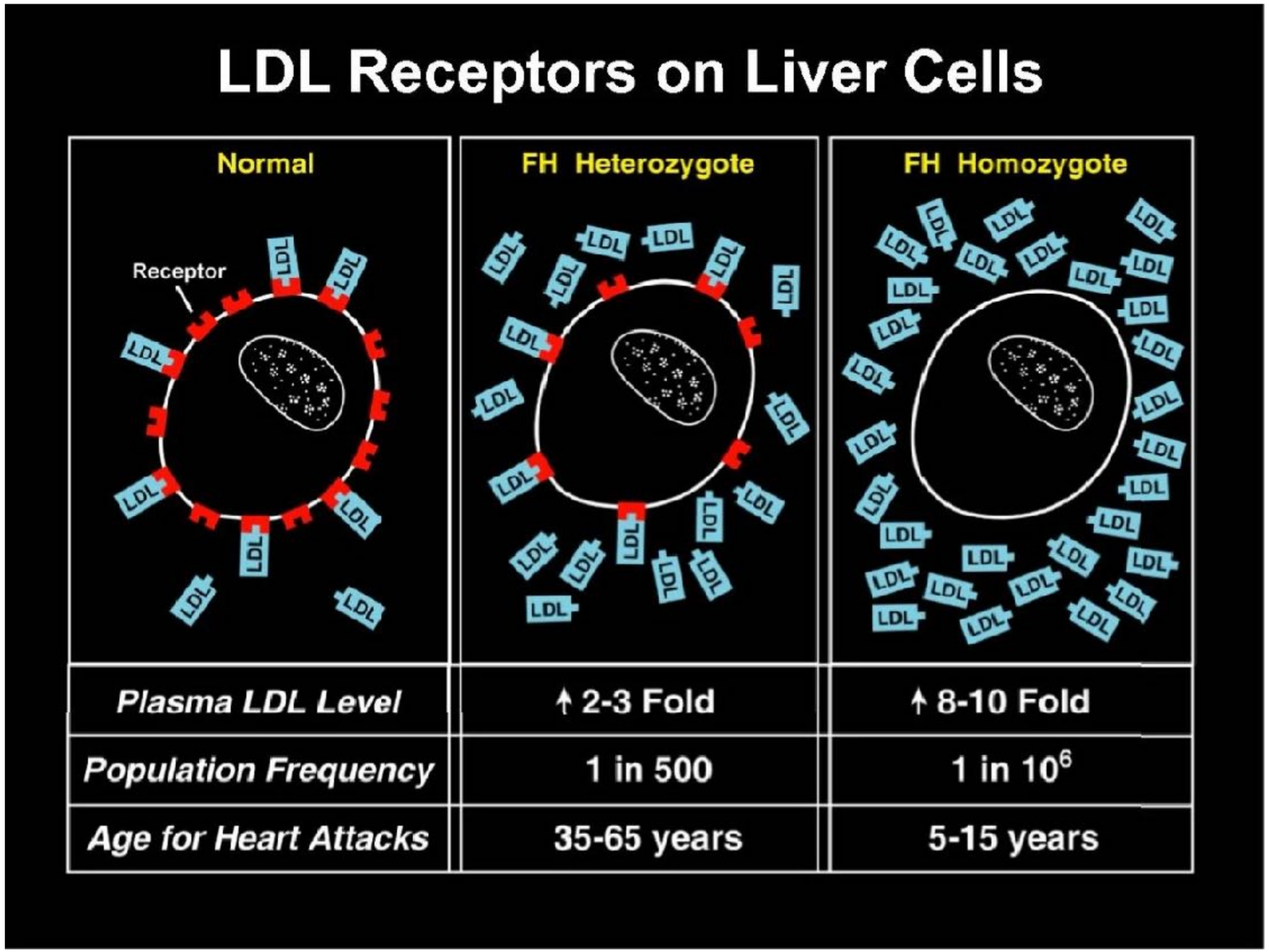


Global Metabolism

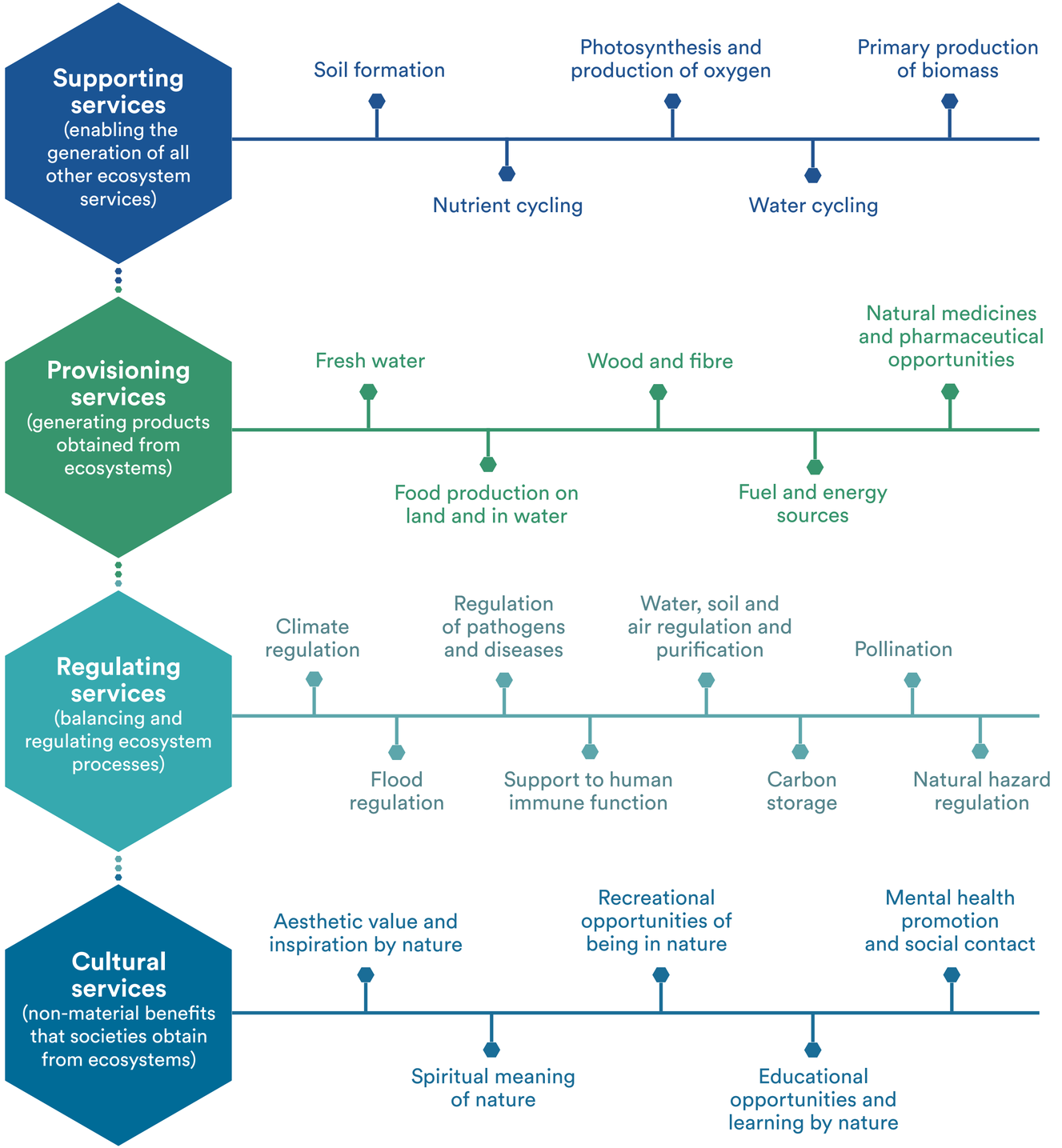
Learning outcomes for today

- Familiarise yourselves with the **interconnections** between **food** and **health**
- Critically analyse how changing **food systems** pose risks to **health**

Human Health

- A **dynamic** state of **physical**, **mental**, and **social well-being**
- **NOT** the **absence** of **disease**
- Responds constantly to **environmental**, **social**, **biological**, **emotional**, and **cognitive** conditions

Food Systems and Health



Food Systems and Health

Food Systems and Health

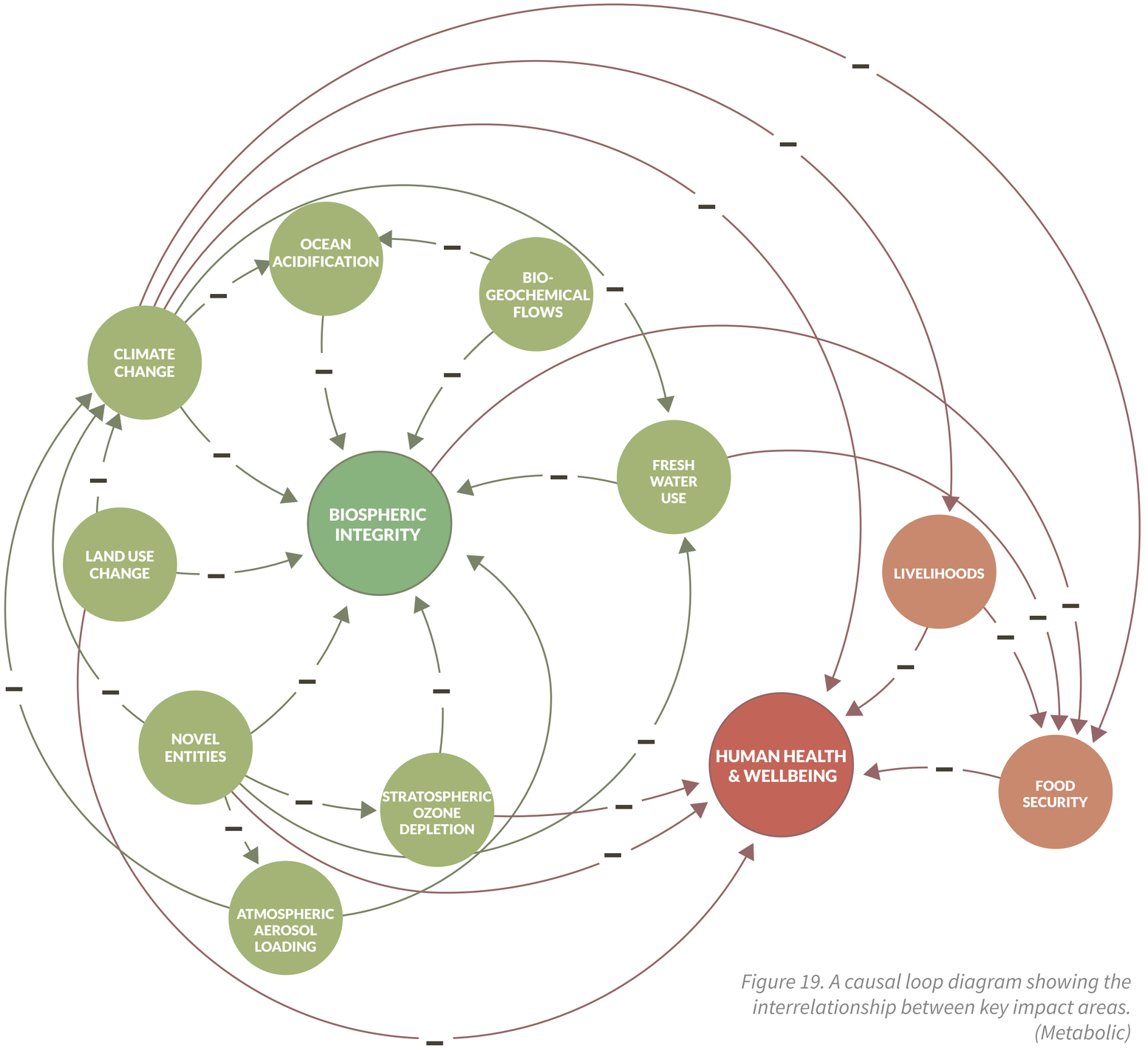


Figure 19. A causal loop diagram showing the interrelationship between key impact areas. (Metabolic)

Food Systems

Human built systems devoted to production, transportation, processing, and distribution of food.

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Food Systems

Food Systems

Human built systems devoted to production, transportation, processing, and distribution of food.

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Problem !!!

ensure food system transformation amidst globalisation and environmental changes

while

preserving human well-being

Food Systems

Human built systems devoted to production, transportation, processing, and distribution of food.

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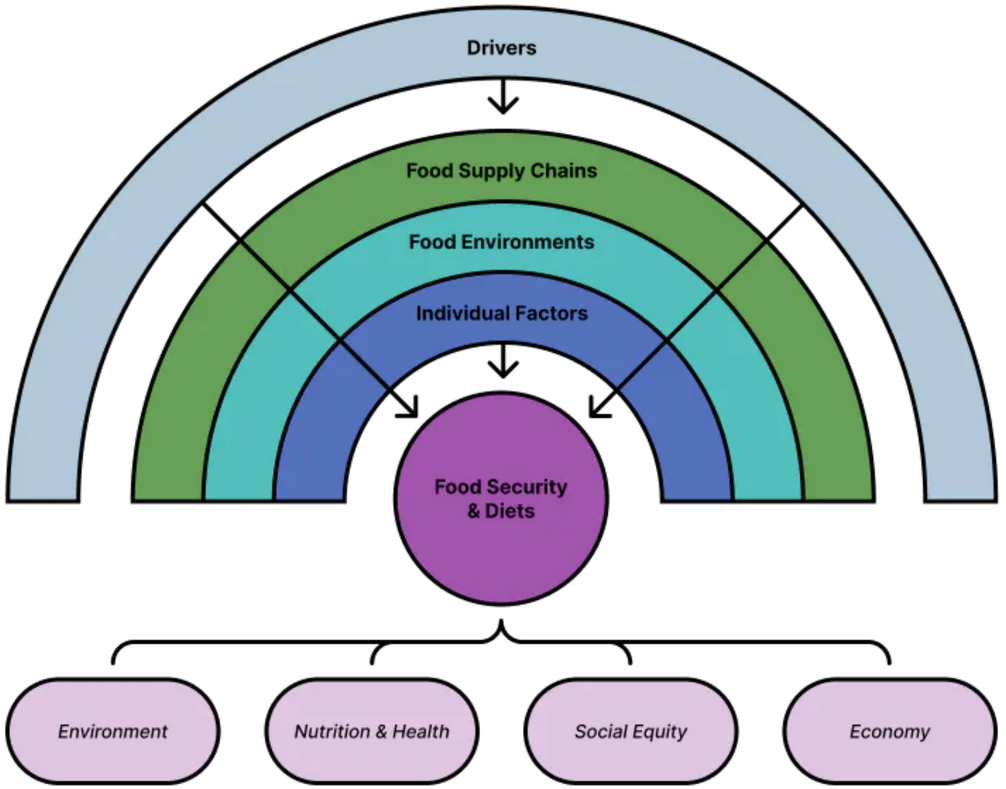
Problem !!!

Food systems affect health in many ways. For example, worldwide **690 million people are hungry**, **2 billion people** have **micronutrient deficiencies** and there are **677.6 million adults with obesity**; **each year zoonoses** are responsible for **2.5 billion cases** of **human illness** and **2.7 million human deaths worldwide**; at least **700 000 people die due to drug-resistant diseases**; **44% of farmers** are **poisoned by pesticides**; and at least **170 000 agricultural workers** are killed.

A Changing World

Driving Trends



Drivers
Politics & Leadership
Biophysical, Climate, & Environment
Globalization & Trade
Sociocultural Dynamics
Population Growth, Migration, & Conflict
Income Growth & Distribution
Land Use & Urbanization

Food Supply Chains
Food Production Systems & Inputs
Food Storage, Loss, Distribution, & Transport
Food Processing & Packaging
Retail, Markets, & Waste

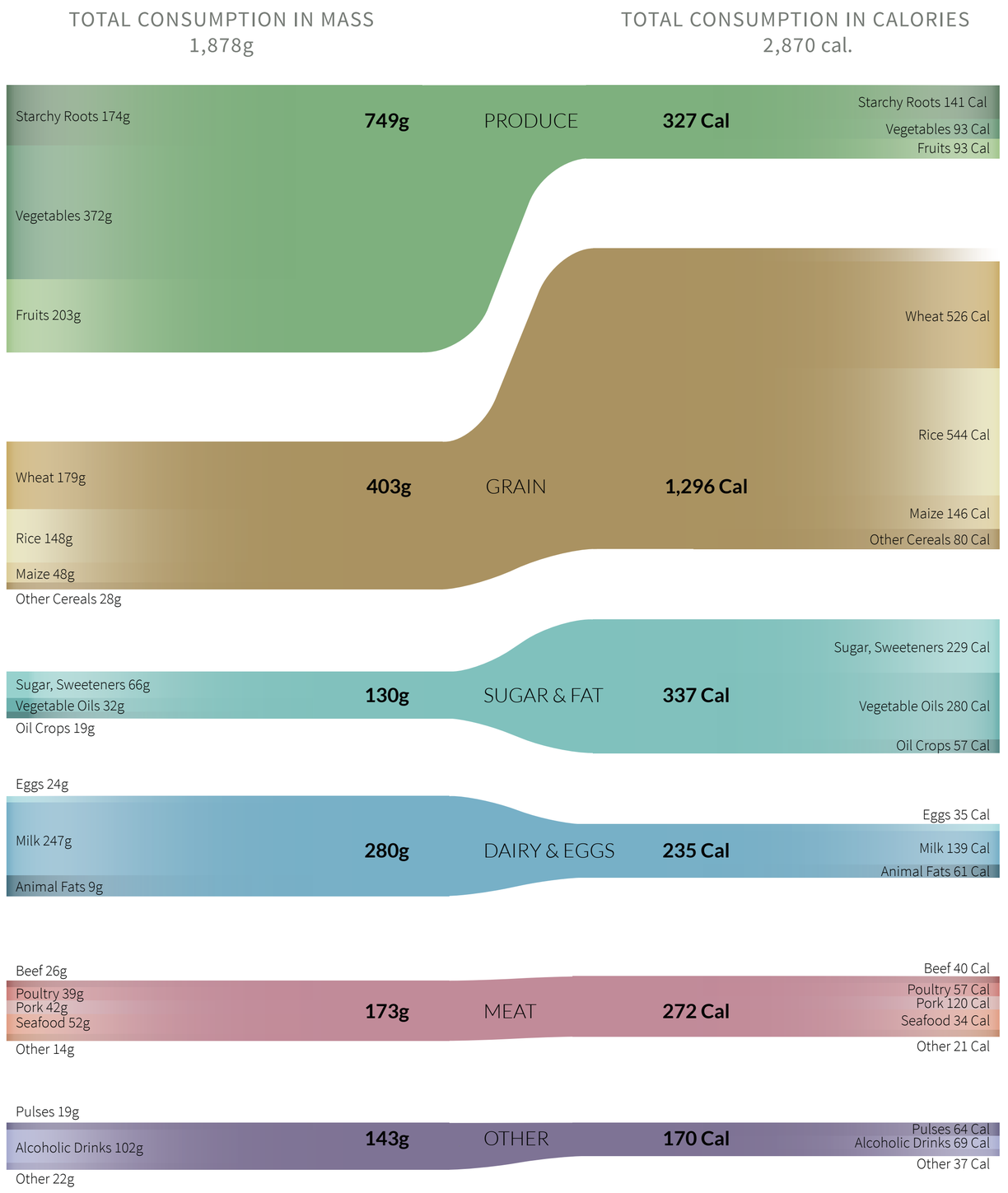
Food Environments
Food Availability
Food Affordability
Product Properties
Vendor Properties
Food Messaging

