Exploratory data analysis in environmental health

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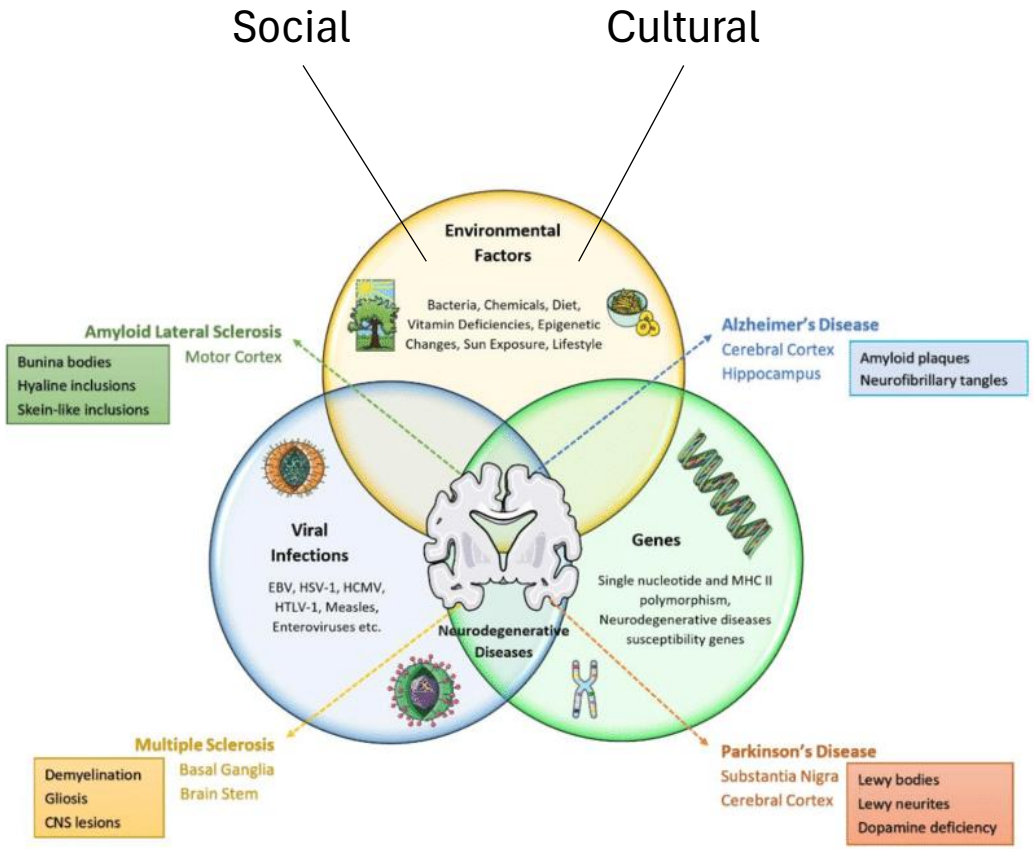
Introduction to spatial epidemiology

Spatial epidemiology (cf lecture #3)

- Epidemiology – an approach used to **find the causes of health outcomes and diseases**
- Spatial epidemiology uses **epidemiologic study designs** that involve georeferenced study subjects, health facilities, or sources of exposure
- Its primary focus is on **populations** Investigates demographic, environmental, behavioral, socioeconomic, genetic, and infectious risk factors
- Four types of spatial analyses in epidemiology:
  1) disease mapping, 2) geographical correlation studies,
  3) risk assessment, 4) cluster detection and disease clustering

