Geography, Primary Care, and GIS: An introduction for primary care researchers

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Primary Care Research Methods & Statistics Conference
Agenda

- Health & Place:
- Geographic Information Systems
  - Components & Types
  - Geocoding
  - GIS & Primary Care research
- Spatial Analysis: Brief introduction
- Where to learn more
Goals

- To introduce you to the field
- To generate or increase your enthusiasm for GIS and spatial analytic methodologies
- So that you’ll leave seeing geographic applications in primary care as more than mapmaking,
- And GIS-driven primary care research outputs...
...as more than a dog and
Pony Show
History tells us...

- Geography is destiny
Clearly, where you live on the planet impacts your health.
Geography & Disparities in health outcomes

- Health Outcomes differ by…
  
  
  - Also Wennberg and colleagues

  - **Neighborhood**: Krieger et al, 2003 – Neighborhood poverty may impact health as significantly as individual poverty

  - Also Kawachi and colleagues
Geography & Disparities in health outcomes

- Racial health disparities are well known, but

- Urbanization, Race & Health:
  - Slifkin et al, 2000:
    - Rural minorities are further disadvantaged vs. urban counterparts in
      - Cancer screening/mgmt
      - Cardivascular disease & Diabetes mngmt/outcomes
  - Gaps between White/Minority widens in rural areas
Geography & Access to Essential Care

I hear we can get eye of newt much cheaper in Canada.
Estimated Impact of Determinants of Health and Health Status of the Population

- Biology/Genetic Endowment: 15%
- Physical Environment: 10%
- Social and Economic Environment: 50%
- Health Care System: 25%

Importance

- Determinants of premature mortality:
  - Behavior >
  - Genetics >
  - Social circumstance >
  - Environmental Conditions >
  - Health Care

- McGinnis 1993
- Mokdad 2001
<table>
<thead>
<tr>
<th>Relationships at the Individual</th>
<th>Socioeconomic Position</th>
<th>Social Status/Hierarchy</th>
<th>Work</th>
<th>Community Relationships and Norms</th>
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<tr>
<td>3. Social Integration or Exclusion; Social Networks</td>
<td>3. Class</td>
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## Where, Who and Health

### Where:
Homes, schools, workplaces, communities

### Who:
Children, youth, adults seniors

### Health Determinants – Factors that affect our health:

- Gender and age
- Genetics
- Income and social status
- Social support
- Education
- Employment/working conditions
- Physical environment
- Early childhood experiences
- Health services
- Personal health practices and coping skills
- Culture
Why is place important

- Environment: Physically exposed to local air, water, soil and other natural environment elements; and to local public infrastructures: transportation, health and human service facilities, and other built environment elements.

- Socially exposed to local social networks, racial/ethnic cultures, and religion.

- The interaction between social and physical environments

- The interaction between individual proximal and ecological distal factors
Questions

- Link place community/neighborhood of residence with health outcomes
  - Spatial inequity of health and health care
  - Local social and physical environments promote or inhibit health or health behaviors
  - Causes, Contributes, and Correlates
Methods - measurement

- Composition
  - Summary Indices from Individuals
    - Population race/ethnicity, education, income

- Context
  - Summary indices from populations
    - presence of accessible primary care services
    - Shared norms, traditions, values and interest
Methods—Analysis of Unit

- What spatial scales for health needs (questions)
  - Primary care and secondary care service areas
  - Different spatial range for different activities

- What spatial scale information available
  - Census tract, zipcodes, counties
  - Small area levels capable of being aggregated to large spatial scales

- What time interval between environmental and any effects on health
  - Cross sectional study design vs cumulative exposures
  - Test the consistency over time of area characteristics
Methods-Tools

- How to generate and organize data on characteristics of Places
  - GIS

- How to evaluate the place effects
  - Multilevel modeling
    - Ecological Fallacy vs Atomic Fallacy
    - Software: Mplus, WinBUGS, S/R
      - Others: SAS GLIMMIX, STATA, HLM, Mlwin
Universal Place Effects on Health?