Individual Factors
Economic
Cognitive
Aspirational
Situational
Behavioral

Outcomes
Food Security
Diets

Impacts
Environment
Nutrition & Health
Social Equity
Economy

Global Food Consumption



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Global Food Consumption

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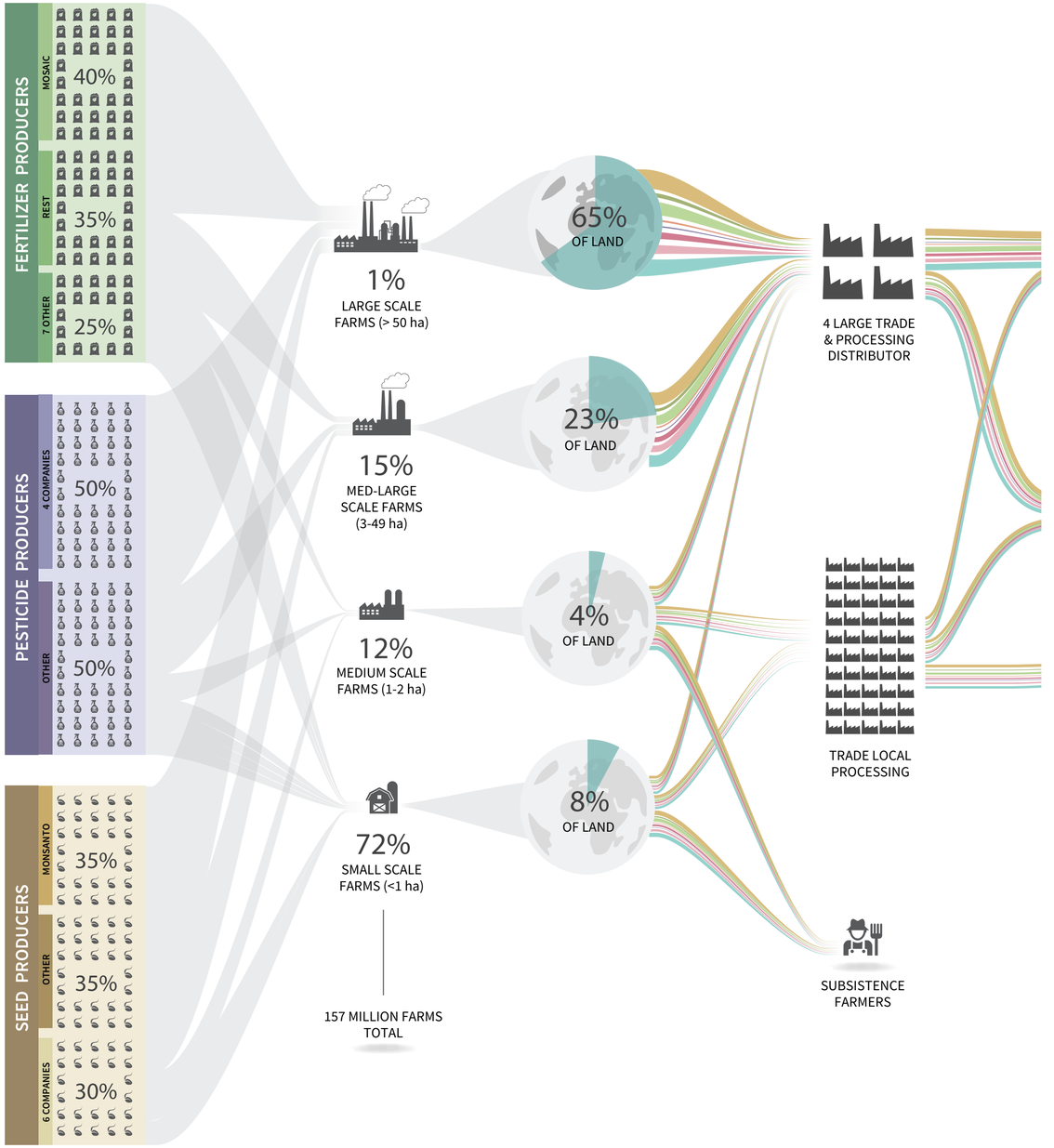
Food Supply Chains



Global Food Consumption

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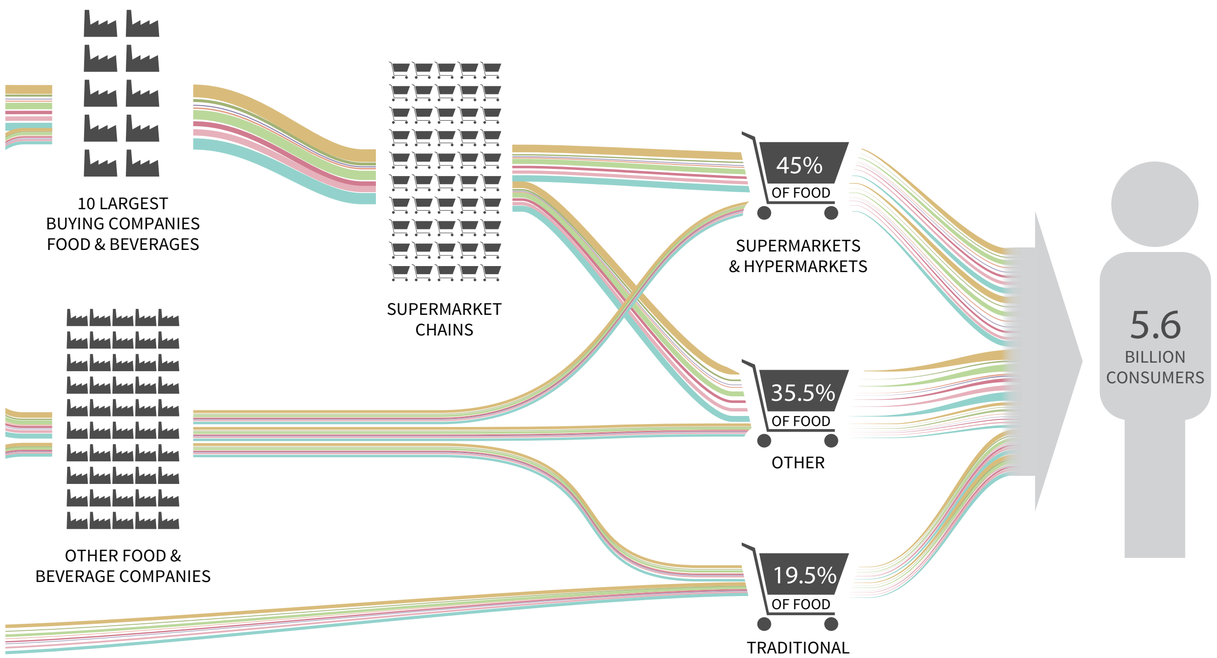
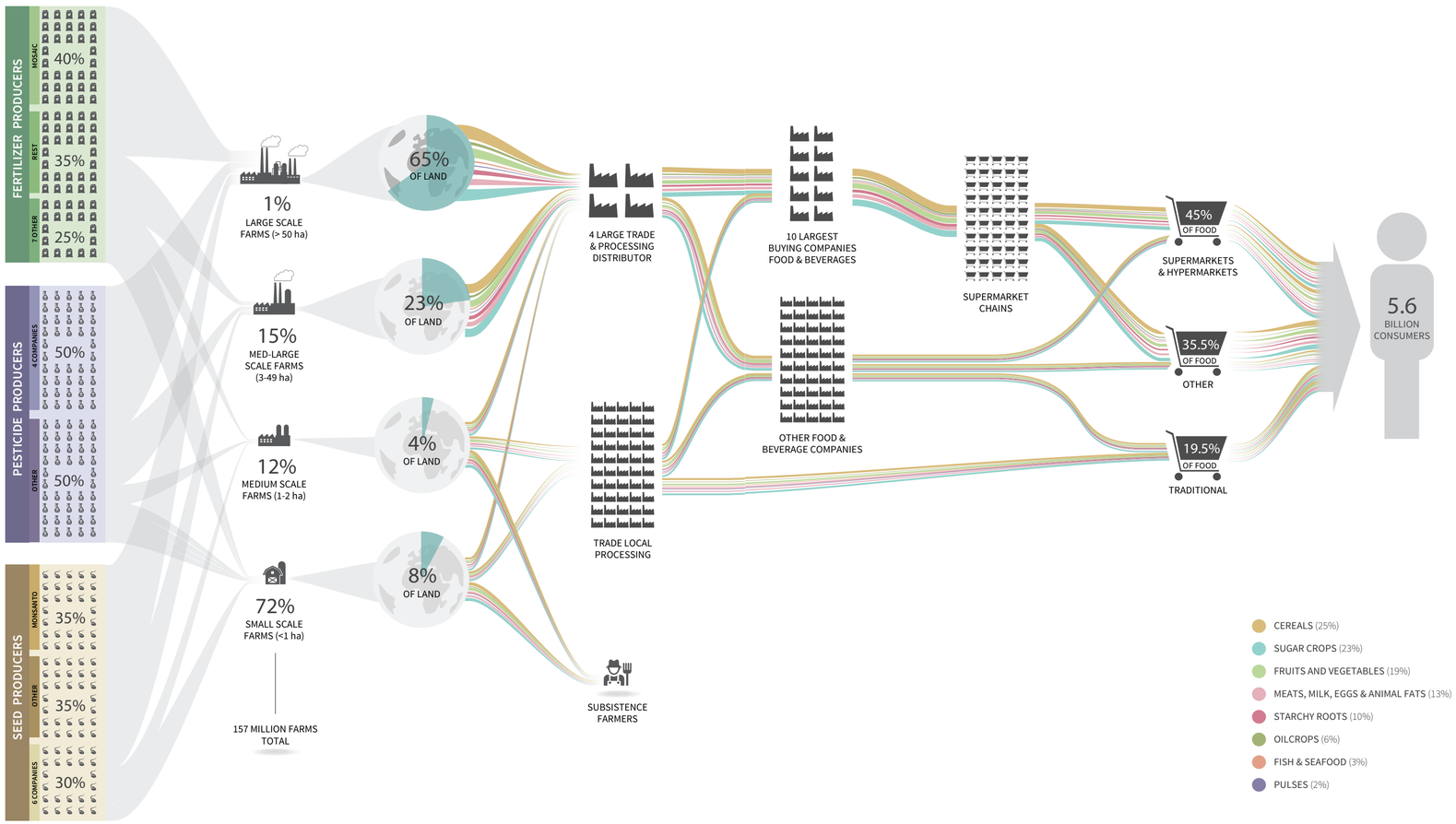
Food Supply Chains



- CEREALS (25%)
- SUGAR CROPS (23%)
- FRUITS AND VEGETABLES (19%)
- MEATS, MILK, EGGS & ANIMAL FATS (13%)
- STARCHY ROOTS (10%)
- OILCROPS (6%)
- FISH & SEAFOOD (3%)
- PULSES (2%)

Global Food Consumption

Food Supply Chains



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Driving Trends

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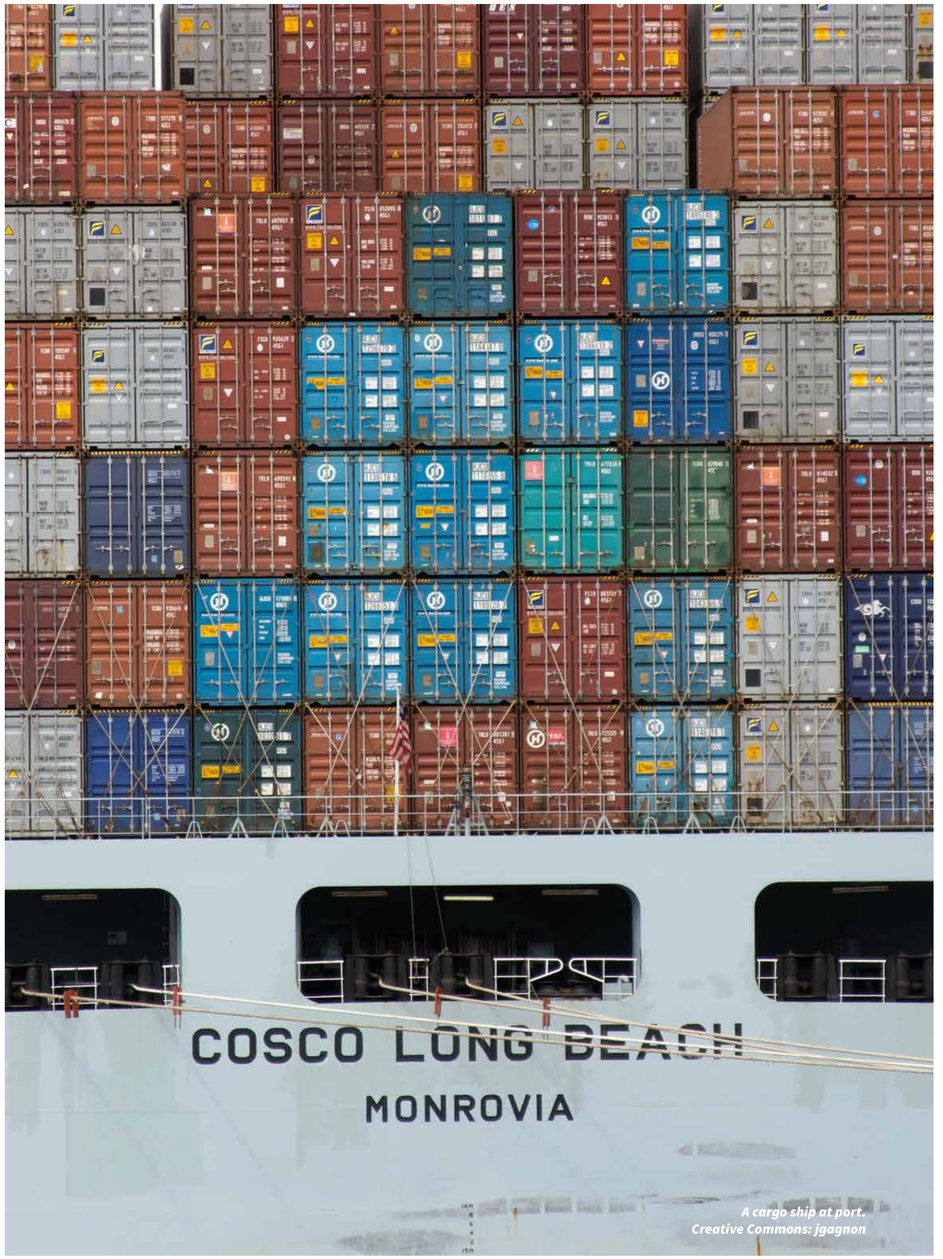
Globalisation



A cargo ship at port.
Creative Commons: jgagnon

GLOBALISATION HAS CREATED SPACE FOR LARGE RETAILERS TO DOMINATE OVER MUCH OF THE DEVELOPED AND DEVELOPING WORLD. TODAY 51% OF GLOBAL FOOD SALES ARE PURCHASED THROUGH SUPERMARKETS AND HYPERMARKETS. FOOD SALES THROUGH THESE CHANNELS ARE GROWING AT AN ANNUAL RATE OF 2%.

Driving Trends

Globalisation

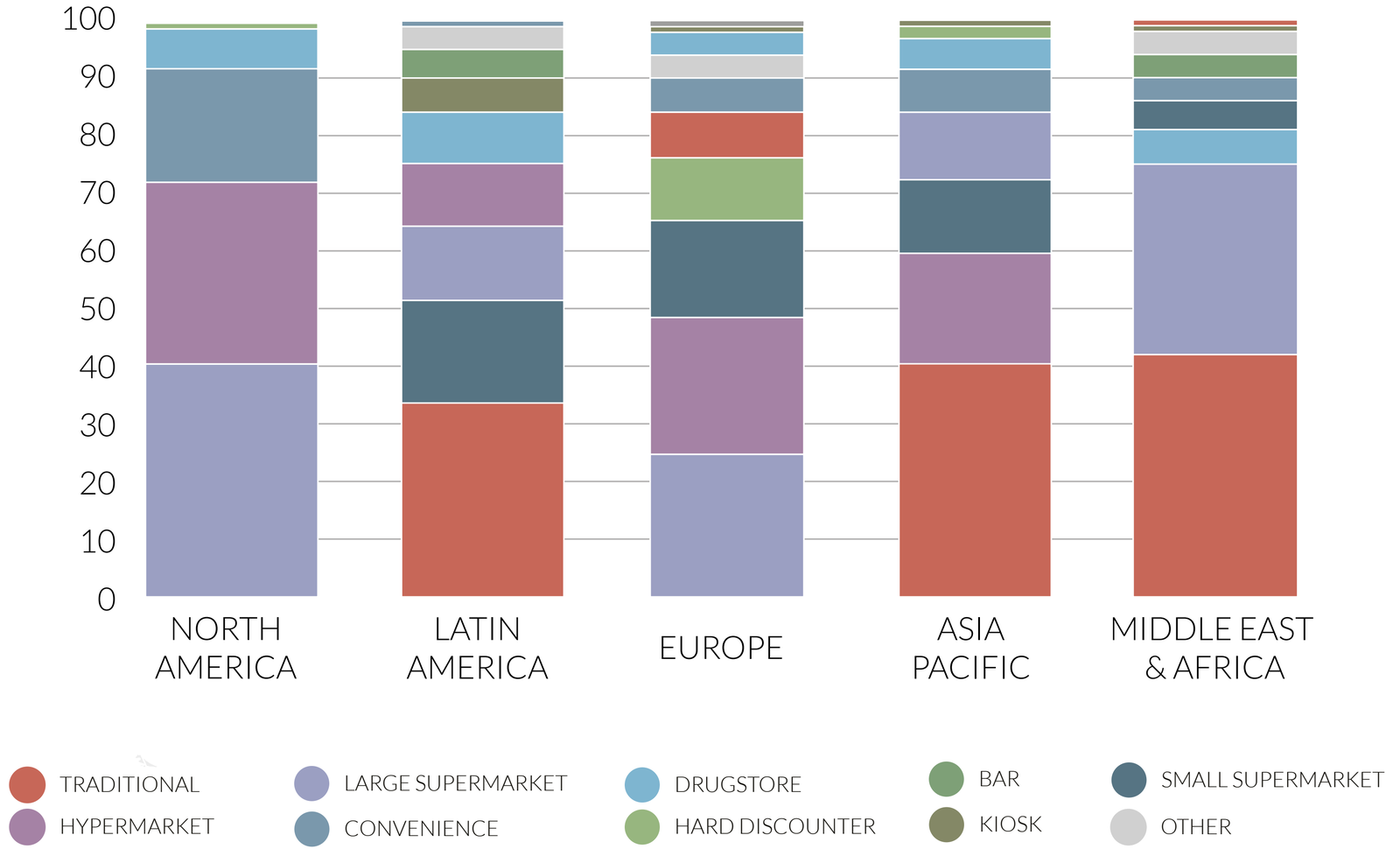
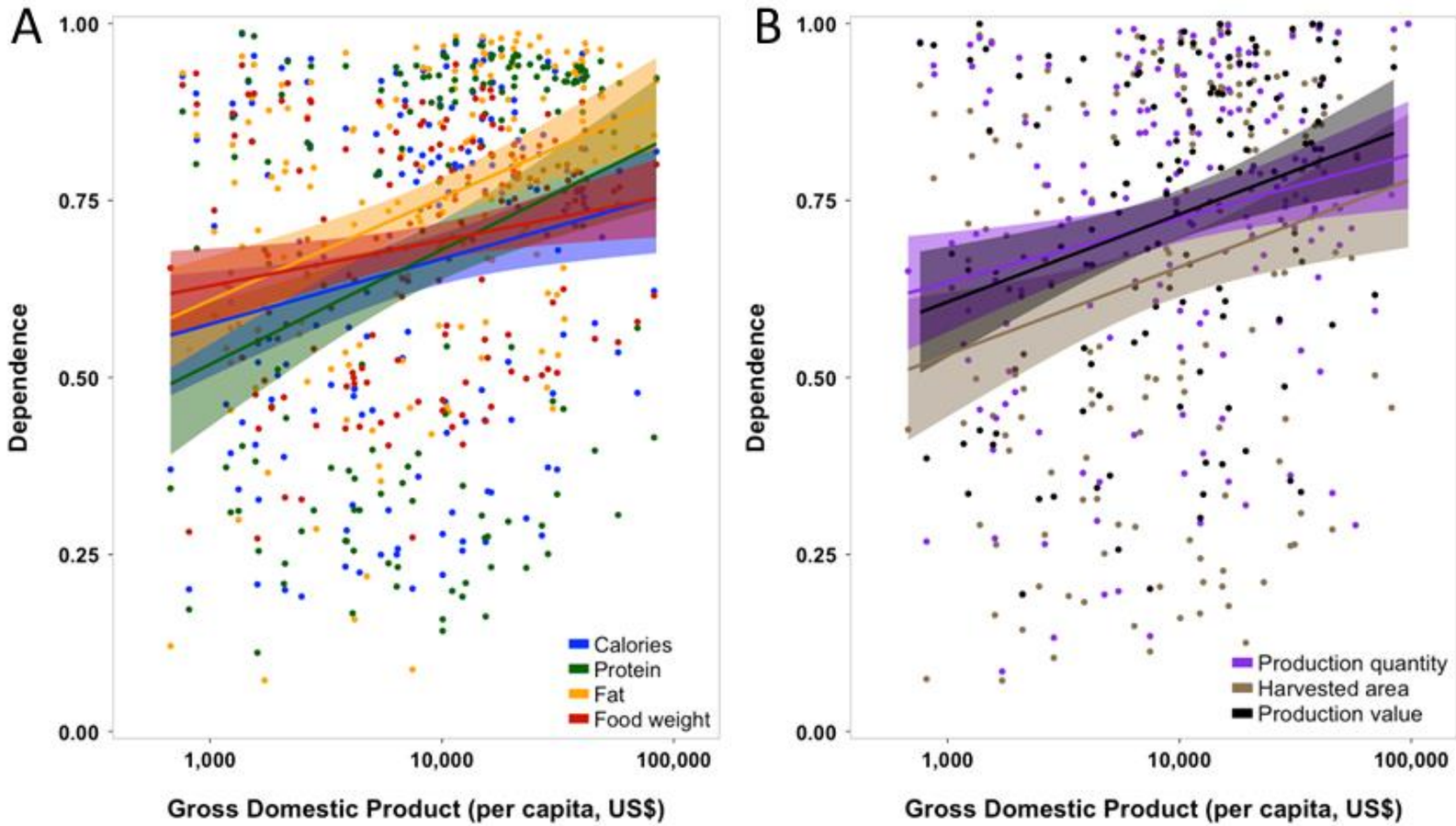


Figure 10: An overview of the different types of food retail channels in each region of the world. (Adapted directly from Nielson "The Future of Grocery," 2015)