The multifactorial nature of disease

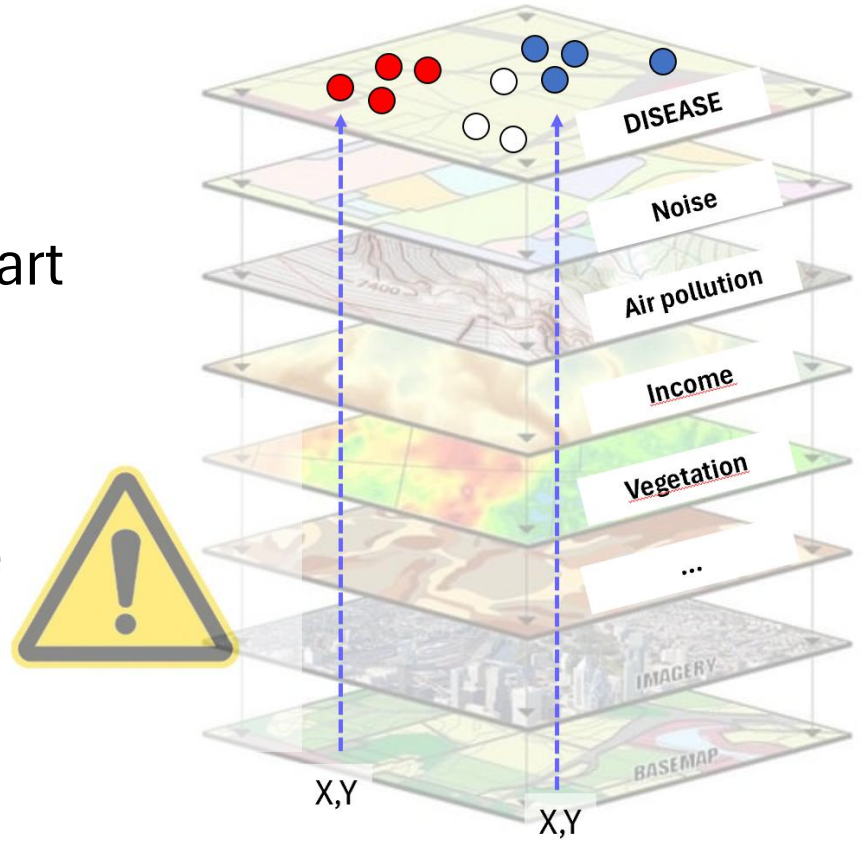
- The task of epidemiology to disentangle the relationships between health and various risk factors (like e.g. detrimental environmental conditions) is very difficult
- The nature of disease is **multifactorial**
- There is a diversity of environmental aggressors
  - Biologic, physical, social, and cultural factors
  - Combined with genetic susceptibility
- This suggests the need to implement <u>multidisciplinary</u> epidemiologic investigations



GIS for interdisciplinary collaboration

- There is a need to utilize tools like GIS and other geospatial methods able to **integrate** multilevel*, spatial, and temporal factors
- The multifactorial nature of disease and availability of geospatial tools favors collaborations and creativity in the field of environmental epidemiology
- Moreover recent technology advances in GIS, mobile & smart phones, sensors, diffusion of innovation (web, social networks) offer novel research opportunities
- The effect of technology → large emphasis on molecular epidemiology and biology of the disease (microlevel) while the macrolevel picture involving the individual in a social, cultural, and physical setting may be missed
- Important to keep in mind in the context of applications in **population health** and in **public health**

*Multilevel analysis is an analytical strategy that examines simultaneously factors at the group level and at the individual level



Integrating contributions of several disciplines

- With interdisciplinary approaches and integration, there are more and more disciplines involved, and the perspectives leading to understanding increase
- Use of GIS and spatial approaches confers key advantages, e.g. the ability to address population-level disease determinants (population health), which were ignored in standard nonspatial individual-level epidemiologic studies leading to simplistic formulations of risk factors (Fielding 1999)