The relationships between places and health vary by types of health outcomes, population groups, types of areas.
What is GIS?

- “Automated systems for the capture, storage, retrieval, analysis, and display of spatial data” (Clarke et al, 1996) (Tim, U.S., 1995)
A simpler definition of GIS

A system which uses data and technology to visualize places relative to each other.
Components of GIS

- Computer Hardware & Software
- Organizational Structure & People
- Database
Creating Data Layers

... linking digital data to “geography”

- Street Addresses
- Streets/Rivers/Land Features
- Hospital/Medical Center/ Clinics
- Zip Codes/Counties
- Spatial Analysis – (i.e. travel times)
- Service Demand/Provider Density
ESRI: ArcView, ArcIMS, ArcGIS, others

ArcGIS 9.1 single license: $2500

May be up to $30,000 for business use

Caliper: Maptitude 4.8, $500

CDC: EpiInfo, contains EpiMap, Free
Types of GIS Data

- **Point**  - Building, house, training program
- **Line**  - stream, interstate
- **Polygon/Area**  - lake, census tract, county
Geographic Features

Geographic features are represented by two types of data.

SPATIAL DATA

ATTRIBUTE DATA

Street Name
Address range on left
Address range on right
Length to travel
Directions to travel
What is Geocoding?

- Geocoding is the process of appending latitude/longitude coordinates to a given database record(s). It is a gateway step toward getting your point location data on the map.
Three basic parts of a geocoding system:

- Your data file
- A geo-reference file, typically streets, or ZIP/CT/BG centroids
- Software used to perform a join between records of the two files
- Quality of geocoding depends on the quality of each of these three parts.
How we Make Data Spatial

EXAMPLE:

• Take the zip code feature in the database and link it to a GIS database

• This can be done for most geographies: county, street address, etc
Census divisions and Geocoding
Census divisions

Census Tract (small, homogeneous, relatively permanent area; MSA’s are subdivided into census tracts)
Average 4,000

Block Group (BG; subdivision of census tracts or block numbering areas)
Average 1,000

Block (identified throughout the country; always identified with a 3-digit number, and some have an alphabetic suffix)
Average 85
GIS and Primary Care

- Dr. Curtis Hames 1950’s
  - Aerial Photography and geographic analysis

- Farley, Boisseau and Froom 1970’s
  - Mapping families, rudimentary spatial analysis

- Parchman 1990’s
  - Preventable hospitalizations & Denomination

- Fryer & Miyoshi
  - Distance to care & Health care workforce studies

- Phillips, Kinman, et al
  - Mapping service areas & assessing access
Methods - Statistical Modeling (1)

- **Multilevel Modeling**
  - Combine both individual and area/neighborhood level factors together
  - Assume the independence between areas
  - Assume the completeness of neighborhood factors

- **Spatial analysis**
  - Spatial heterogeneity - Localized context effects
  - Spatial autocorrelation - Extended context
Multilevel Spatial Analysis
- Combine both multilevel modeling and spatial analysis
- Area/neighborhood level factors
- Spatial random effects
  - Spatial heterogeneity
  - Spatial autocorrelation
Methods-Statistical Modeling(3)

- Multilevel Bayesian Spatial Analysis
  - Combine both multilevel modeling and spatial analysis
  - Selections of area/neighborhood level factors
  - Spatial random effects
    - Spatial heterogeneity
    - Spatial autocorrelation
  - Bayesian Inference via MCMC
    - Complexity of the models
Methods-Statistical Modeling (4)

- **Multilevel Bayesian Spatial SEM (Structural Equation Modeling)**
  - Correlated health outcomes
    - Obesity, physical activity and food intake
  - Correlated individual or area/neighborhood level factors
    - SES: Education, Income, Occupation
Methods-Statistical Modeling(5)

- Multilevel Spatial Panel Data Analysis
  - Longitudinal outcomes
  - Spatial dynamics of context effects
Methods - Statistical Modeling (6)

- Multi-scale Multilevel Spatial Analysis
  - Analysis for different area units
  - MAUP (Modified Area Unit Problem)
    - Context effects may change at different scale
    - Policy implications for the consistency and inconsistency of context effects.
Getting Started... Or learning more

- Books (examples from the group)
- Articles (Handout)
- Institutional Resources
- ESRI Coursework
- Federal Resources
- Web-based interactive mapping
- Geographic Health Data Resources
Explore your Institutional Resources

Joint Center For GIS and Spatial Analysis

The Joint Center of GISSA of University of Cincinnati! All dreams are welcome here.

