Physical activity and spatial epidemiology in physical activity research: a global equity lens

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PHYSICAL ACTIVITY EPIDEMIOLOGY

Behavioral Epidemiology Framework (Sallis et al., 2006)

1. Establish *link* between health behavior and clinical health outcome
2. Identify the *factors associated* with the behavior
3. Design and test *interventions* to promote the desired health behavior
4. *Translate and disseminate* findings to change policy and practice
The pandemic of physical inactivity

- Physical inactivity is a known risk factor for obesity, cardiovascular diseases, type II diabetes, some cancers.

- A fourth of the world’s population is insufficiently active.

- 5.3 million deaths per year are attributable to physical inactivity (9% of all deaths).

- Physical inactivity costs healthcare systems 54 billion dollars per year.

- The annual deaths attributable to physical inactivity result in productivity losses of 13.7 billion dollars.

- Physical inactivity is responsible for 13.4 million DALYs (Disability Adjusted Life Years).
PHYSICAL ACTIVITY IS A COMPLEX BEHAVIOR...

PA Intensities
- Light PA
- Moderate PA*
- Vigorous PA*

PA Domains
- Discretionary Time
- Transport-based
- Occupational
- Home-based

Exercise, Sport
2. Identify factors associated with the behavior: An Ecologic Approach

- Environmental changes have modified lifestyle patterns
  - Higher energy intake (nutrition)
  - Lower energy expenditure (physical activity)

- Demographic, epidemiological and nutritional transitions
  - Globalization
  - Urbanization
Inter-personal strategies to promote physical activity

Although effective....
- Low to moderate effect
- Low maintenance
- Low coverage
- Low potential for scalability

Environmental strategies to promote physical activity

“Physical activity occurs in specific places”

Sallis et al., 2006; Reis, Salvo et al., 2016
Spatial epidemiology

- The description and analysis of geographically indexed health outcome data with respect to demographic, environmental, behavioral, socioeconomic, genetic and infectious risk factors

- Considers the influence of both space and place on health outcomes

- Physical (In)Activity is known to be influenced by space and place

- **Space**: geographic location (latitude/longitude)
  - **Place**: physical, natural, social, cultural, political and historical context of a space

- Space (and its influence on health) is rarely independent of place
Spatial Epidemiology integrates *spatial thinking* to public health research and practice.

- **Geographic Perspective**: The “where” as a central aspect of research
- **Skills**: GIS, spatial regression, geostatistics, GPS data processing
- **Content Knowledge**: Epidemiology, Public Health, specific health outcomes

**Spatial Epidemiology** = Using *Spatial thinking* as a way to:
- ✓ Formulate new problems
- ✓ Approach existing problems
- ✓ Design studies
- ✓ Analyze data
- ✓ Interpret findings
- ✓ Translation and scale-up
Basic components of spatial epidemiology

1. Disease & risk factor **mapping → descriptive**
2. Spatial cluster detection → **descriptive, analytic**
3. Analysis of space & place-based correlates and determinants of health → **hypothesis testing**
4. Identifying space &/or place-varying relations → **hypothesis testing** (effect modification)
5. **Prediction** of health outcomes occurrence in space → **geostatistics**

*Not “just mapping”…*

Although maps can be **very** helpful!
Latin America as a key setting

The Americas is the most inactive region of the world, with Latin America as a large contributor → and notice lack of data from some countries still!!

Globally, 1 in 4 people are inactive →
In Latin America, 1 in 3 people are inactive!
Latin America as a key setting

- Most **urbanized** region of the world → over 80% of Latin Americans live in urban settings
- **Rapid demographic and epidemiologic transitions** have led to **double burden of disease**
- Lots of experience in studying and addressing undernutrition and infectious diseases, but less so for chronic disease prevention and management
- Physical inactivity is **not yet recognized as an “independent” and important risk factor**
- **Physical activity and public health research is nascent** → **LOW RESEARCH CAPACITY**
  - Few academic programs specializing in this area
  - Few PhD level academics in the region
  - Low research output
  - **Little locally-relevant evidence to implement policies & programs for increasing population levels of PA**
As a result of most of the capacity and evidence in this field deriving from HICs...

- Research hypotheses are formulated with certain assumptions which make sense in HIC settings but not so much in certain LMICs.

- Study conclusions and broad messages are also a result of this framework:

  “The healthy choice should be the easy choice”
Is being physically active always a choice?
In most cities of the US >75% of households have at least one private motor vehicle.

In contrast, in most cities of Latin America, private motor vehicle ownership in cities is <40%.

In the US, it is estimated that only those living in the bottom 5-15% of income (varies by city) cannot afford owning at least one private motor vehicle in their household.

In cities of countries like Mexico, the bottom 55-70% cannot afford owning a private motor vehicle by virtue of their income and the cost of covering basic human needs.
Research is lacking where its more needed!

Where people live...

Where physical activity research takes place...
Walkability

Walkability is a measure of how conducive a place is for walking.

US Walkability Index =

\[
\text{US Walkability Index} = (z\text{-intersection density}) + (z\text{-net residential density}) + (z\text{-retail-to-floor area ratio}) + (z\text{-land use mix})
\]

NQLS - Accelerometer-based MVPA Min/day in Walkability-by-Income Quadrants

Frank et al 2004; Frank et al 2010
AIM: To precisely estimate the association of several built environment features with physical activity and BMI among adults using pooled data from 17 cities in 12 countries

- State of the art, comparable measures: accelerometers, GIS
- Rationale: Maximizing the variability of the exposure
Mismatch...

Outskirts of Atlanta

Outskirts of Mexico City
Rationale: Maximizing the variability of the exposure (neighborhood walkability)

BUT the relationship between walking and walkability may not be linear
GIS-measures: Buffers around each participant’s residential address using the street network

Digitized data for block-level audits (230 blocks)

Key BE features – Individual

1. US-based Walkability Index
2. Residential Density
3. Proportion of Commercial Land-Use
4. Entropy (land-use mix)
5. Intersection density (connectivity)
6. Count of parks
7. Number of public transit routes
8. Distance to closest park*

Buffer sizes: 500 M and 1 KM
IPEN – Mexico : Results

US Walkability Index (GIS-based) → Accelerometer-based MVPA

Objective Neighborhood Environment (GIS-based)
- Residential density
- Street Connectivity
- Land-Use Mix

Perceived Neighborhood Environment (NEWS)
- Residential density
- Street Connectivity
- Land-Use Mix

Salvo et al., 2014; Salvo et al., 2015; Jauregui et al., 2016
Recent findings from the pooled analysis of IPEN

Kerr et al., 2016; Christiansen et al., 2016
Choice-based vs. necessity-based physical activity frameworks

Any walking during Leisure time

Any walking for transport
Re-defining walkability and considering livability at large, and the importance of local vs. global contexts?
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Natural experiments assessing the role of urban transformations on physical activity

• ECOBICI Expansion Evaluation Study in Mexico City
  • Natural Experiment
  • Two year project
  • Includes 3 studies:
    ✓ Serial cross-sectional study consisting of direct observation of bicyclist counts in 3 areas of Mexico City
    ✓ Individual-level sample to understand determinants of travel mode choice
    ✓ Secondary “big data” analysis
“The environment is key to make physical activity the easy, accessible and natural choice for leisure and transport for all” – Gil Peñaloza

CONTEXT MATTERS!

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