Driving Trends

Gross Domestic Product



Driving Trends

Food Environment

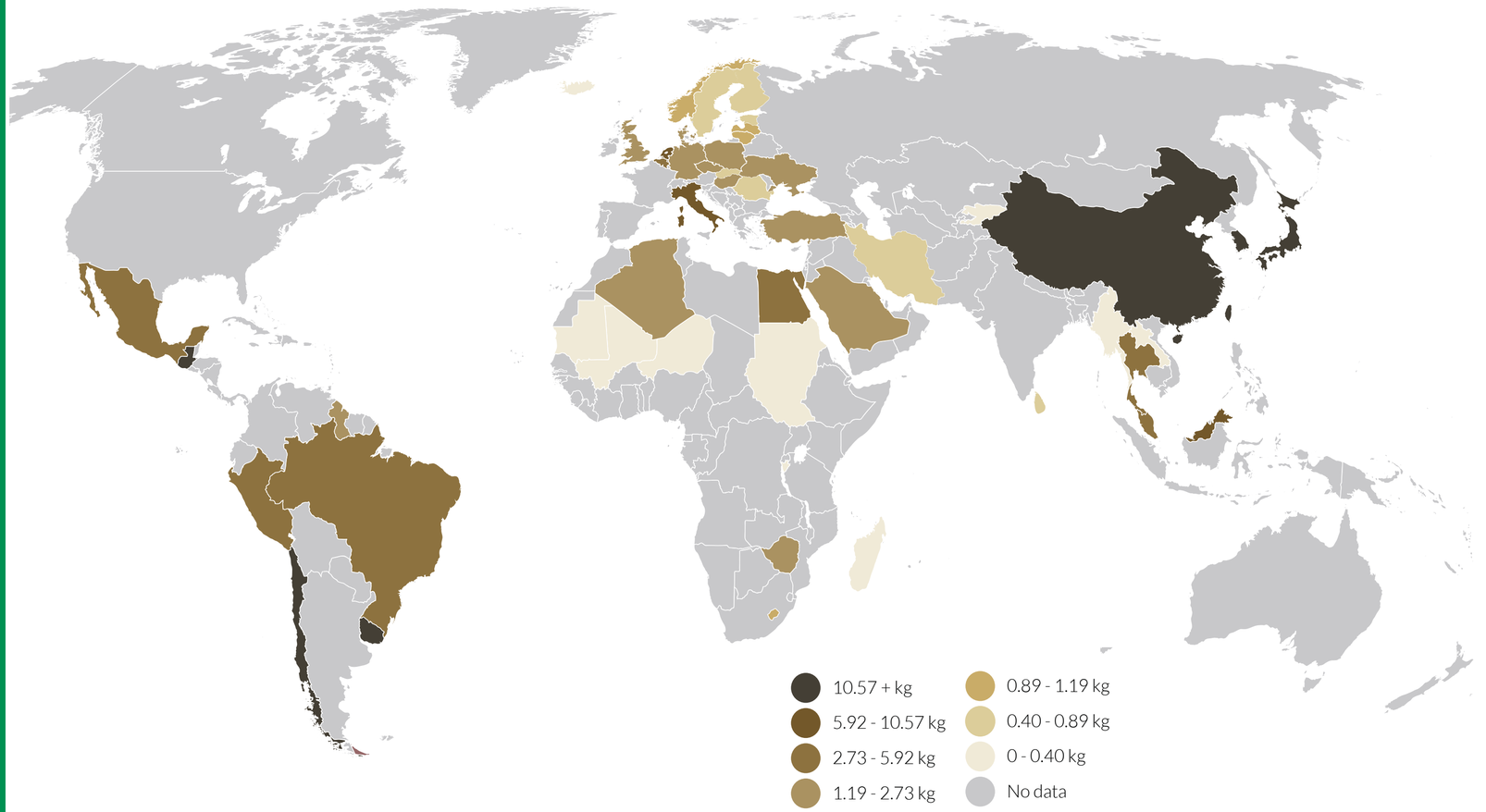


Figure 22: Pesticide use per area (kg pesticide use per hectare arable land). (FAO, 2015b)

Driving Trends

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Food Environment

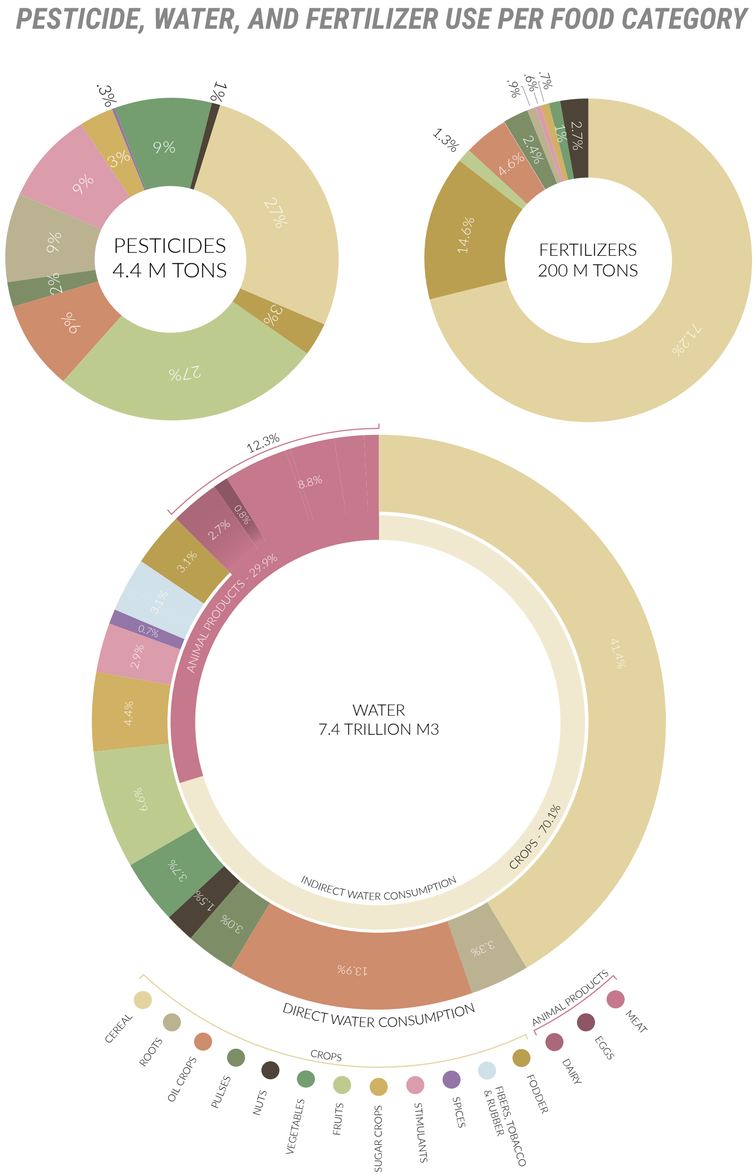

Figure 6: Pesticide, fertilizer, and water inputs per major food type. (FAO, 2015b; Mekonnen & Hoekstra, 2011)

Food Systems & Human Health

The five interconnected and interrelated impact pathways through which food systems negatively affect human health

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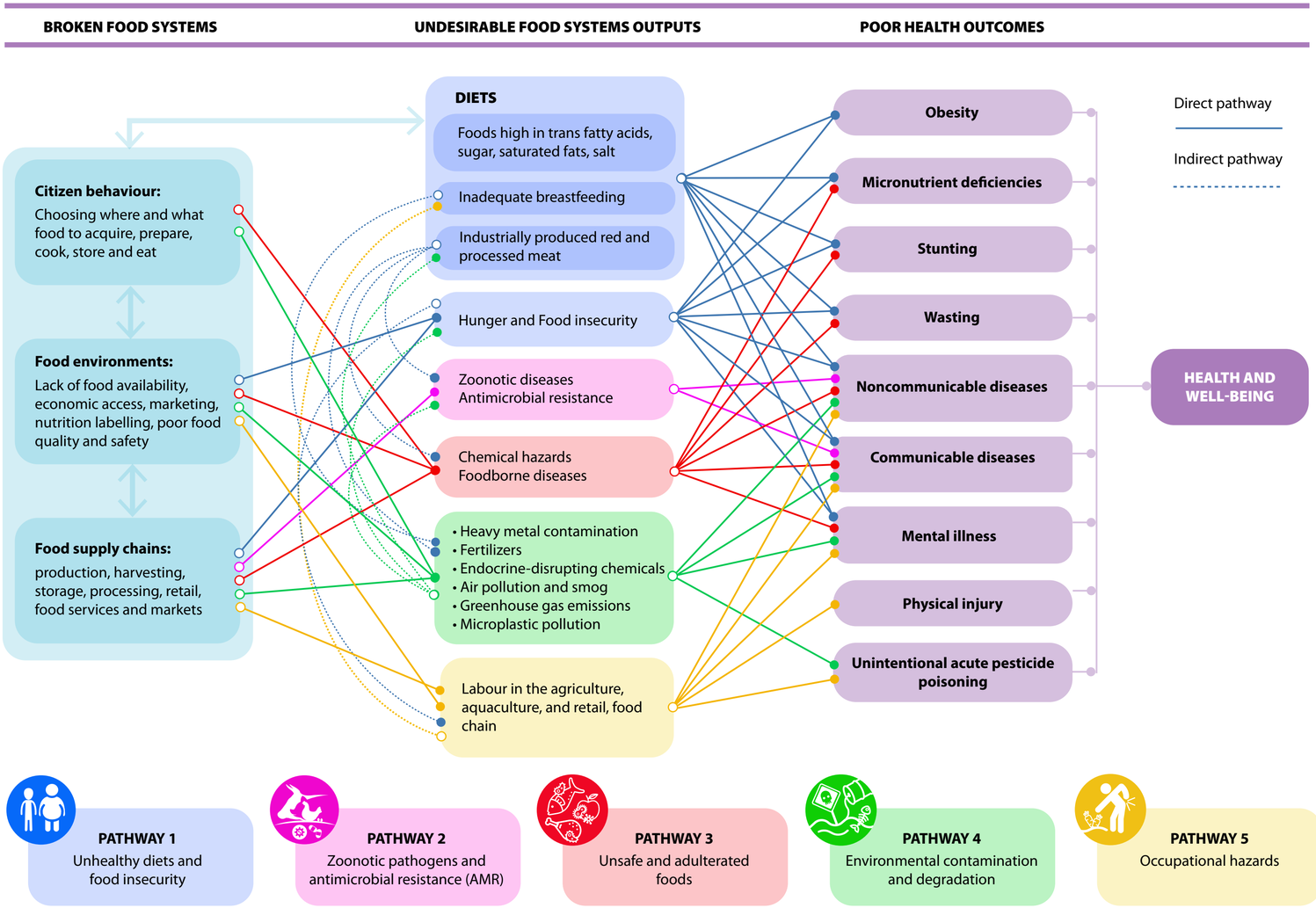
Broken Food Systems

Figure 1. The five interconnected and interrelated impact pathways through which food systems negatively affect human health



Food Systems & Human Health

The five interconnected and interrelated impact pathways through which food systems negatively affect human health

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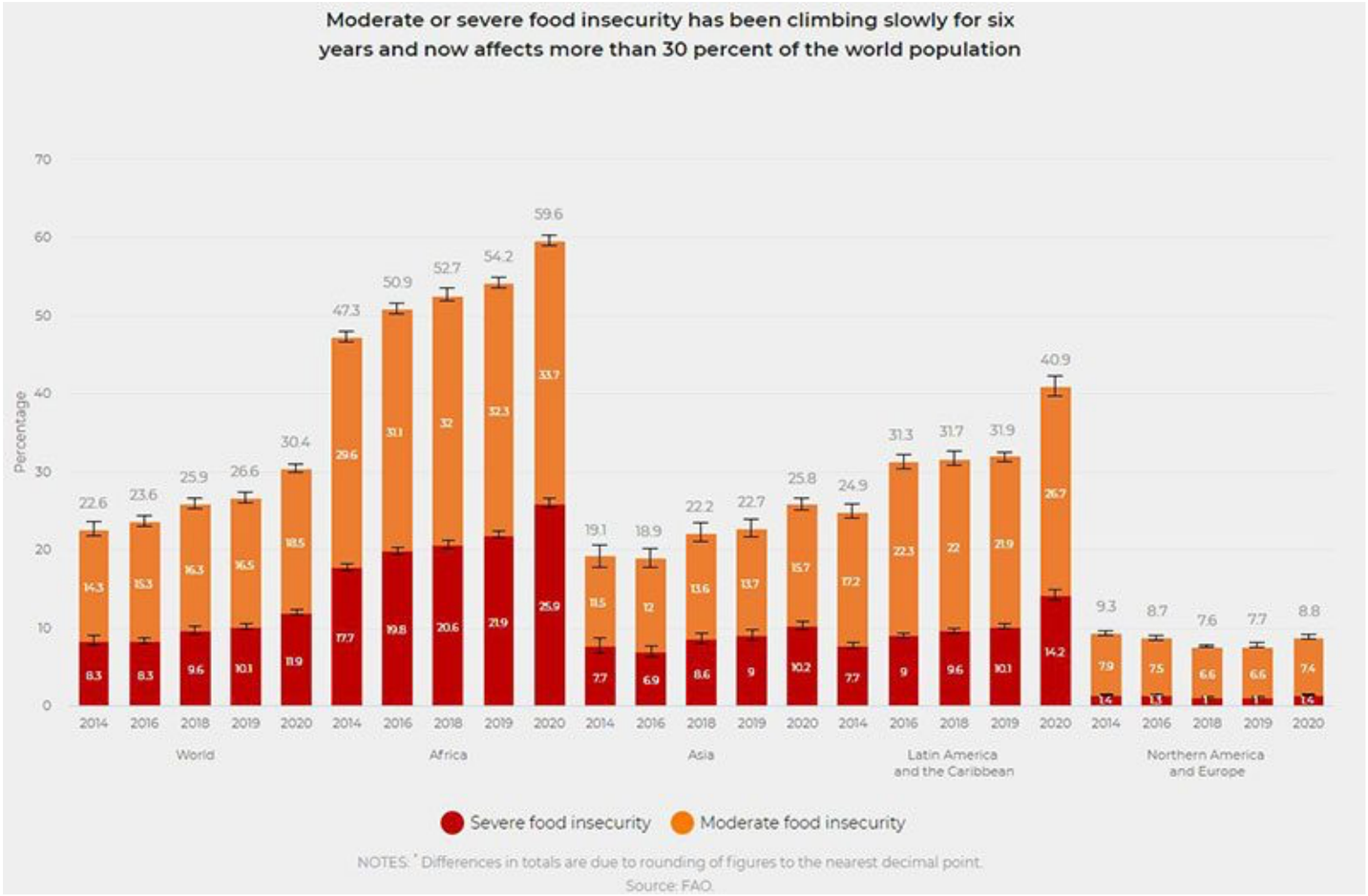
Food Insecurity

Unhealthy diets and food insecurity. This pathway comprises the aspects of food systems that lead to unhealthy diets or food insecurity and therefore contribute to malnutrition in all its forms. Malnutrition and hunger pose the highest risks to human health in terms of death and illness and include obesity, micronutrient deficiencies, stunting, wasting, communicable and noncommunicable diseases and mental illness.



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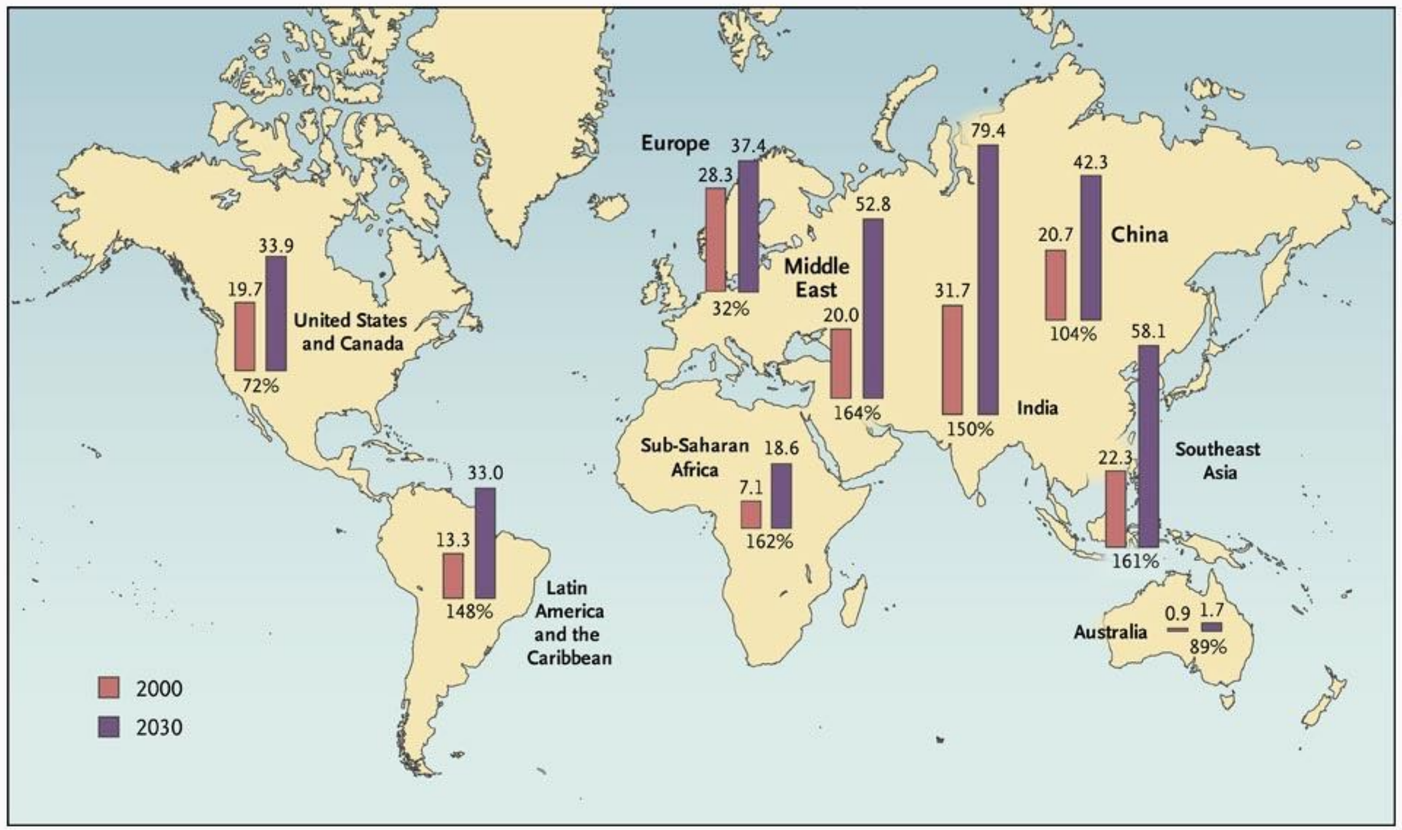

millions of people with metabolic syndrome

Food Systems & Human Health

The five interconnected and interrelated impact pathways through which food systems negatively affect human health

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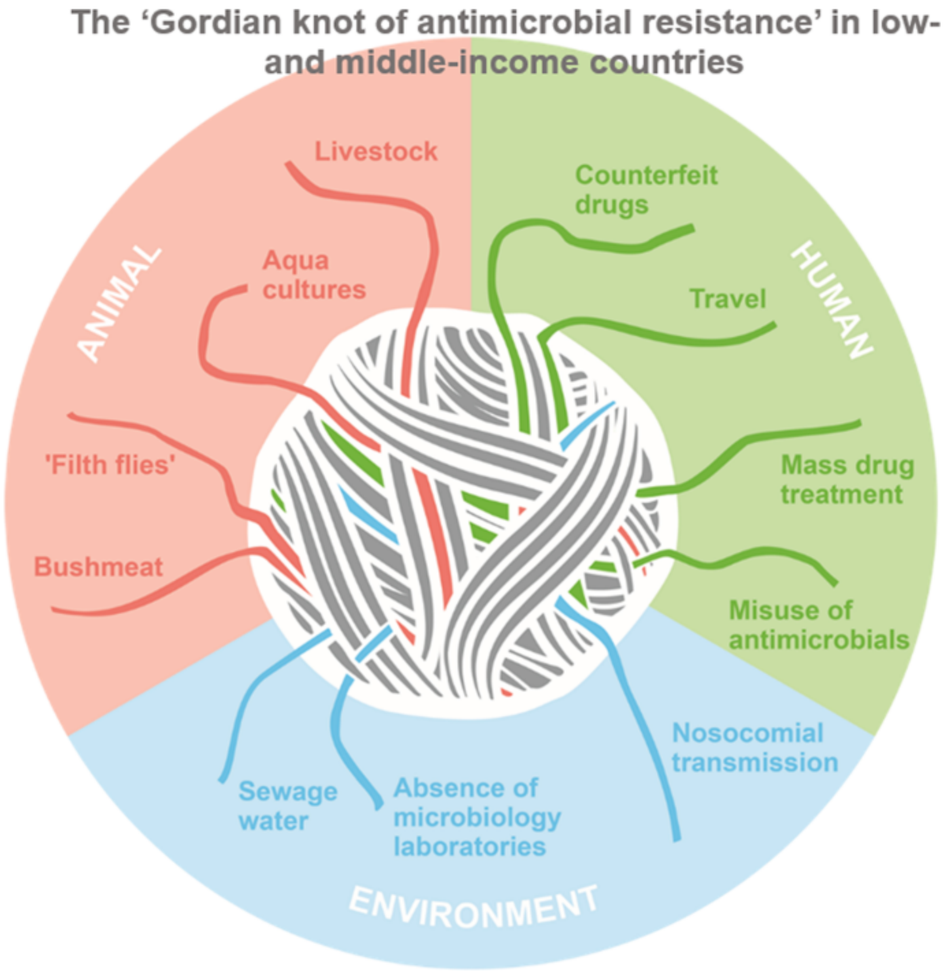
Pathogens

Zoonotic pathogens and antimicrobial resistance. This pathway comprises the ways in which farmed, ranched and wild caught animals in food supply chains and the use of antibiotics result in zoonotic diseases and antimicrobial resistance, which further result in communicable and noncommunicable diseases in humans.