The Joint Center for Geographic Information Systems and Spatial Analysis (GISSA) consists of faculty from the Department of Geography and School of Planning, in collaboration with faculty from other academic units, such as Architecture, Business School, Biology, Computer Science, Environmental Engineering, Environmental Health, Institute of Policy Research, College of Medicine, College of Business Administration, and College of Education.

The objectives of the Center are:

- To maintain an advanced technological environment for teaching, research and consultation in GIS and spatial analysis;
- To provide training programs for GIS users, managers, executives and public officials;
- To provide consulting services for the application of GIS and spatial analysis in environmental studies, urban and regional planning, and locational analysis for government and business;
- To promote coordination of GIS activities at University of Cincinnati with GIS networks being established by local governments and utility companies in the Greater Cincinnati region.

The Joint Center of Geographic Information System and Spatial Analysis, University of Cincinnati, Cincinnati, Ohio
Training Seminars and Workshops

Training seminars are FREE recordings of our live training seminars, viewable at your convenience.
Workshops are recordings of our live training seminars, viewable at your convenience, plus these additional pieces:

- Printable slides of the presentation
- Questions and answers from the live training seminar
- A software exercise with accompanying data
- An optional exam to assess understanding
- A certificate for successfully completing the exam

Training Seminars

- Editing in ArcGIS 9: Tips and Tricks [FREE]
- Editing in ArcGIS 9: Tips and Tricks II [FREE]
- Geoprocessing CAD Data with ArcGIS [FREE]
- Geoprocessing Using ModelBuilder [FREE]
- Getting Started with ArcGIS Business Analyst [FREE]
- Getting Started with ArcObjects in ArcGIS [FREE]
- Getting Started with Scripting in ArcGIS 9 [FREE]
- HAZUS-MH (Multi-Hazards) for Decision Makers [FREE]
ESRI: Coursework

ESRI Training and Education

Home > Course Catalog > Search Results

Search Results

You searched for [Blank] with All Software

145 courses found: View Instructor-Led (42) View Self-Study (103)

Advanced Analysis with ArcGIS
Instructor-Led (Classroom)
$1,350.00 USD
Go to schedule

Advanced Techniques for Labels and Annotation
Instructor-Led (Web)
$525.00 USD
Go to schedule

Analyzing School Safety Using ArcGIS
Self-Study (Virtual Campus)
$25.00 USD

Aprender ArcGIS 9
Self-Study (Virtual Campus)
$175.00 USD
First module FREE

Aprender ArcGIS 9 Spatial Analyst
Self-Study (Virtual Campus)
$125.00 USD
First module FREE

Arc Hydro: GIS for Water Resources
Instructor-Led (Classroom)
$1,350.00 USD

ArcGIS Annotation: Tips and Tricks
Self-Study (Virtual Campus)
$30.00 USD
ESRI offers classes at US learning centers across the country. Outside the US, please contact your ESRI International Distributor.

Click on a learning center for a class schedule, maps and driving directions, and training coordinator contact information.
Public Health GIS News and Information

Public Health GIS News and Information is a bimonthly, electronic report "dedicated to scientific excellence and advancement in disease control and prevention through the use of Geographic Information Systems (GIS) technology." The report, which began in 1994, provides timely information on a variety of GIS topics, including technical and outreach assistance; notification of relevant professional meetings, events, and conferences; communication from GIS users; Web developments; and public health GIS literature.

