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Environmental Epidemiology: Space & Time modelling

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Environmental Epidemiology: Space & Time modelling

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Fundação Oswaldo Cruz

Outline

1. Oswaldo Cruz Foundation
2. Introduction
3. Study Design
4. Modelling

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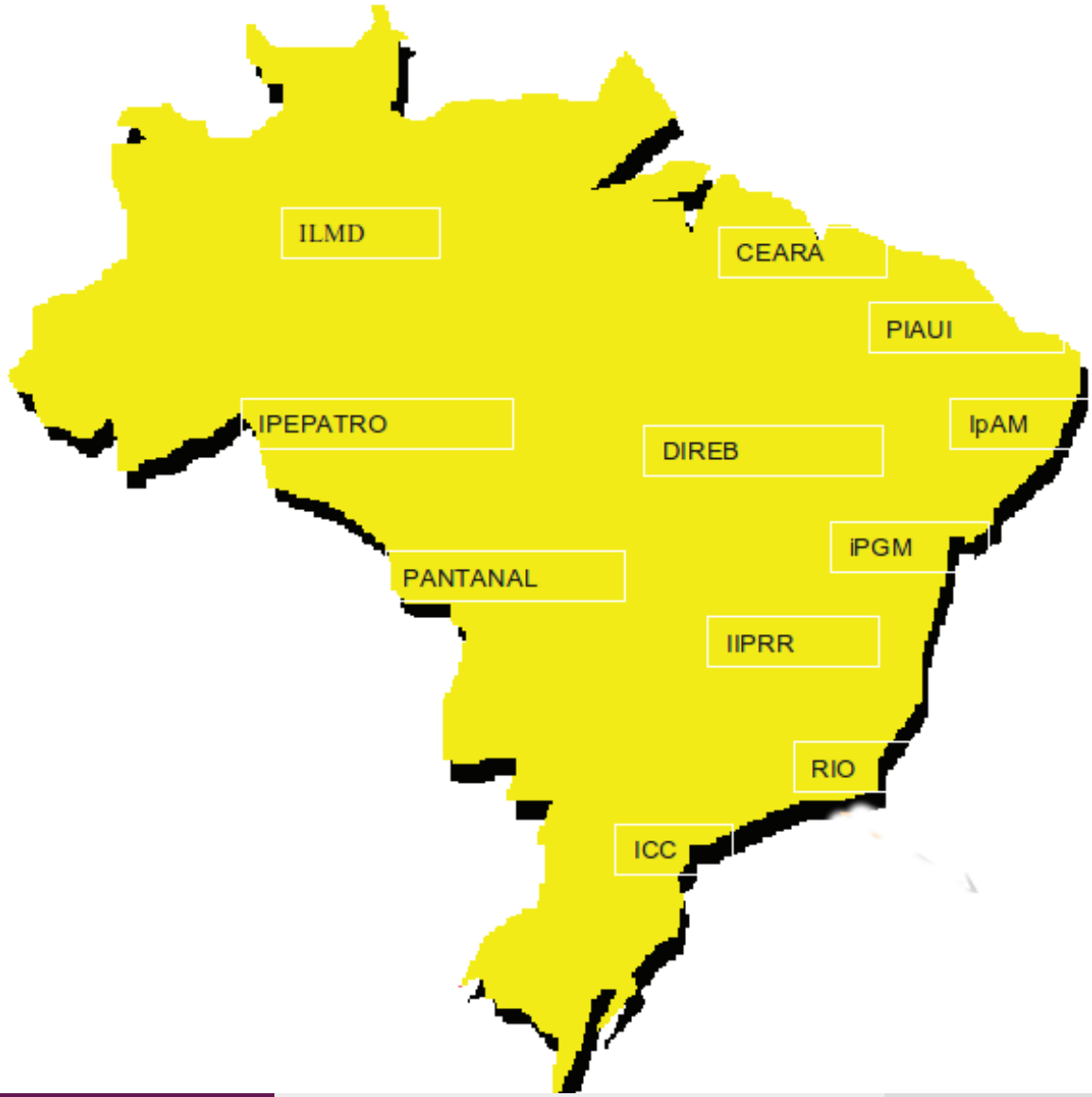
About Fiocruz



About Fiocruz

- 10 Research Institutes
- National School of Public Health
- 2 Hospitals
- 2 Production Plants: immuno-biologic and pharmaceutic products
- Technology Development Centre
- High School (technical)
- Centre for Historical Studies (health and science)
- Health Information Centre
- National Reference for Health Products Quality Control
- Network of Epidemiology Surveillance – coordination of 23 state labs

Fiocruz in some numbers

- About 5k employees
- 900 researchers
- 5k students/year
- 20 posgrad programs
- 5k temporary workers

International Cooperation

International Cooperation

- Support for the development of National Public Health Institutes: Argentina, Guinea-Bissau, Mozambique, Panama, El Salvador
- Posgrad courses abroad (master degree and specialisation): Argentina, Peru, Mozambique, Angola, Cape Verde, Guinea-Bissau
- Development of joint research projects and formal cooperation aggreements with lots of universities: Yale, Michigan, York, Pasteur Institute, Exeter, Porto....
- Transfer of technology for health products production: Argentina, Mozambique, Nigeria
- International Cooperation Office for Africa in Maputo/Mozambique

Where I work

Many thanks

This course is offered at Fiocruz, in the Postgraduate Program of Epidemiology and Public Health. All material was developed in collaboration with:

- Oswaldo G. Cruz
- Antonio G. Pacheco
- Aline Nobre

Many thanks as well to all students who criticised previous practicals.