Food Systems & Human Health

The five interconnected and interrelated impact pathways through which food systems negatively affect human health

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Unsafe Food

Unsafe and adulterated foods. In this pathway, food systems are the cause of various diseases and illnesses (e.g., micronutrient deficiency, stunting, wasting, communicable and noncommunicable diseases and mental illness) when foods and water contain infectious or toxic hazards, microbial pathogens, such as bacteria, viruses and parasites, or chemical residues, contaminants or biotoxins. These contaminants can occur in unsafe food supply chains or unhealthy environments or due to unsafe behaviour.

Food Systems & Human Health

The five interconnected and interrelated impact pathways through which food systems negatively affect human health

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Food Processing

1/5 OF ALL PRIMARY CROPS ARE PROCESSED BEFORE CONSUMPTION.

THE US FOOD PROCESSING INDUSTRY IS GROWING AT A RATE OF 5% ANNUALLY.

Food Systems & Human Health

The five interconnected and interrelated impact pathways through which food systems negatively affect human health

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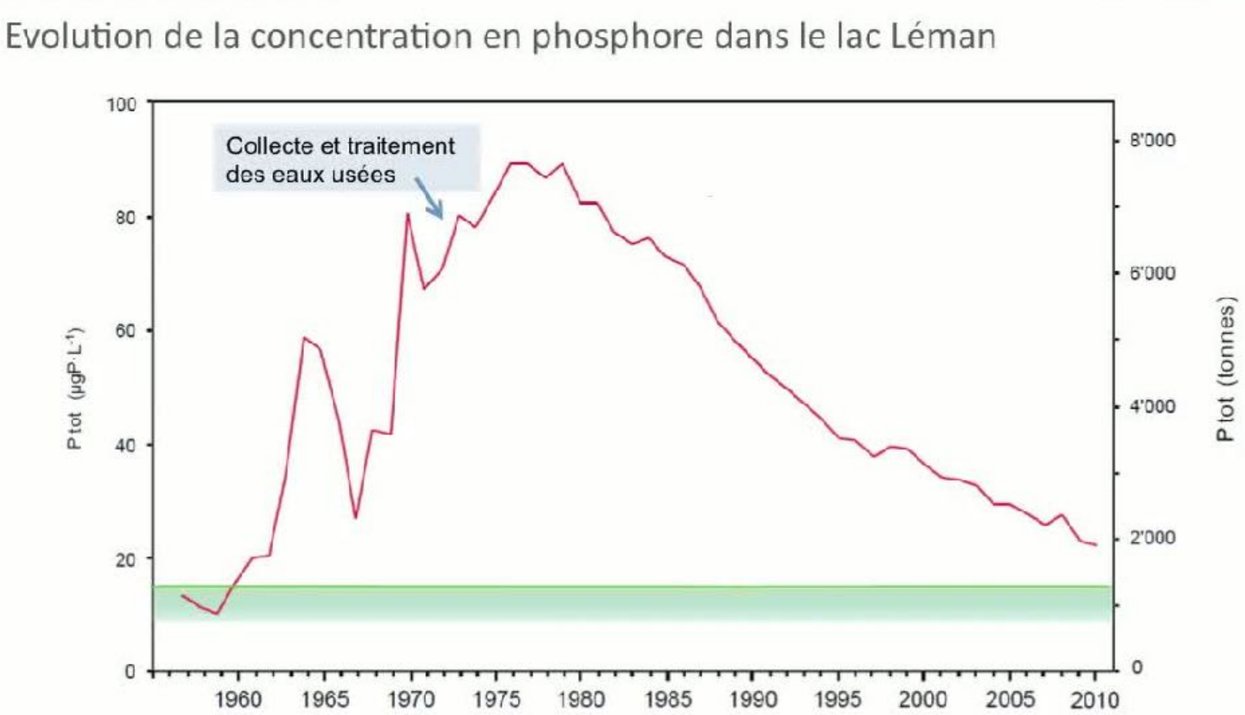
Food Processing

Environmental contamination and degradation. This pathway comprises contamination of the environment by use in food supply chains and food environments of fertilizers, manure, products containing heavy metals, endocrine-disrupting chemicals or hormone-growth promotors, which can cause various conditions, such as mental illness and other noncommunicable and communicable diseases. It includes the ways in which food production, food environments and citizen behaviour degrade the environment by emitting air pollution, greenhouse gases and microplastics, which affect our health and well-being.



Food Systems & Human Health

The five interconnected and interrelated impact pathways through which food systems negatively affect human health

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A view of a typical landfill, where most food waste is likely to end up.

Environmental Contamination & Waste

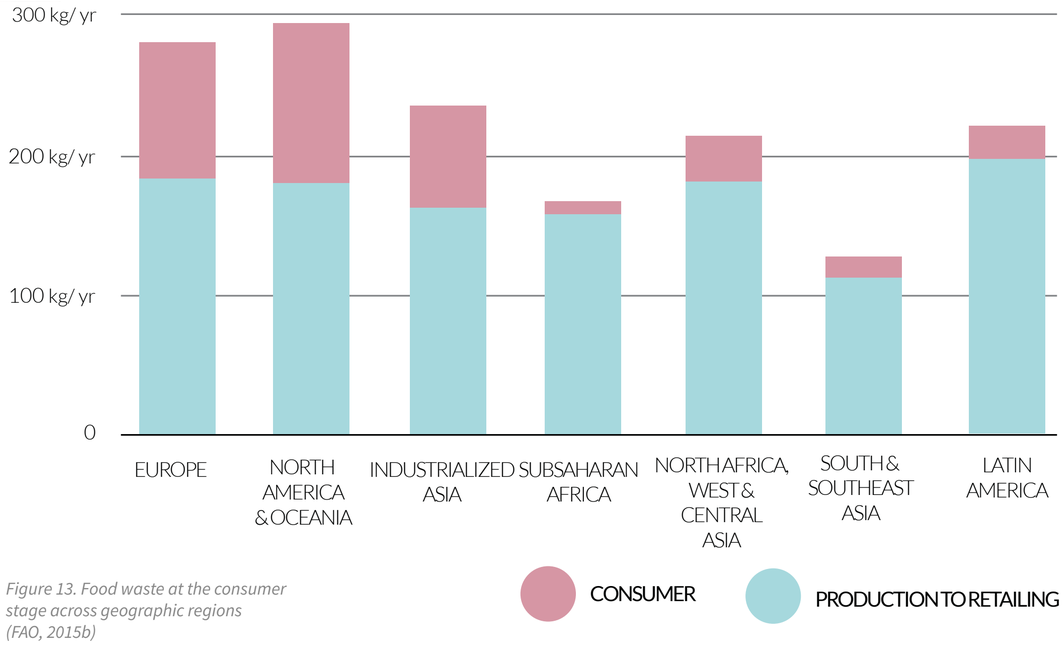

Figure 13. Food waste at the consumer stage across geographic regions (FAO, 2015b)

Food Systems & Human Health

The five interconnected and interrelated impact pathways through which food systems negatively affect human health

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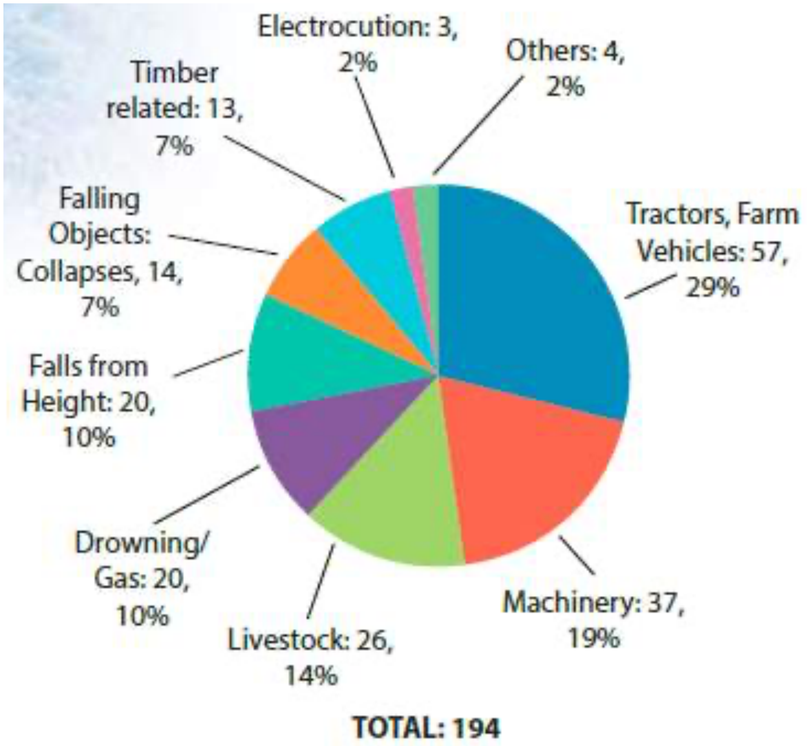
Occupational Hazard

Occupational hazards. This pathway comprises the many physical and mental health effects on people working in the food system (e.g., farmers, fishermen, agricultural workers and people working in food retail, processing and other sectors of the food chain) due to the nature of their work or their working conditions. The effects include heat and cold stress, injuries, exposure to chemicals through the use of pesticides, fertilizers and insecticides, biological risks such as snakebites, infectious and parasitic diseases, zoonoses, ergonomic risks and psychosocial risks leading to stress and mental illness, including suicide.

AGRICULTURE IS ONE OF THE 3 MOST HAZARDOUS SECTORS TO WORK IN.



Food Systems & Human Health

The five interconnected and interrelated impact pathways through which food systems negatively affect human health

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Child Labour

Occupational hazards. This pathway comprises the many physical and mental health effects on people working in the food system (e.g., farmers, fishermen, agricultural workers and people working in food retail, processing and other sectors of the food chain) due to the nature of their work or their working conditions. The effects include heat and cold stress, injuries, exposure to chemicals through the use of pesticides, fertilizers and insecticides, biological risks such as snakebites, infectious and parasitic diseases, zoonoses, ergonomic risks and psychosocial risks leading to stress and mental illness, including suicide.

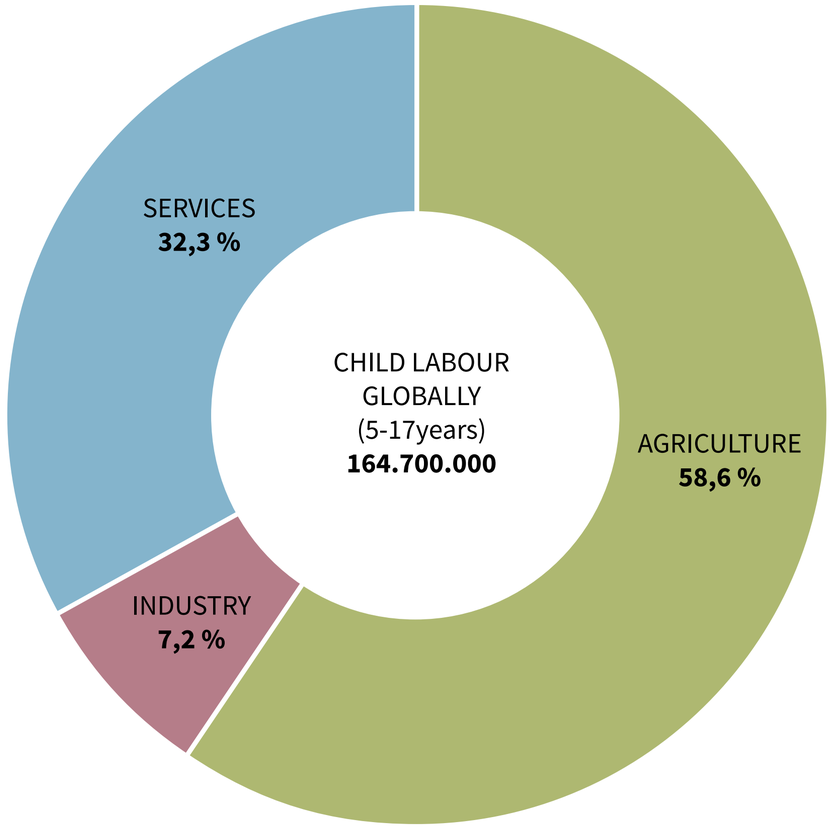
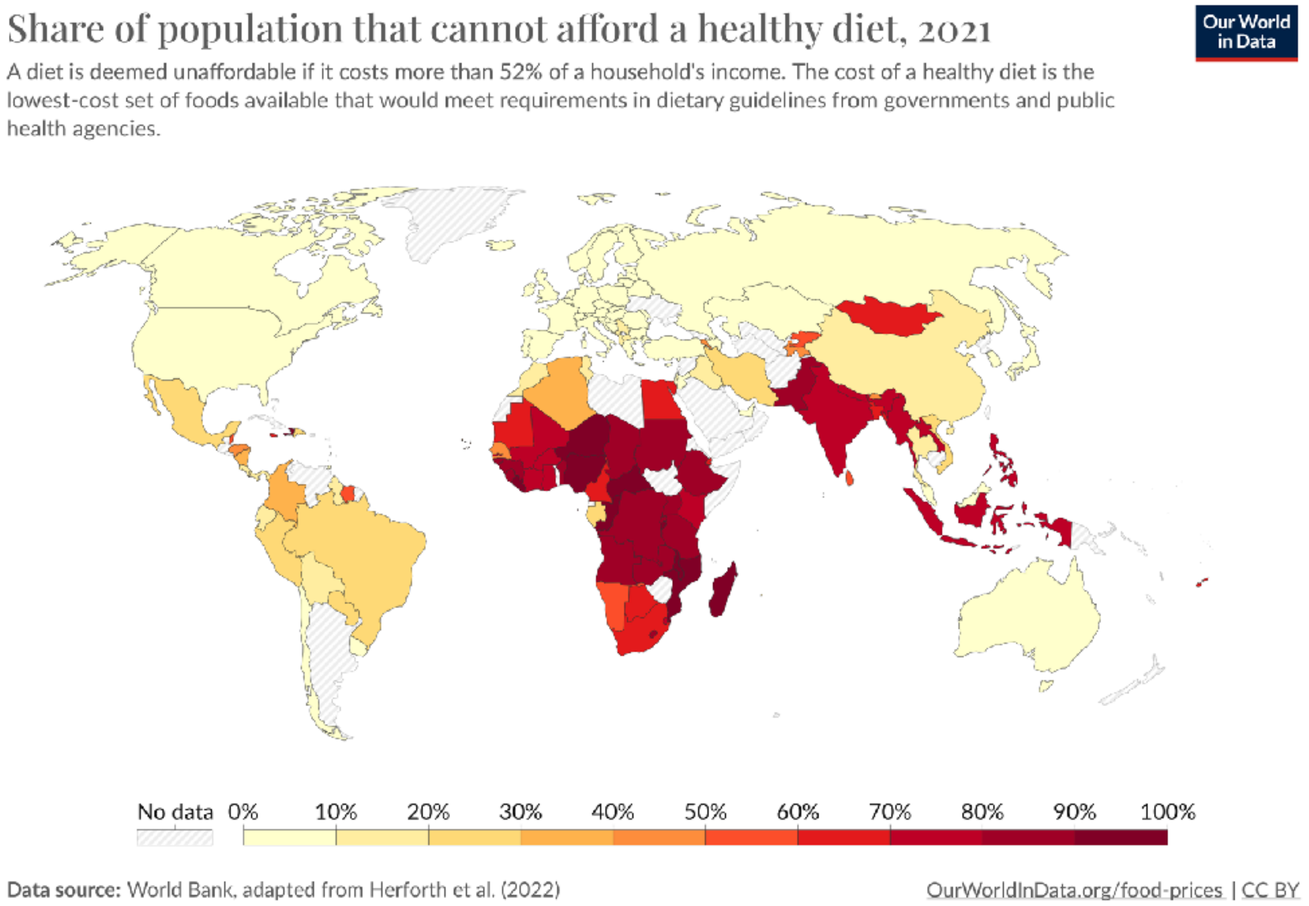


Figure 24: An overview of the main sectors in which child labour is occurring globally. (ILO, 2015)

Break

15 min Break

Consequences of Broken Food Systems on human health



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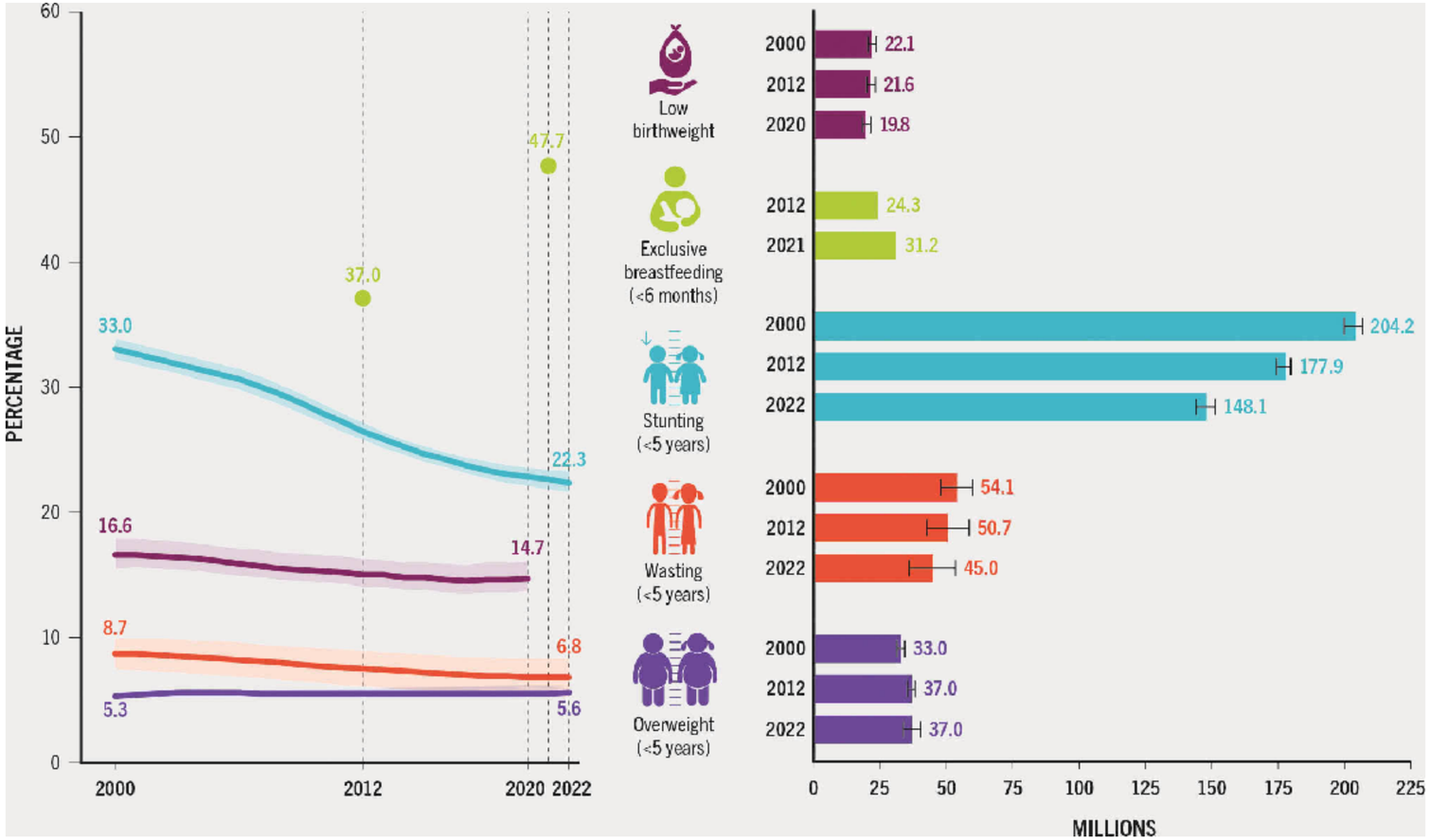
Poor Health Outcomes