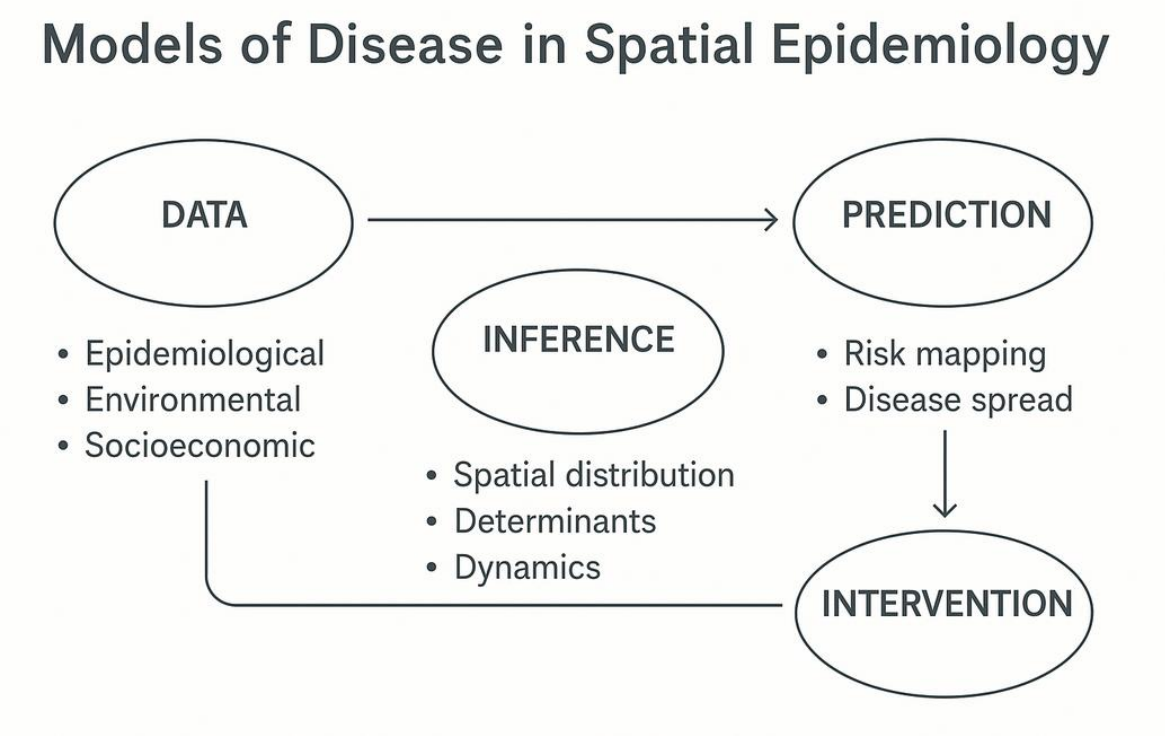
- But we lack an **integrating process** enabling a rigorous new description of risk and disease (Lawson et al. 2016): the way this integrative approach is implemented must be theoretically described
- We need integrative disease models taking into account the current challenges for public health

Challenges for public health

- Today public health faces unprecedented challenges
  - Important global population growth
  - Aging population
  - Possible irreversible changes in environmental health determinants (globalization and climate change)
- In the case of globalization, negative health effects implied by neoliberal model of global market are: i) spread of disease (trade and migrations), ii) loss of government policy impact, iii) increased labor insecurity (stress, deprivation)
- Climate change: major effects in urban areas where 55% of the world's population lives (68% in 2050; 74% in Switzerland) - inadequate housing, no proper sanitation, bad waste management, bad air quality, noise, water and soil contamination, urban heat islands, lack of space for walking, cycling and active living (cities are epicentres of an **epidemic of non-communicable diseases** (WHO, 2024)

What is the role of models of disease in spatial epidemiology ?