Upcoming reports are available free through the Public Health GIS Users Group listserv and this Web site. To become a listserv member, please e-mail listserv@listserv.cdc.gov and type subscribe GIS-STATES-EDU in the body of the message.

Additionally, the current report, as well as several past issues, can be viewed or downloaded below.

Current Report

http://www.cdc.gov/nchs/about/otheract/gis/gis_publichealthinfo.htm
GIS: Federal Resources (examples)

- National Cancer Institute: Interactive cancer maps by region

- CDC: Resources for creating public health maps
  - [http://www.cdc.gov/epiinfo/maps.htm#Sources](http://www.cdc.gov/epiinfo/maps.htm#Sources)
  - Monthly GIS resource newsletter
What about web-based GIS engines?
HealthLandscape is an interactive web atlas that allows health professionals, policy makers, academic researchers and planners to combine, analyze and display information in ways that promote understanding and improvement of health and healthcare.
The Public Health Disparities Geocoding Project Monograph

Geocoding and Monitoring US Socioeconomic Inequalities in Health: An introduction to using area-based socioeconomic measures

GENERATING ABSMs

Generating ABSMs: concepts, methods, and measures

Generating area-based measures of socioeconomic position requires an explicit approach to understanding what socioeconomic inequality is and how to measure it, at multiple levels. In this section we briefly review our definitions of "social class" and "socioeconomic position," and then delineate our approach to generating and appraising the validity and utility of our Project's area-based socioeconomic measures (ABSMs).

Definitions: social class and socioeconomic position

Starting first with definitions, in the Public Health Disparities Geocoding Project we used the construct of "social class" to refer to social groups arising from interdependent economic relationships among people. Stated simply, broad classes—like the working class, business owners, and their managerial class—exist in relationship to and co-define each other. One cannot, for example, be an employee if one does not have an employer and this distinction—between employee and employer—is not about whether one has more or less of a particular attribute, but concerns one's relationship to work and to others through a society's economic structure.
The Dartmouth Atlas Project works to accurately describe how medical resources are distributed and used in the United States. The project offers comprehensive information and analysis about national, regional, and local markets, as well as individual hospitals and their affiliated physicians, in order to provide a basis for improving health and health systems. Through this analysis, the project has demonstrated glaring variations in how health care is delivered across the United States. The project is run by Center for the Evaluative Clinical Sciences at Dartmouth Medical School.

**spotlight**

In an Op-Ed published in The New York Times on Monday, July 20, 2006 ("Too Many Doctors in the House"), David C. Goodman, M.D., M.S., the director of the Dartmouth Health Workforce Program, argues that plans to increase the size of the physician workforce in the United States are "like prescribing more drugs for an already overmedicated patient, [and] may only make things worse." Goodman argues that the per capita supply of physicians is unrelated to the quality of care provided, and "will continue to fill more hospital beds, order more diagnostic tests -- in short, spend more money. But our resources would be better directed toward improving efforts to prevent illness and manage chronic ailments like diabetes and heart disease." The research findings were published by the Journal *Health Affairs* in its March/April 2006 issue.

Dr. Goodman is a professor of Pediatrics and of Community and Family Medicine at Dartmouth Medical School. His research focuses on the geographic distribution of physicians in the United States, how variations in the per capita supply of different kinds of medical specialists affect the amounts of health services provided to patients, and the failure of greater per capita supplies of medical specialists to improve health outcomes.

**The Care of Patients with Severe Chronic Illness: A Report on the Medicare Program by the Dartmouth Atlas Project**

This online report on differences in the management of Medicare enrollees with severe chronic illnesses was released Tuesday, May 16, 2006. The focus of the new study is the...
Where can I find Geographic Health Data? (examples)
Some Nationally representative Datasets are Geocoded

BRFSS Maps

Download GIS Data

Click the links below to download the BRFSS GIS Maps data for analysis. These files contain data and documentation, and are available in Zip Archive File (ZIP) format. The zip format contains one or more files within it and is compressed to minimize the file's size. Use any zip utility to unzip these archives.