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Definition – Environmental Epidemiology

- a branch of epidemiology[1] concerned with discovery of the environmental exposures associated with diseases or injuries
- identification of public health actions to avoid and manage risks associated with harmful exposures
- exposures, naturally occurring or not:
  - proximal: directly leading to a health condition → E.g..: air pollution, hazardous waste, pesticides, radiation, in general through air, food, water or skin contact, disease vectors
  - distal: indirectly altering proximate exposures or leading to changes in ecosystems and other support systems for human health → disorganised occupation of urban areas, global environment change

[1] The study of the patterns, causes, and effects of health and disease conditions in populations

Aims

- identify populations at risk
- identify and quantify the effects of potential harmful agents
- study the effect of location on health

Scientific Questions

- What is the temporal pattern of dengue fever in Thailand?
- Does it depend upon the climate?
- Does the cases show a tendency to cluster together?
- Does the risk vary spatially over the city?
- Is risk elevated at some specific location?

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Study Design

- Observational studies $\rightarrow$ assignment of subjects outside the control of the investigator
- At individual level: all measurements taken from the individual $\rightarrow$ cross-sectional, cohort and case-control studies
- At group level: measurements obtained from populations $\rightarrow$ ecological studies

Ecological Studies

- "ecological fallacy" $\rightarrow$ causal inferences from group data to individual behaviour
- based on fallacious ideas:[2]
  - that individual-level models are more perfectly specified than ecological-level models
  - that ecological correlations are always substitutes for individual-level correlations
  - that group-level variables do not cause disease

[2] Schwartz. The Fallacy of the Ecologic Fallacy: Potential Misuse of a Concept and Its Consequences. Am.J.Public Health, 1994;84:819-824

Ecological Studies

- Two different questions:[3]
  - What are the causes of disease cases?
  - What are the causes of the population incidence of a disease?

The trees

or

the forest?

For this course: the forest

[3] Rose G. Sick Individuals and Sick Populations. Int J Epidemiol. 2001 Jun;30(3):427-32

Study Design: however...

- Ecological questions can be answered mixing individual and ecological data
- Back to Ecology: "*scientific study of the relationships that living organisms have with each other and with their natural environment*"

Geographical unit of analysis

- Area:
  - census tract
  - neighbourhood,
  - city,
  - state, country...
- Data source:
  - Mortality – the oldest (bills of mortality, see William Farr)
  - Regular disease notification – concept of disease surveillance (Karel Raška, 1968)
  - Discharge data
  - Health services use
- The main idea is that the data is comprehensive:
  - under-registration
  - double registration
  - lack of proper georeference
  - missing data
  - changes in disease classification and diagnosis

Geographical unit of analysis

- Point:
  - location of household
  - location of amplifiers – transit, schools, transportation hubs
- Data source:
  - address from the notification – Google(?)
  - mobile phones
  - sentinel services
- Problems:
  - where is the exposure?
  - precision
  - bias
  - not comprehensive – needs a good sample scheme
- Change of support

Temporal unit of analysis

- Using notification data: epidemiological week
- Mortality: daily
- Time lag between environment event and disease
- Total time covered – 10 years, 6 months?

Study Design – examples to think about

- Air pollution, global warming and respiratory diseases
- Influenza:
  - in India,
  - in Italy,
  - in Brazil
- Tuberculosis – is it useful to look for spatial or temporal patterns?

Bias sources – on population counts

- 10 years lag between demographic census
- quality of census
- migration
- changes in borders
- small areas

Bias sources – on exposure

- pinpoint the source can be difficult
- lack of precision
- different geographical support for exposure and disease

Scale

What happens when looking closer?

Attribute	Definition	Trend
Resolution	Power to distinguish nearby points	↗
Homogeneity	Statistical characteristic of the data	↗
Stability	Random fluctuation	↘
Data availability	in space and time	↘

All different sources together

- Socio-economic aspects
- Climate
- Pollution and other health hazards
- Vectors
- Human cases

We need to integrate all this information!

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Definitions

- Uncertainty vs measures of variability
  - Both give intervals – in statistics we have confidence intervals:
  - "*Confidence intervals consist of a range of values (interval) that act as good estimates of the unknown population parameter*"
  - How good? you decide the size of accepted error (5%, 10%, 1%)
- Reproducibility
- Validity

Test or Estimate?

- Questions can be formulated as hypotheses to be tested
- In general we want to estimate the effect of time, location, covariates
- Never forget that "*Everything is related to everything else, but near things are more related than distant things*" [4], valid statement both for temporal and spatial distances

[4] Tobler: "First law of geography"

Modelling

- Mathematical description of the variation in data, so that:
  - it is not inconsistent with the data
  - it respects the scientific knowledge
  - it is as simple as possible

  - What conclusions can be drawn?
  - Practical?
  - Reliable?

Main models

- simple and multiple
- linear models
- generalised linear models
- additive models
- time series
- point pattern analysis
- areal modelling