- Models of disease in spatial epidemiology translate raw geographic health data into structured understanding, inference, and prediction of spatial patterns, determinants, and dynamics of diseases

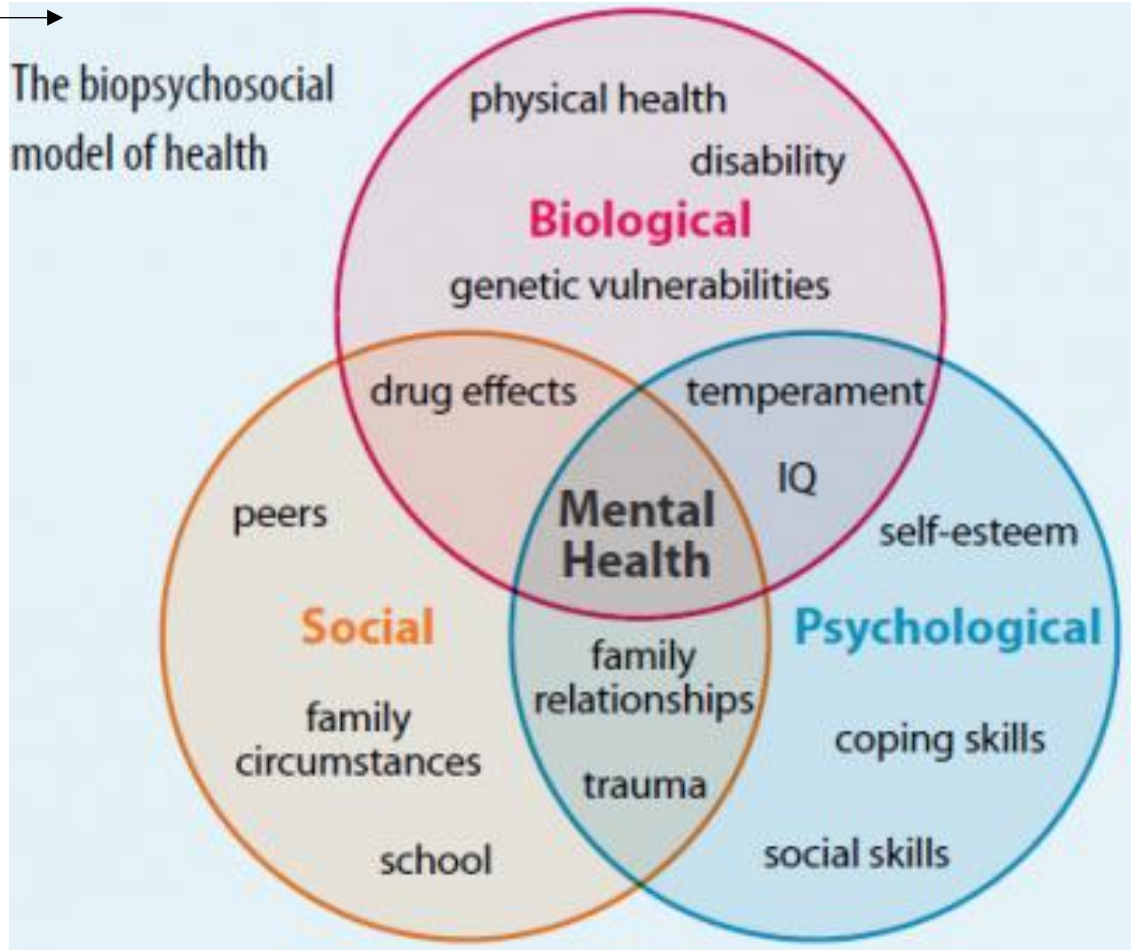


- They form the analytical backbone of modern spatial public health, linking space, population, and environment