Stunting, Wasting, Obesity



Poor Health Outcomes

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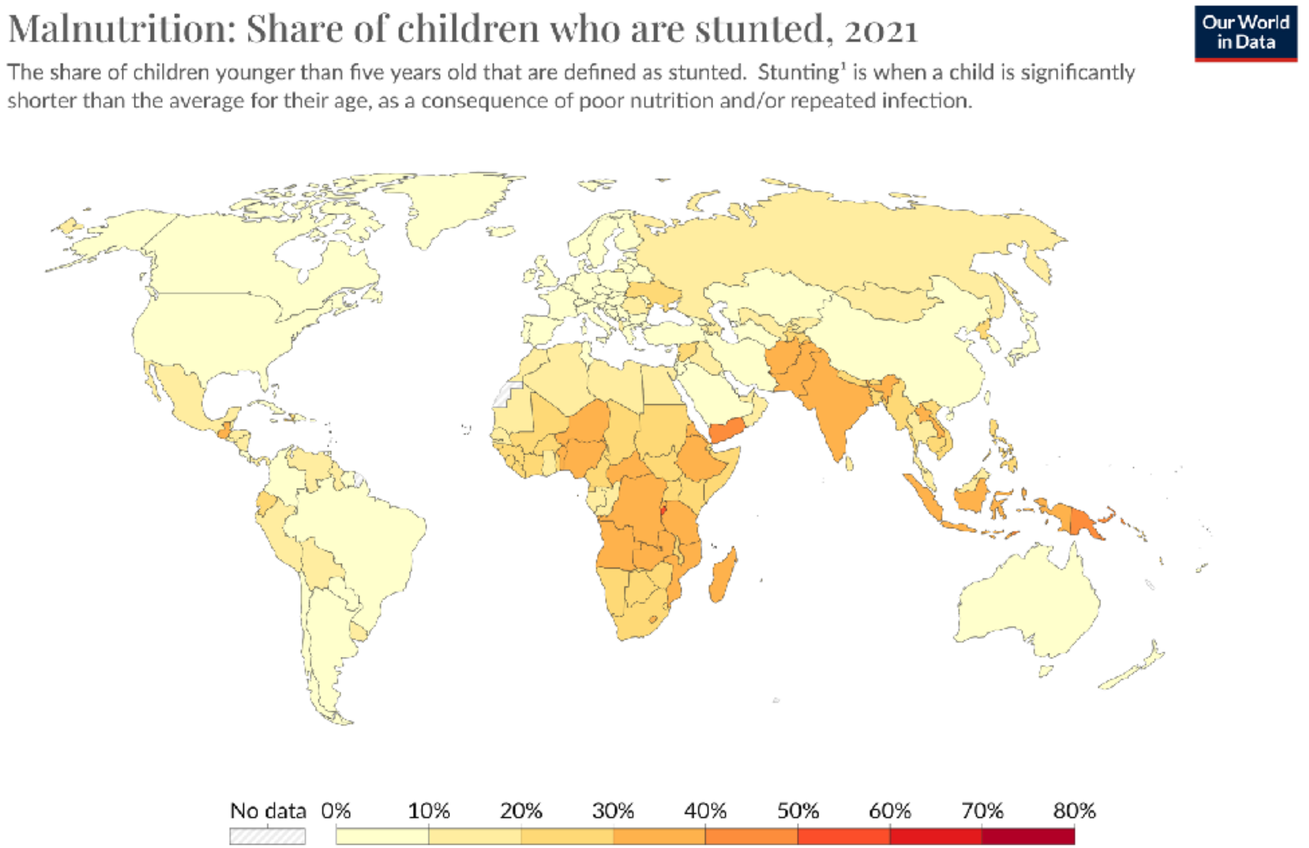
Stunting



Poor Health Outcomes

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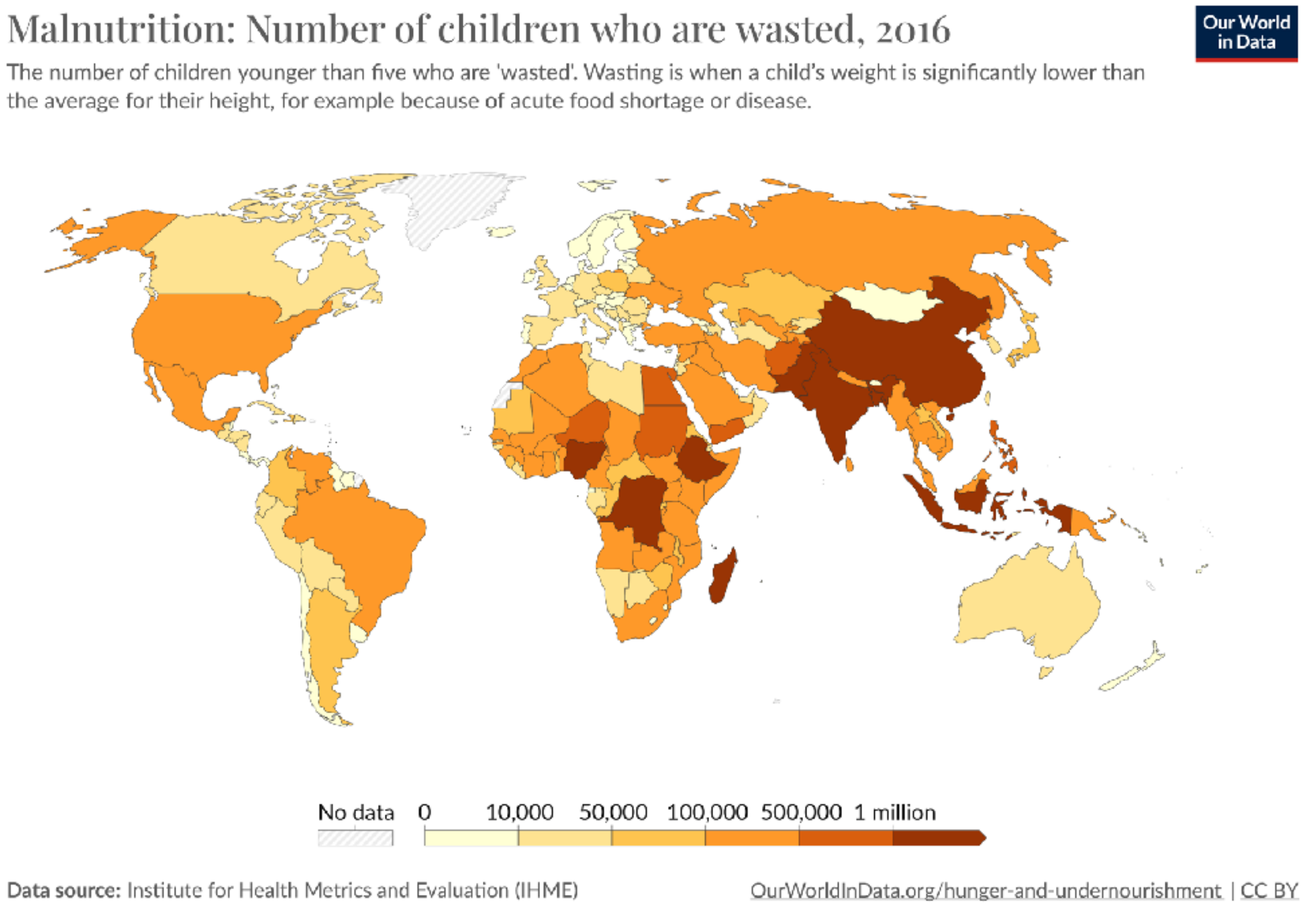
Wasting



Poor Health Outcomes

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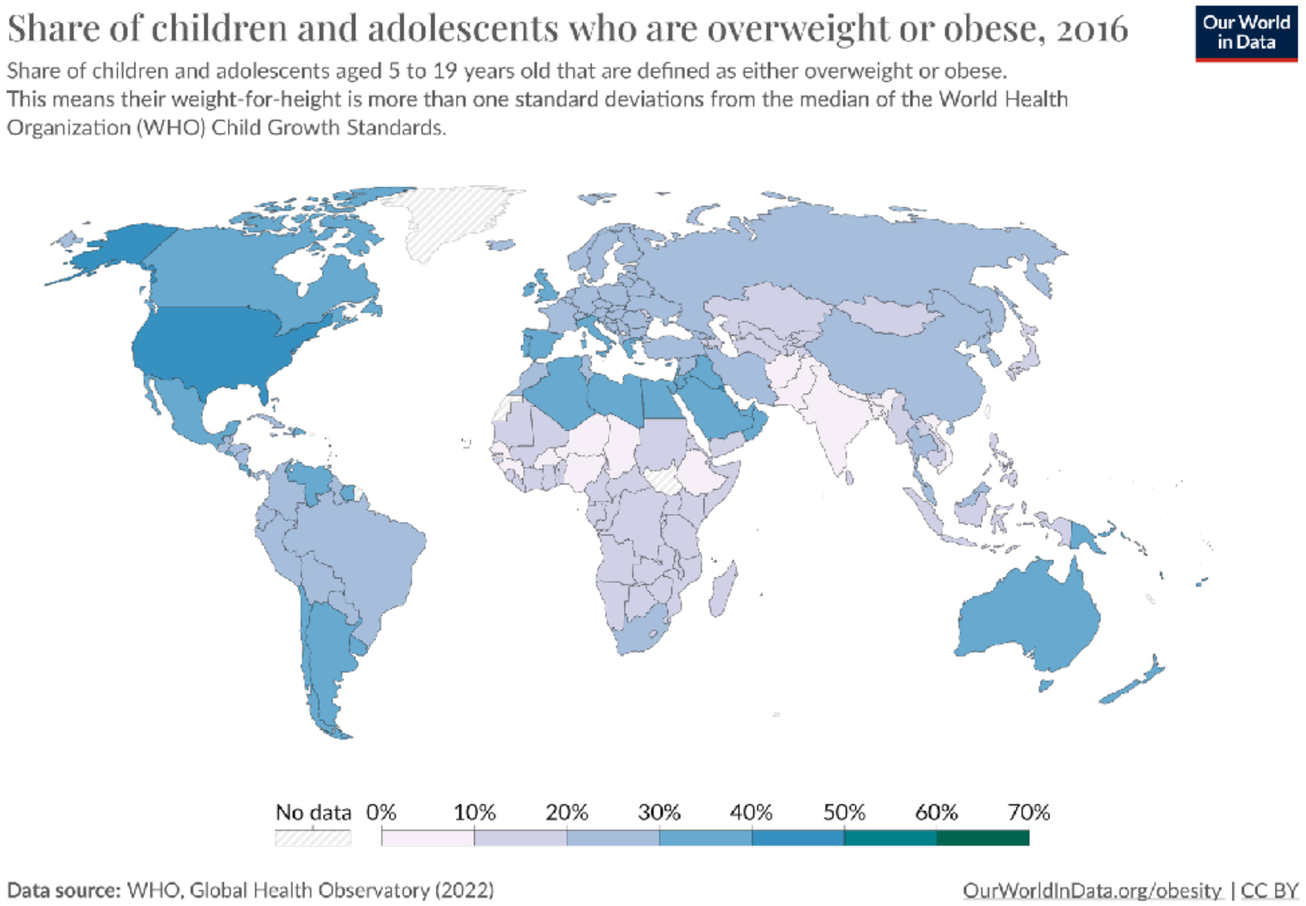
Overweight in the young



Poor Health Outcomes

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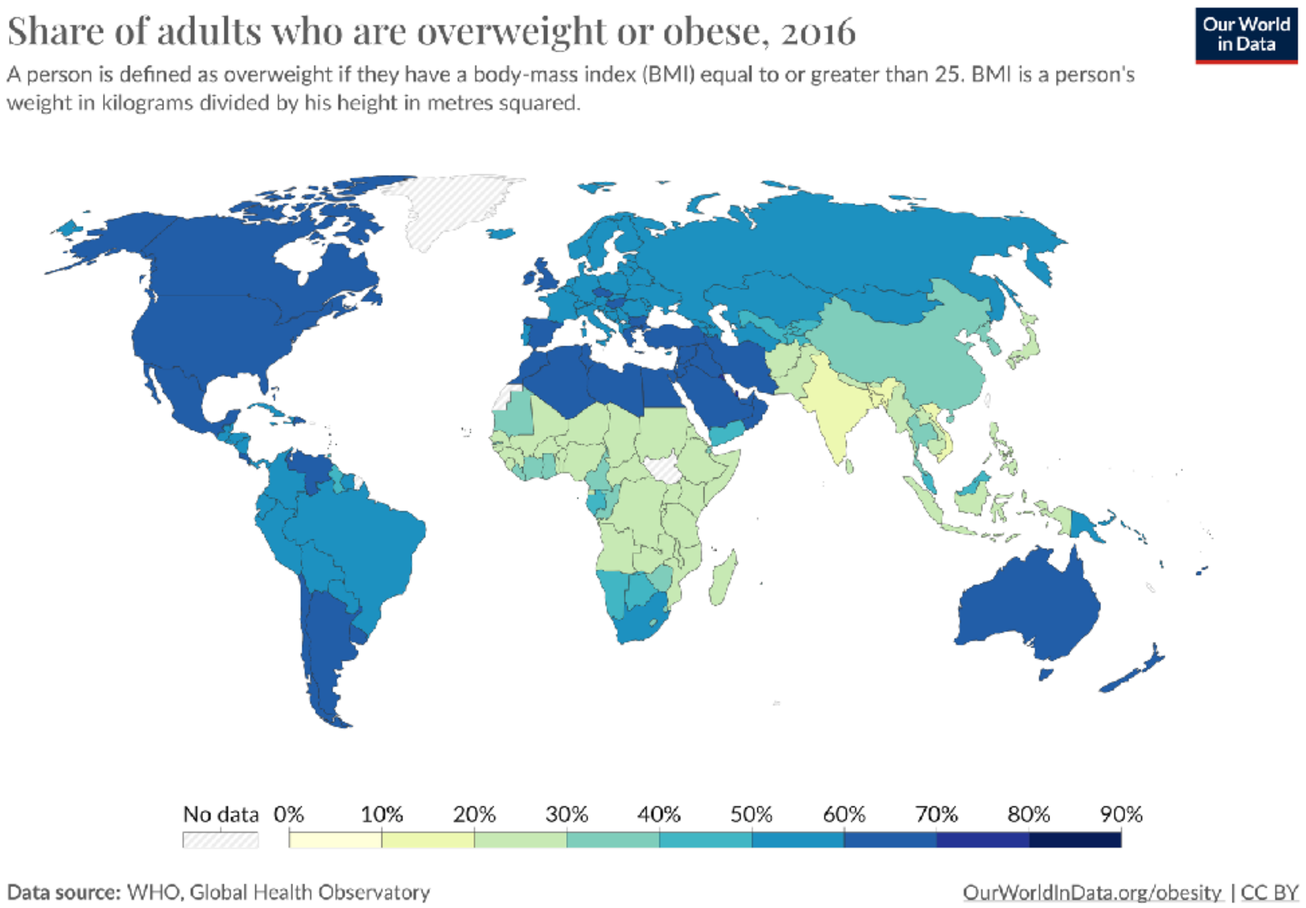
Obesity



Poor Health Outcomes

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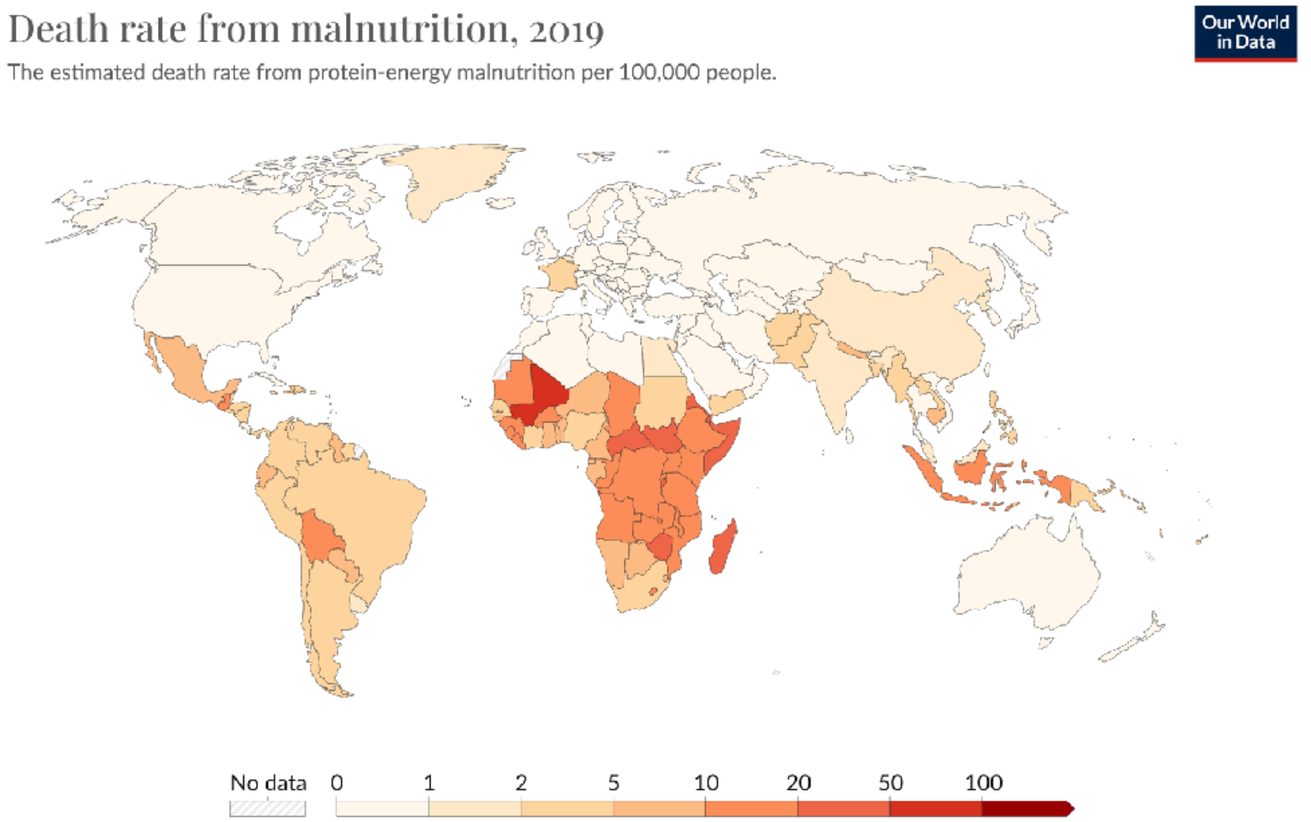
Death by Malnutrition



Poor Health Outcomes

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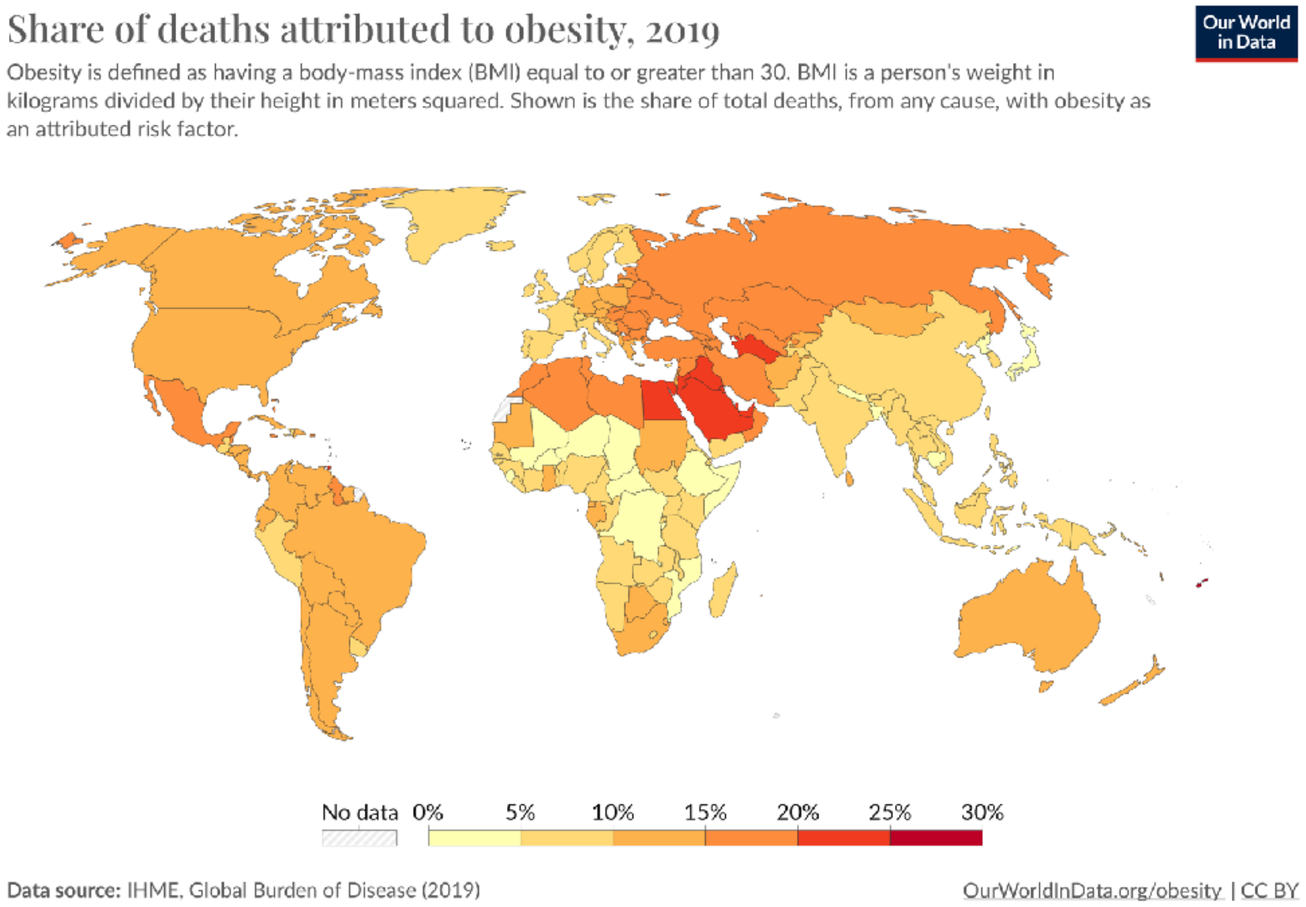
Death by Obesity