The zip files contain BRFSS data that is mapped for both the states and metropolitan/micropolitan statistical areas (MMSAs). In these data sets, the BRFSS data has been attached to shapefiles which can be viewed using different desktop GIS applications, for example, ArcGIS from ESRI. You can open the shapefiles in a desktop GIS application and generate your own maps using this data.

These data files are a subset of the BRFSS data intended for use with a GIS package only.

Complete data sets and documentation are available in the BRFSS and SMART sections of the site.

GIS Data Files

2004 BRFSS GIS Data

BRFSS/SMART GIS shapefile data and documentation for 2004

2003 BRFSS GIS Data

Would you like to use our data?
Expanding Acceptable Transfer Requirements: Transfer Instructions for Permanent Electronic Records

DIGITAL GEOSPATIAL DATA RECORDS

1.0 PREFACE

As part of the Electronic Records Management (ERM) E-Gov Initiative to improve electronic records management in Federal agencies, and in cooperation with other Federal agencies, NARA is issuing guidance to supplement current requirements in 36 CFR 1228.270 for transferring permanent electronic records to NARA.

This guidance expands currently acceptable formats to enable the transfer of permanent digital geospatial data records created for Geographic Information Systems (GIS) to NARA. The specific requirements below build upon the existing requirements for geospatial data records in 36 CFR 1228.270 (d) (3) and (e) (2), which are applicable where appropriate.

2.0 INTRODUCTION

Geospatial data records from GIS are a priority electronic records format identified by NARA and partner agencies as part of the Electronic Records Management (ERM) initiative, one of the 24 E-Gov initiatives under the President’s Management Agenda. A major goal of this
Resources for Creating Public Health Maps

Download free shapefiles for Windows version Epi Info™
Submit a new Website for this list

Public Health and GIS Overviews

Geographic Boundaries

- Principal Repositories
- US State Geographic Data Sources
- Global Positioning System
- Images
- Additional Sites

Data

- Demographic
- Health Outcomes
- Environmental and Health Risk Exposure

Geostatistics/Spatial Analysis
Global Public Health GIS Projects
Conferences and Symposia
Software
Consultants

Public Health and GIS Overviews
CDC - State Data sources

US State Geographic Data Sources

- Alabama Geological Survey Geospatial Data Clearinghouse
- Alaska Geospatial Data Clearinghouse
- Arizona Clearinghouse Node for Spatial Resources
- California Environmental Resources Evaluation System
- Connecticut Map and Geographic Information Center
- Delaware Spatial Data Clearinghouse
- Georgia Spatial Data Infrastructure
- Hawaii Statewide GIS Program
- Indiana GIS
- Kentucky Office of Geographic Information
- Louisiana Statewide GIS
- Maine Office of GIS
- Maryland MDMaps
- Massachusetts Geographic Information System: MassGIS
- Minnesota Geographic Data Clearinghouse
- Missouri Spatial Data Information Service
- Montana State Library GIS
- Nebraska Geospatial Data Center
- Nevada Geographic Information Virtual Clearinghouse
- New Hampshire GRANTInet
- New Jersey DEP's GIS Web Page
- New Mexico Resource Geographic Information System Program
- New York State GIS Clearinghouse
- North Carolina Geographic Information
- Pennsylvania Spatial Data Access
- South Carolina GIS Data Clearinghouse
- South Dakota GISodial Survey
- Tennessee GISource
- Texas Natural Resources Information System
- Vermont Geographic Information System
- Virginia TIGER/Line Data Browser
- Washington State Geospatial Clearinghouse
Using your own clinic’s data + population data

- Defining Health Service Areas
- Examine “market” penetration rates
- Find underserved areas your service areas
- Determine areas of inequitable access to subgroups (e.g. racial subgroups) in need of services
- Improve the capacity for COPC
GIS: The Future

- Healthy People 2010 Goal:
  - Increase proportion of all major nat’l, state, & local data systems using geocoding and GIS to 90%

- Web-based interactive mapping available at the clinic level for use by clinicians/ clinic leaders