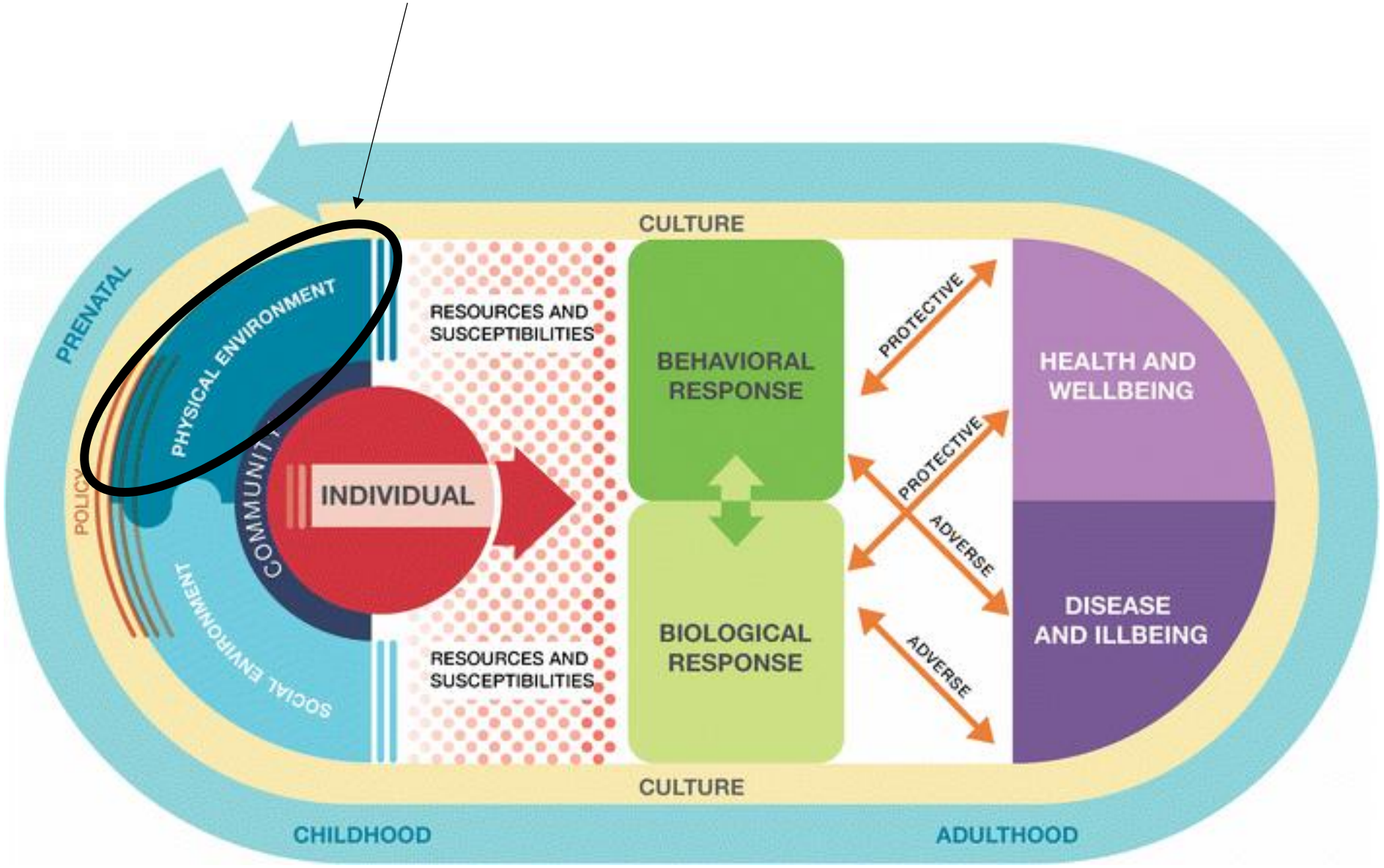
Models of disease

- Since the late 1970s, dominant model of disease is the **biopsychosocial model** proposed by George Engel in 1977
- To understand a person's medical condition it is not simply the biological factors to consider, but also the psychological and social factors (Gatchel et al. 2007)
- Environmental factors were not in the picture

- **Integrated Socio-Environmental Model of Health and Well-Being** – ISEM (Alvarez et al. 2018)



- **Integrated Socio-Environmental Model of Health and Well-Being** – ISEM (Alvarez et al. 2018)
- How social and environmental factors combine and interact to affect health and well-being over the life span
- → understand how the underlying environmental (including social, demographic, psychological) and genetic factors produce risks and how these translate into health, disease, and quality of life
- **Key role for spatial approaches**



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Thank you for your attention !