Poor Health Outcomes

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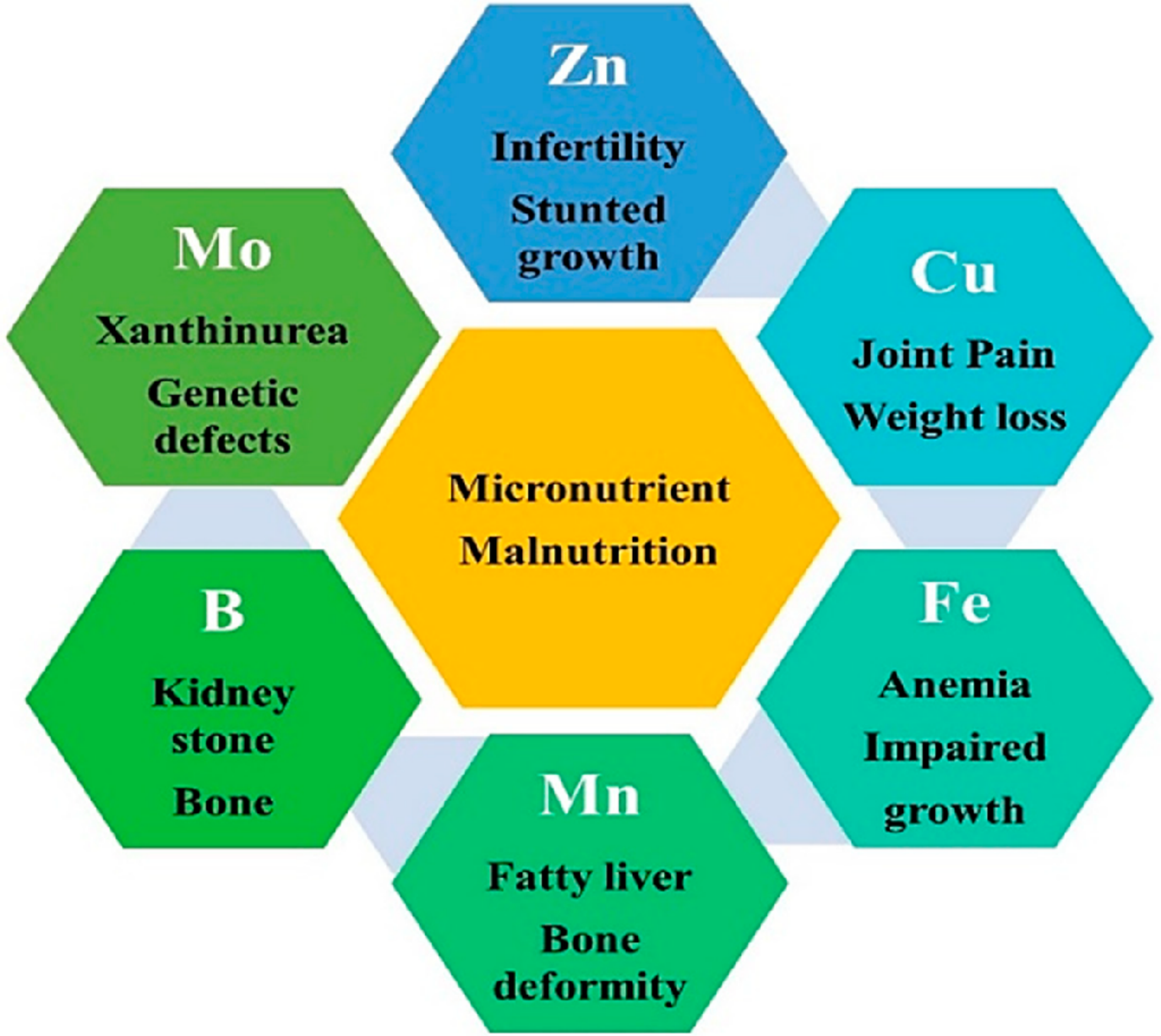
Micronutrient Deficiency



Poor Health Outcomes

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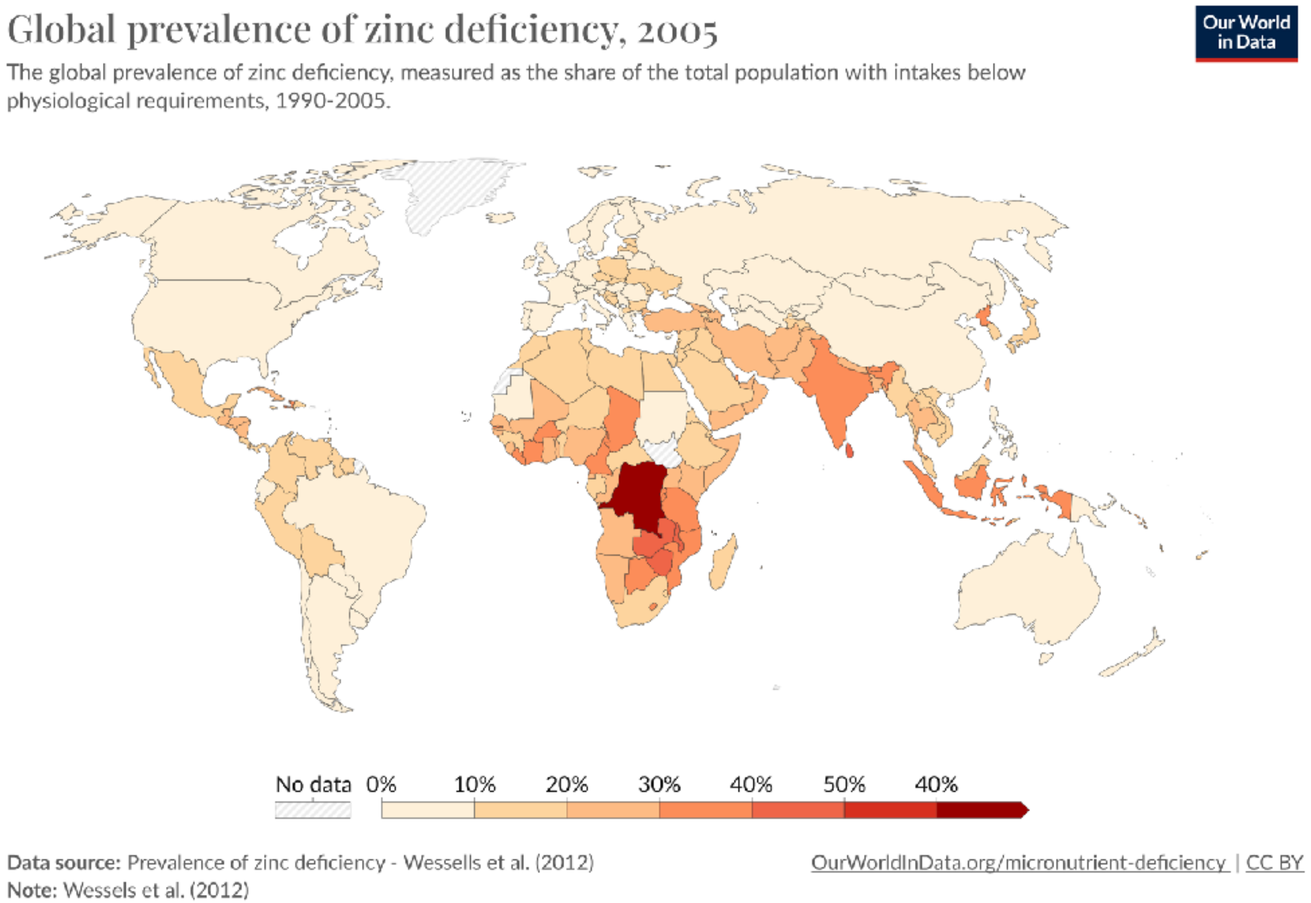
Micronutrient Deficiency



Poor Health Outcomes

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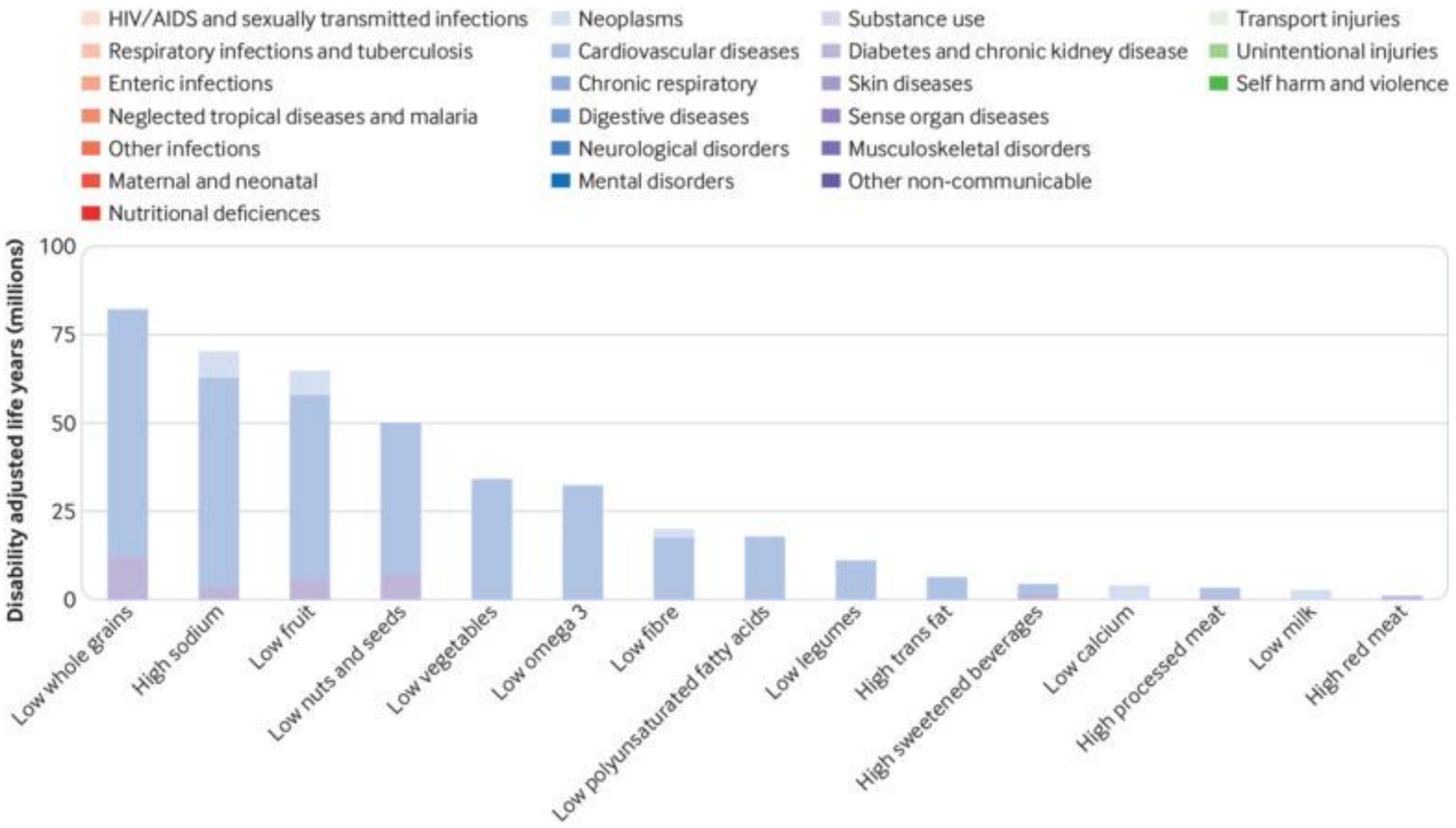
Diseases



Poor Health Outcomes

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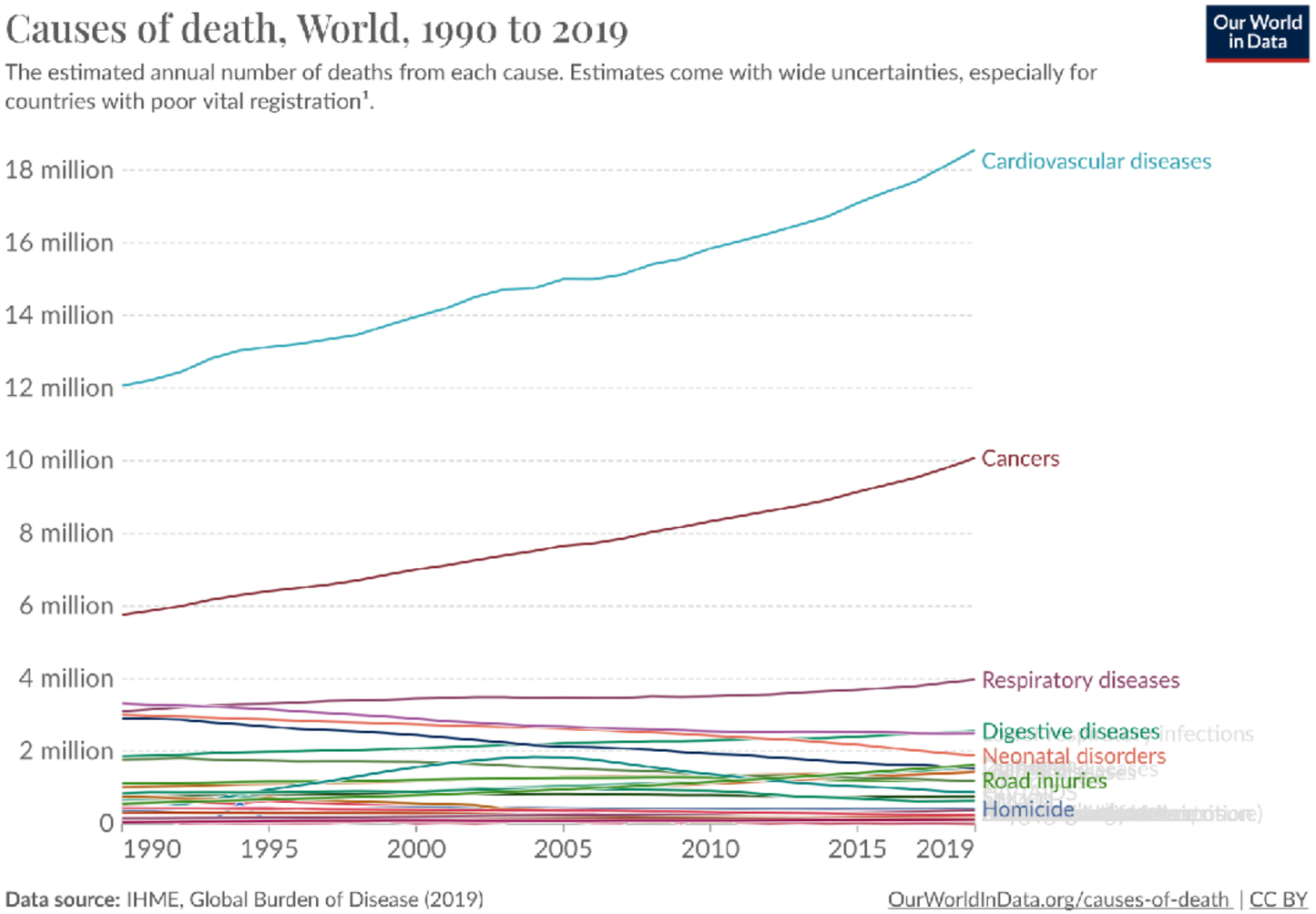
Diseases



1. **Civil and Vital Registration System**: A Civil and Vital Registration System (CVRS) is an administrative system in a country that manages information on births, marriages, deaths and divorces. It generates and stores 'vital records' and legal documents such as birth certificates and death certificates. You can read more about how deaths are registered around the world in our article: How are causes of death registered around the world?

Poor Health Outcomes

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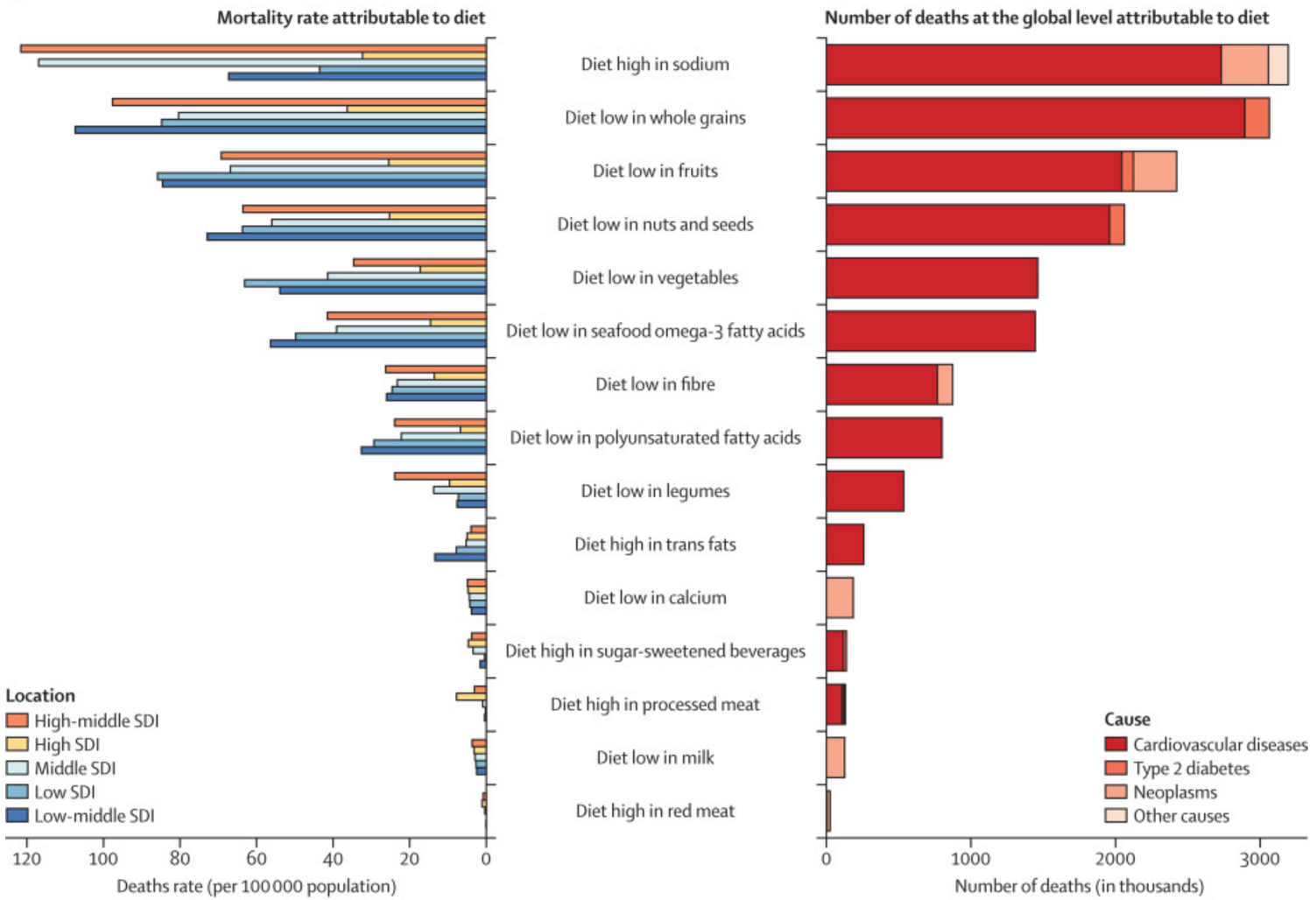
Diseases



SDI= socio-demographic index

Poor Health Outcomes

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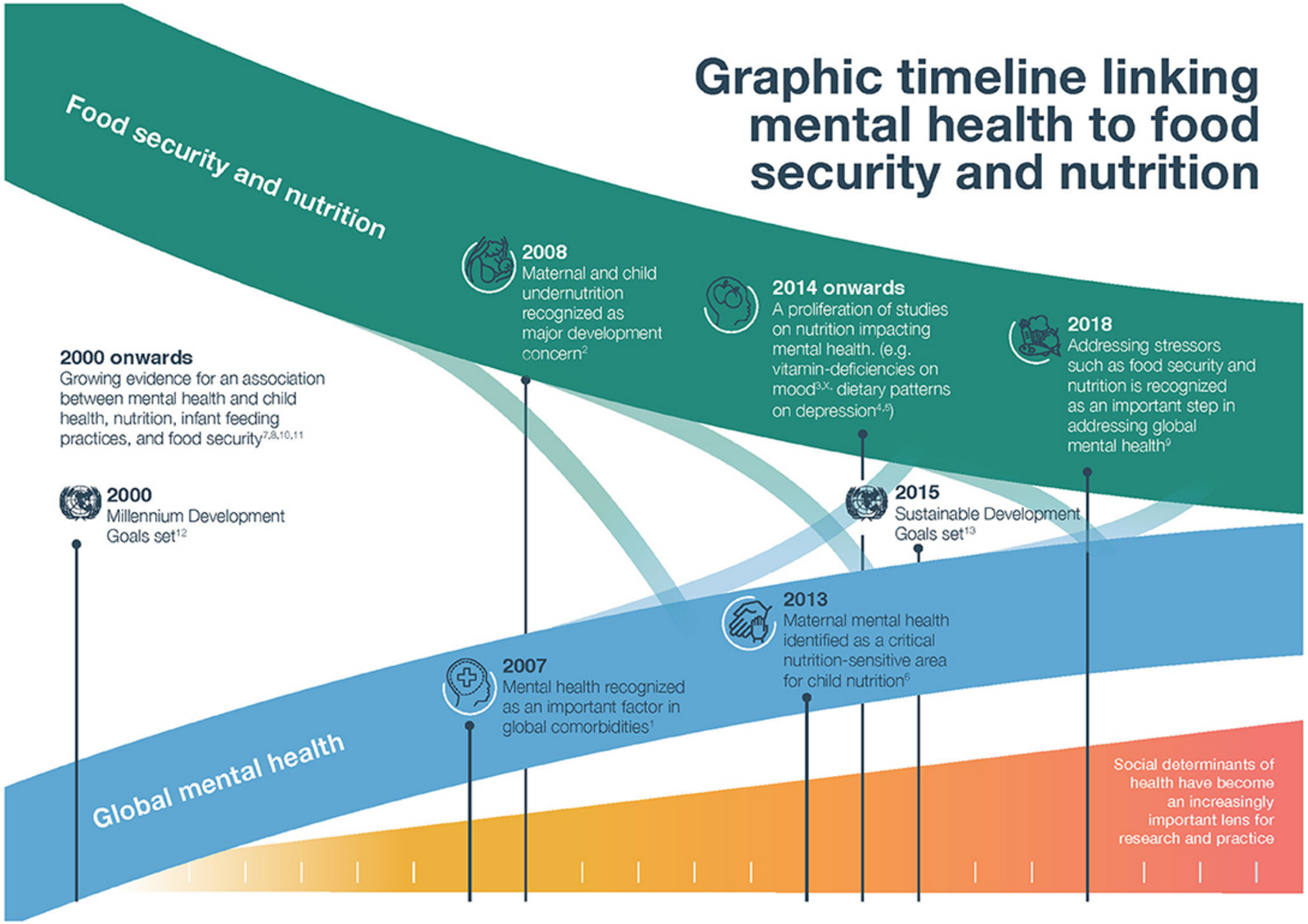
Mental Illness



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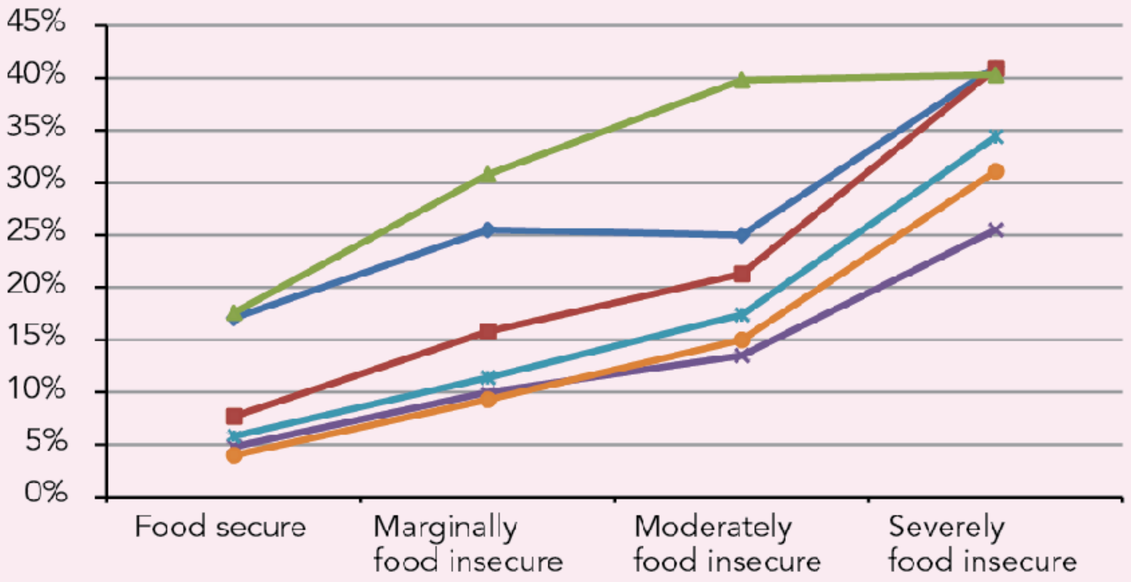
Mental Illness

Adverse mental health outcomes reported by Canadian adults (18-64 years of age), by household food insecurity status[2]



Data Source: Statistics Canada, Canadian Community Health Survey (CCHS), 2005-2012

Adapted from: Tarasuk V, Cheng J, Gundersen C,de Oliveira C, Kurdyak P. The relation between food insecurity and mental health care service utilization in Ontario. Can J Psychiatry. 2018. DOI: 10.1177/0706743717752879

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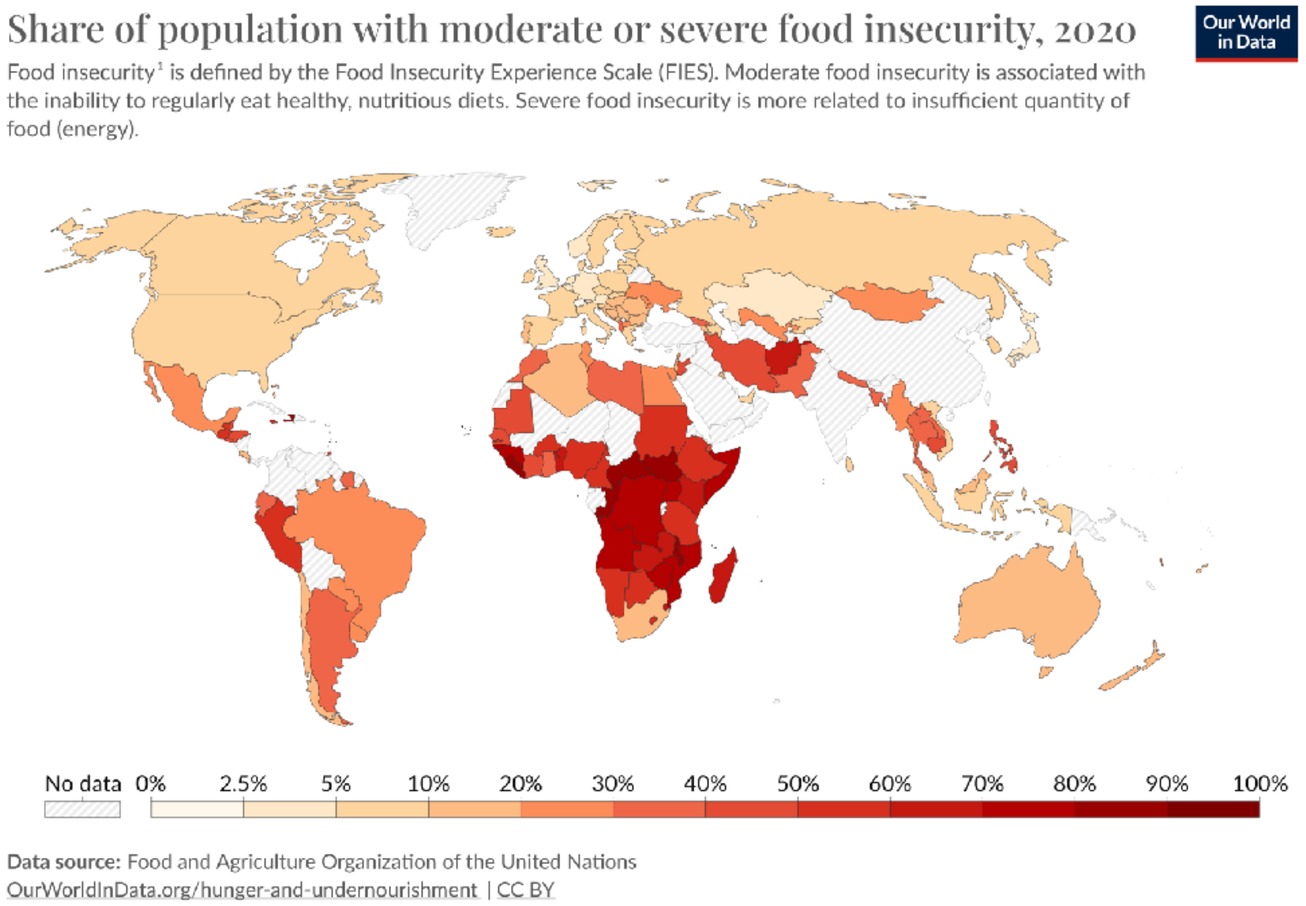
Mental Illness



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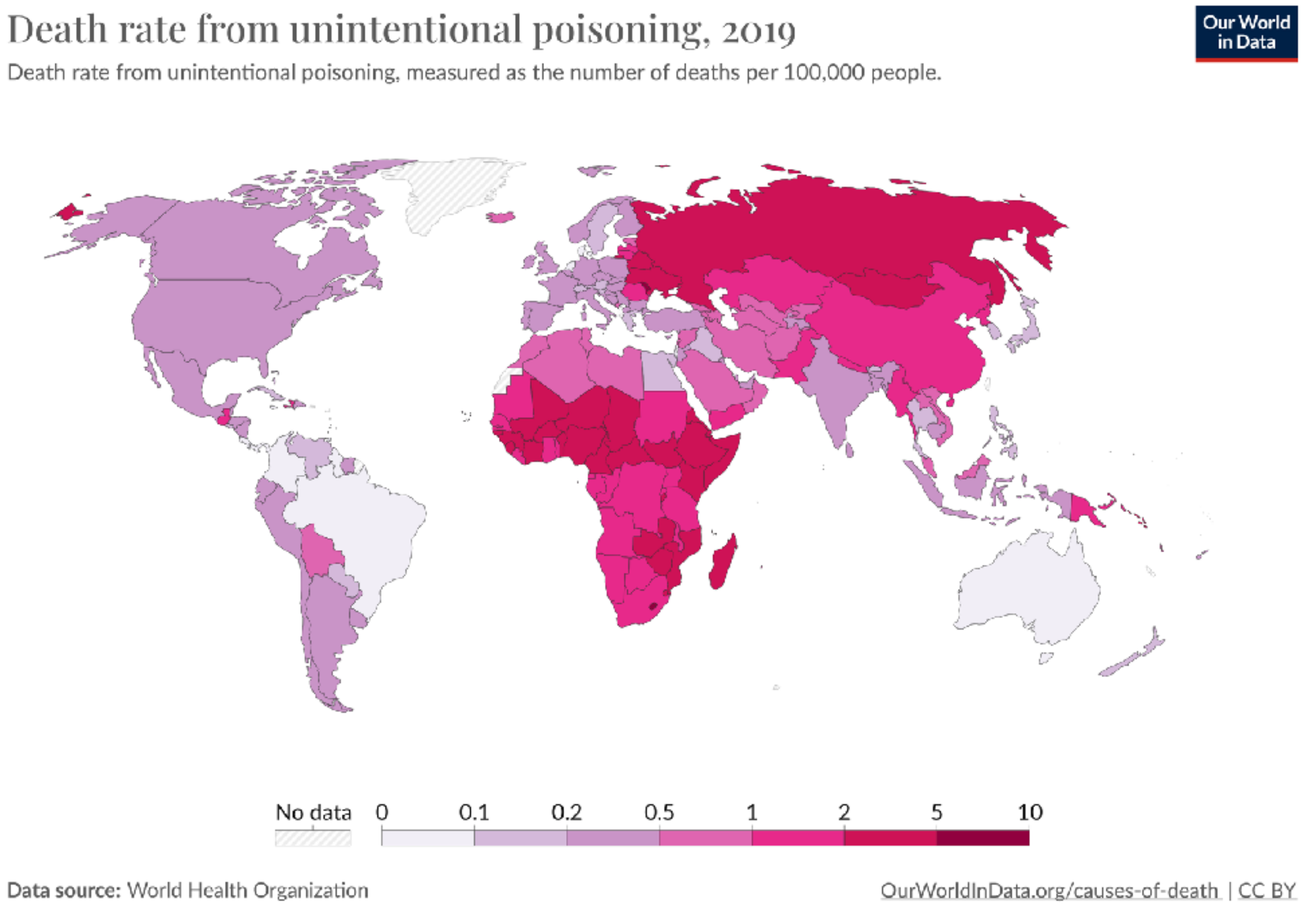
Poisoning



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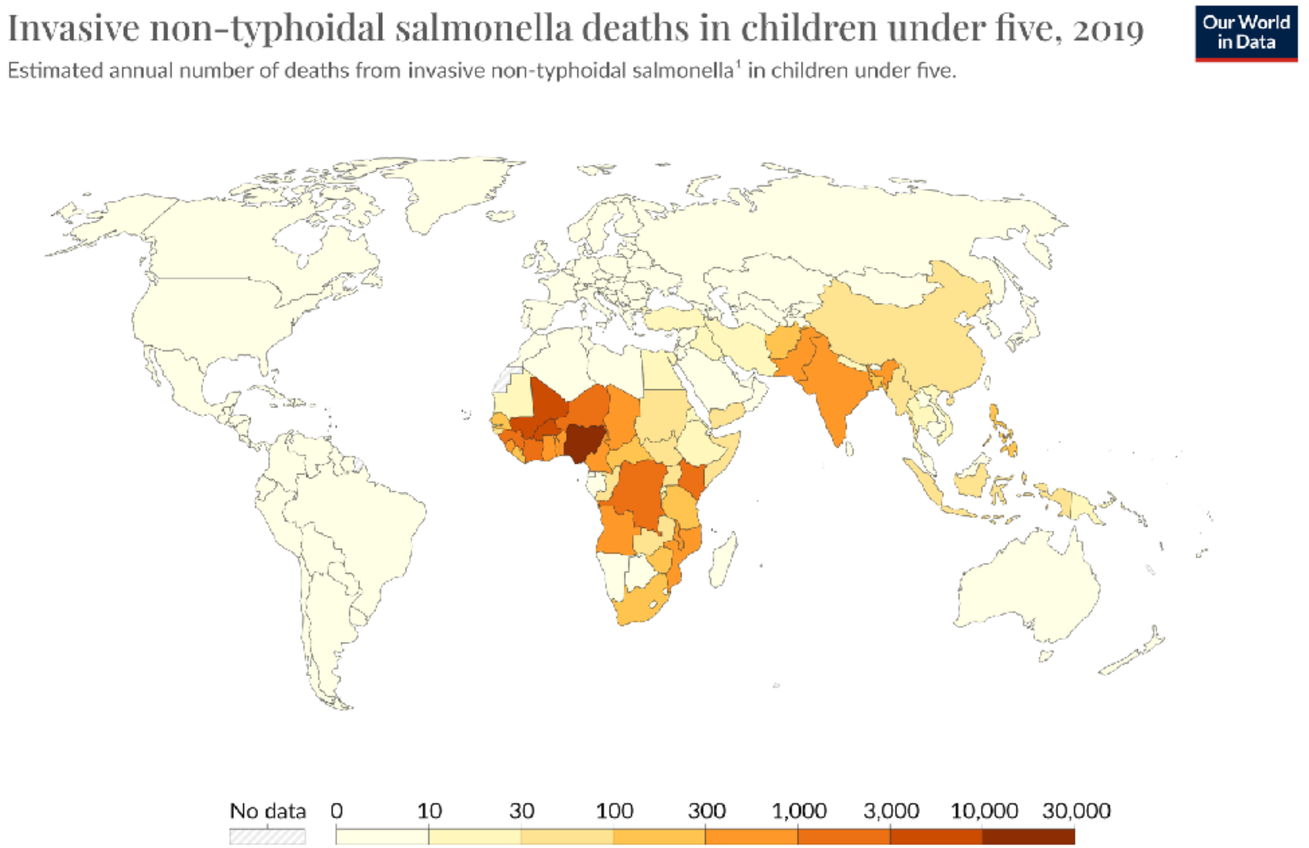
Poisoning



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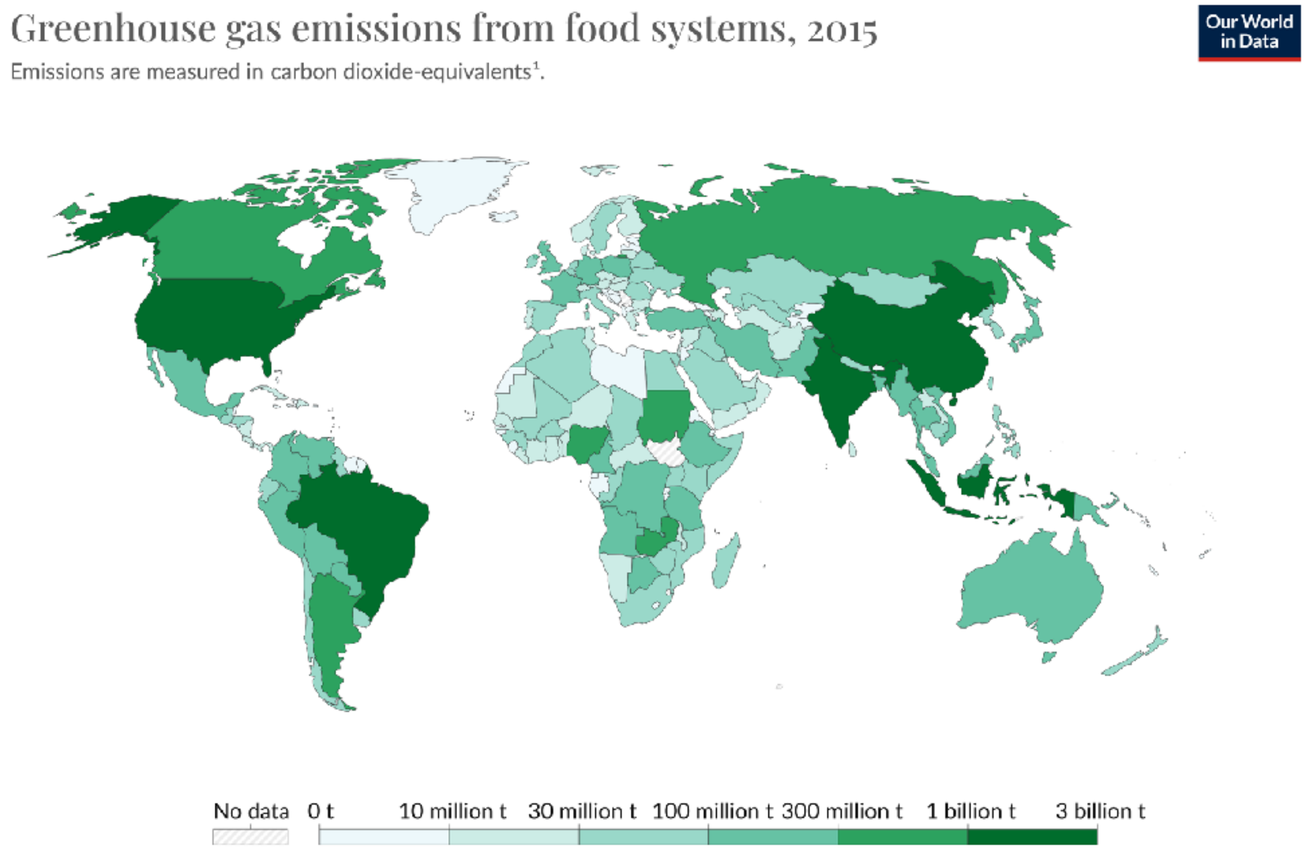
Environment Contamination



Poor Health Outcomes

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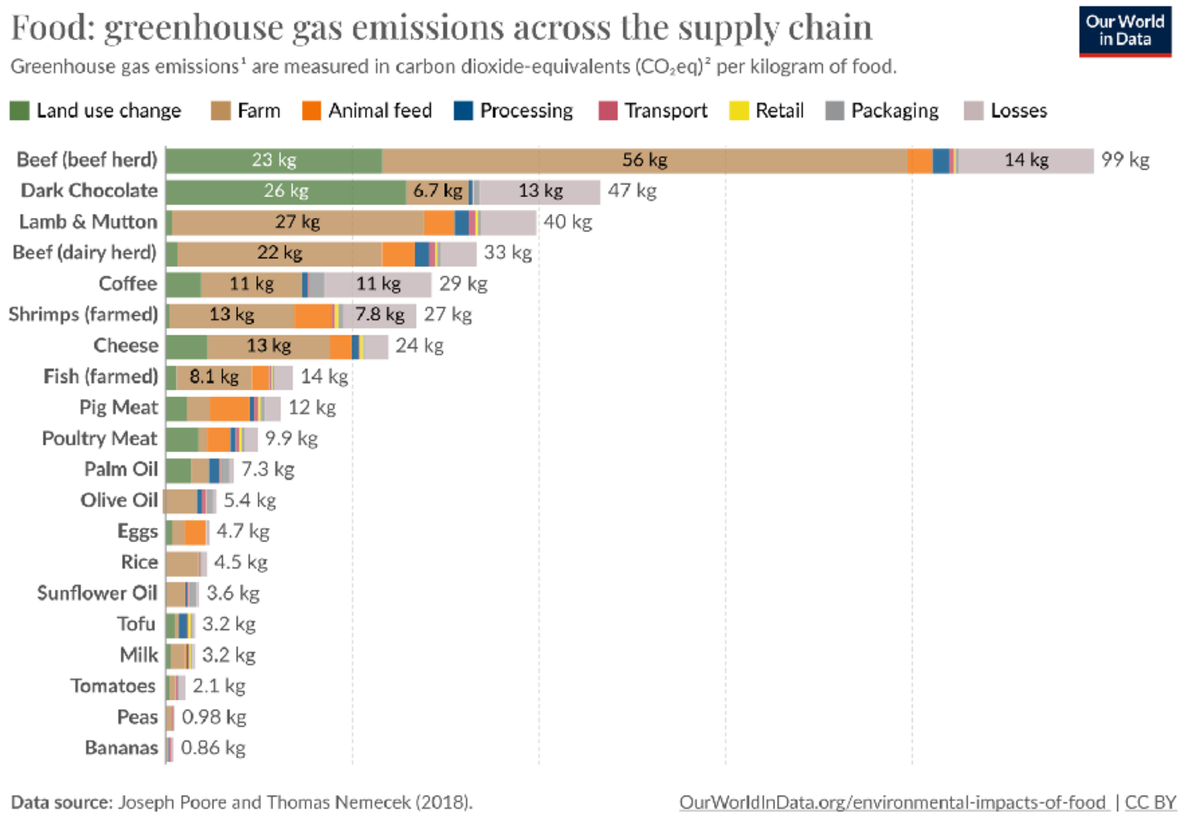
Environment Contamination



1. Greenhouse gas emissions: A greenhouse gas (GHG) is a gas that causes the atmosphere to warm by absorbing and emitting radiant energy. Greenhouse gases absorb radiation that is radiated by Earth, preventing this heat from escaping to space. Carbon dioxide (CO_2) is the most well-known greenhouse gas, but there are others including methane, nitrous oxide, and in fact, water vapor. Human-made emissions of greenhouse gases from fossil fuels, industry, and agriculture are the leading cause of global climate change. Greenhouse gas emissions measure the total amount of all greenhouse gases that are emitted. These are often quantified in carbon dioxide equivalents (CO_2eq) which take account of the amount of warming that each molecule of different gases creates.

2. Carbon dioxide equivalents (CO_2eq): Carbon dioxide is the most important greenhouse gas, but not the only one. To capture all greenhouse gas emissions, researchers express them in "carbon dioxide equivalents" (CO_2eq). This takes all greenhouse gases into account, not just CO_2. To express all greenhouse gases in carbon dioxide equivalents (CO_2eq), each one is weighted by its global warming potential (GWP) value. GWP measures the amount of warming a gas creates compared to CO_2. CO_2 is given a GWP value of one. If a gas had a GWP of 10 then one kilogram of that gas would generate ten times the warming effect as one kilogram of CO_2. Carbon dioxide equivalents are calculated for each gas by multiplying the mass of emissions of a specific greenhouse gas by its GWP factor. This warming can be stated over different timescales. To calculate CO_2eq over 100 years, we'd multiply each gas by its GWP over a 100-year timescale (GWP100). Total greenhouse gas emissions – measured in CO_2eq – are then calculated by summing each gas' CO_2eq value.

Poor Health Outcomes

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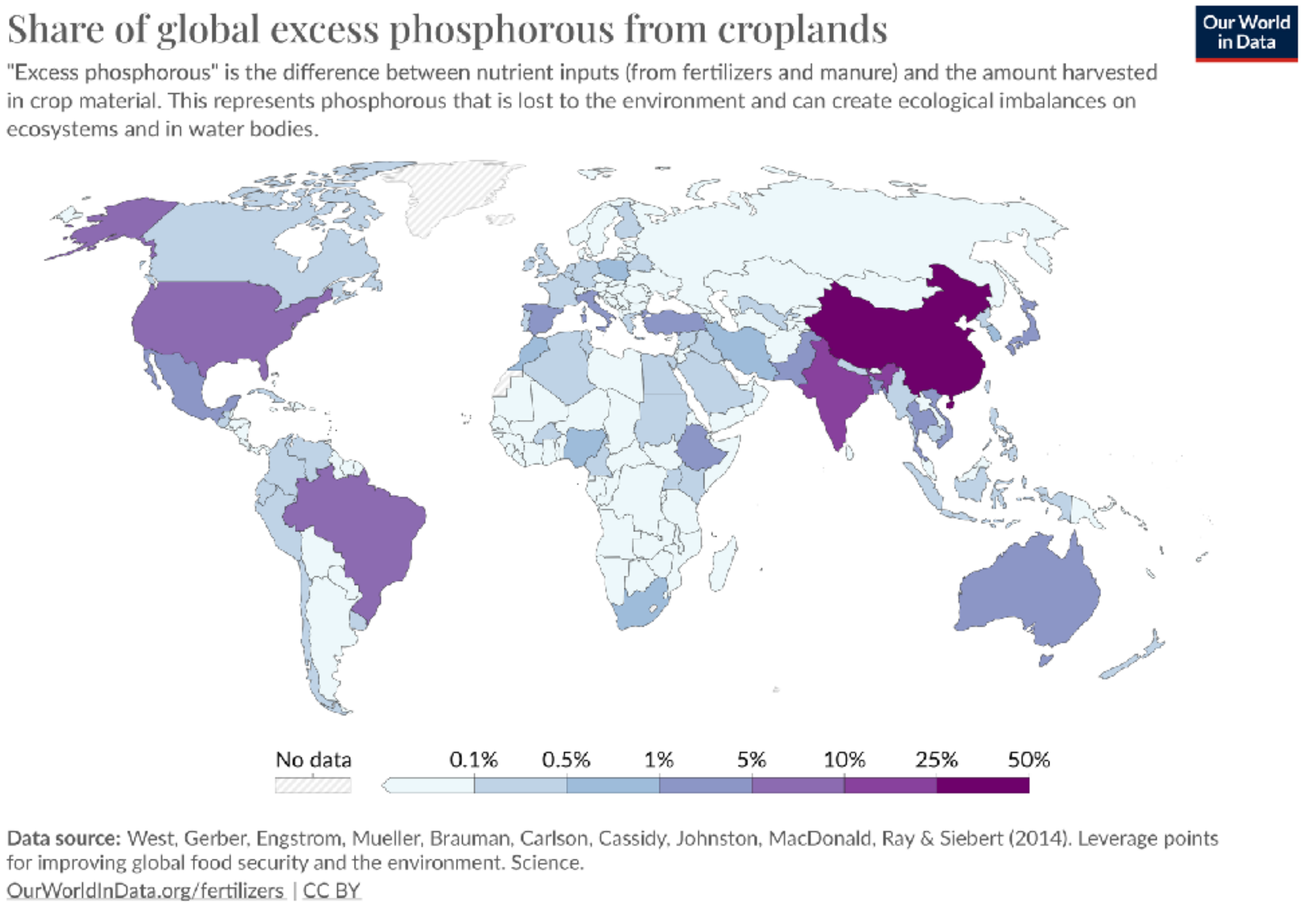
Environment Contamination



Poor Health Outcomes

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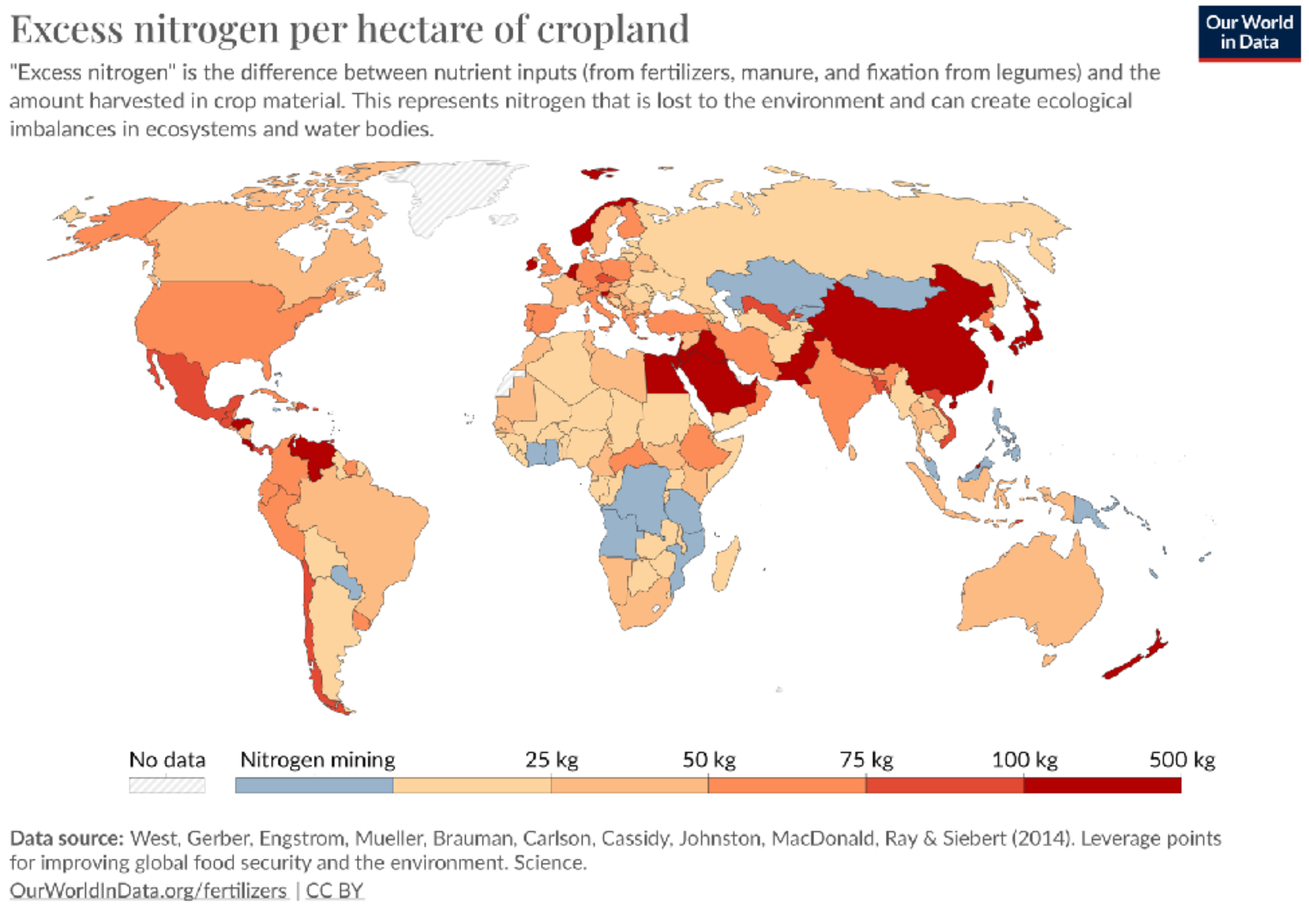
Environment Contamination



Poor Health Outcomes

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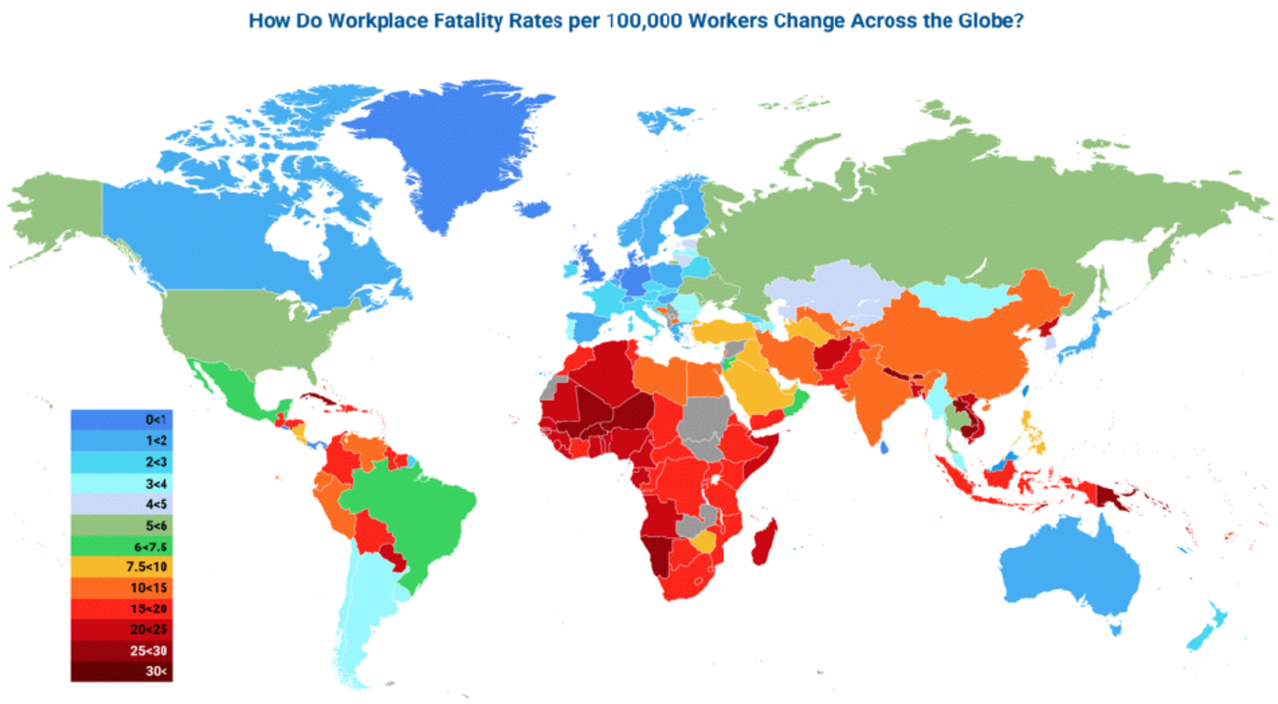
Physical Injury



Delivering Better Health

The four key determinants impacting human health through food systems

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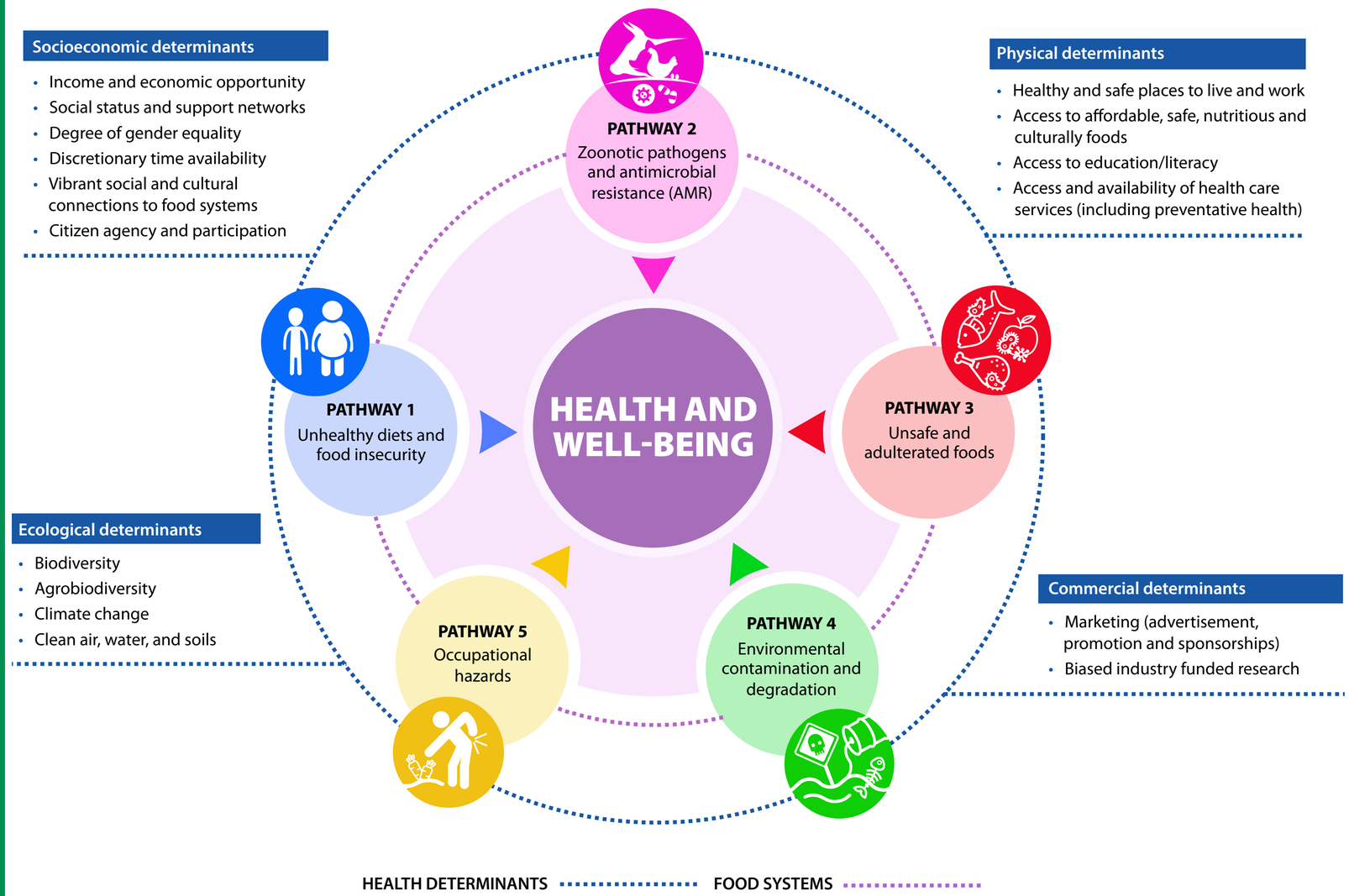

Challenges

Systemic challenges for the food system must be addressed simultaneously for the system to be considered sustainable.

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Nutritious Food for All

1. **Reducing overall food demand**
2. **Progressively shifting to lower-impact, less-resource-intensive food sources**
3. **Ensuring that scarce resources (land, water) are allocated to food production as a priority over non-food uses**
4. **Improving economic access to food**
5. **Improving farmer productivity in the developing world**

Challenges

Systemic challenges for the food system must be addressed simultaneously for the system to be considered sustainable.

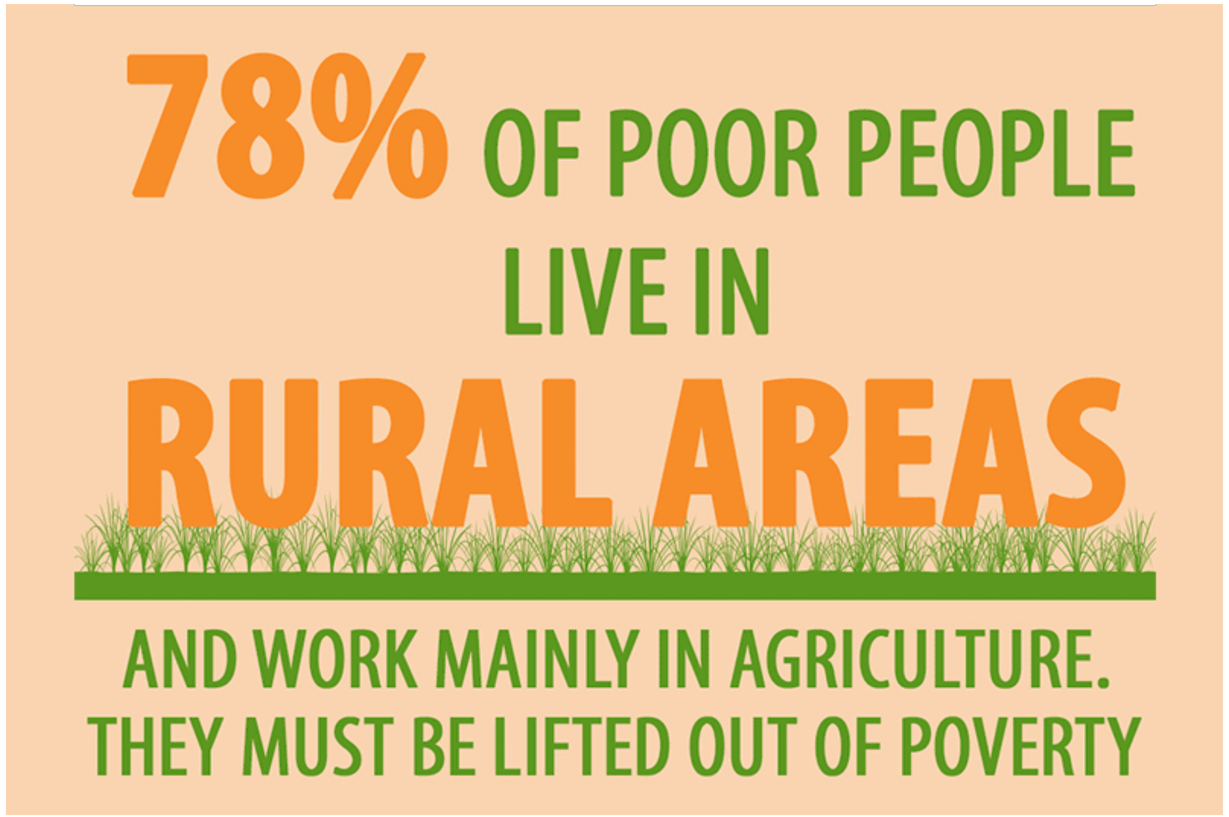
Planet Boundaries

1. Reducing impact of existing agricultural, fishing, and aquaculture practices (e.g, applying conservation measures, phasing out damaging fishing practices)
2. Placing limits on system expansion and intensification, particularly when addressing global yield gap (e.g., reducing arable land expansion, and if necessary directing it towards marginal lands, enforcing fisheries quotas more effectively)
3. Investing in the development of new sustainable agricultural and aquaculture techniques (e.g., organic cultivars, agroecological practices, alternative fish feeds, etc.)

Challenges

Systemic challenges for the food system must be addressed simultaneously for the system to be considered sustainable.

Supporting Livelihoods



Q&A

Discussion