UNIVERSITY OF PUERTO RICO
MEDICAL SCIENCES CAMPUS
GRADUATE SCHOOL OF PUBLIC HEALTH
DEPARTMENT OF BIOSTATISTICS AND EPIDEMIOLOGY

Respiratory Health Effects on Residents Living Near a Cement Plant in Puerto Rico

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Introduction

The Environmental Protection Agency, (2006) informed that contamination with particulate matter associated with cement industry could contain toxic elements such as: arsenic, antimony, chrome, dioxins, lead & thallium, among others. These elements could present hazard exposures to the residents of communities located near the plant.

Introduction

Some of the contaminants associated with the cement industry and its health effects are:

- **Particulate matter (PM_{10} y $PM_{2.5}$)**
  - reduces lung function, increases pulmonary inflammatory reactions, increases asthma events among the exposed.
- **Hydrogen Chloride-** causes severe irritation.
- **Sulfur Dioxide-** severe obstruction of respiratory system.
- **Nitrogen Oxide -** cough, shortness of breath, fatigue.

Introduction

- Cement (Portland cement type) has been produced in Ponce, Puerto Rico since the early 1950s. First, it was a government industry, then it was a private consortium (Ponce Cement, Ferré), and in 2004 it was bought by Cemex (Ponce Cemex).
- During the past few years, communities near the cement industry (Ponce Cemex) have presented over 40 complaints to the Environmental Quality Board to investigate the fugitive dust from the plant that was affecting their health.

PUERTO RICO

PONCE

Background: Air Quality

Ponce, Puerto Rico

PM_{10} - During 2003-2005, Ponce registered the highest concentrations of PM_{10} with an average of 43.6 µg/m^3. During the same time frame the average for San Juan was 29.9 µg/m^3.

$PM_{2.5}$* - Ponce's annual average was 7.39 µg/m^3 with a maximum of 26.6 µg/m^3. Acceptable level <15µg/m^3 (www.EPA.gov/air/particlepolution/standards.HTML; July 2007)

Source: **Environmental Quality Board, 2005**

Background: Respiratory Problems

Puerto Rico

- Asthma: 12.2%
- Sinusitis: 7.12%
- Nasal allergies: 5.38%

Ponce

- Asthma: 8.97%
- Sinusitis: 3.19%
- Nasal allergies: 3.29%

* Puerto Rico Health Department, 2003

Justification

- Leaders from communities near the cement plant approached the Biostatistics and Epidemiology Department to express their concern regarding contamination and the health of the community.
- Students of the Master in Public Health (MPH EPI and MPH BIO) designed a study to determine the prevalence of respiratory diseases in two geographic areas in Ponce.
    - Area I: Las Delicias I and Morell Campos (near cement plant)
    - Area II: Villa del Carmen (comparison community)

Research Question

Is the prevalence of respiratory diseases in the exposed communities (Las Delicias I and Morell Campos) different from the prevalence of respiratory diseases in the comparison community (Villa del Carmen) in the municipality of Ponce?

Methods

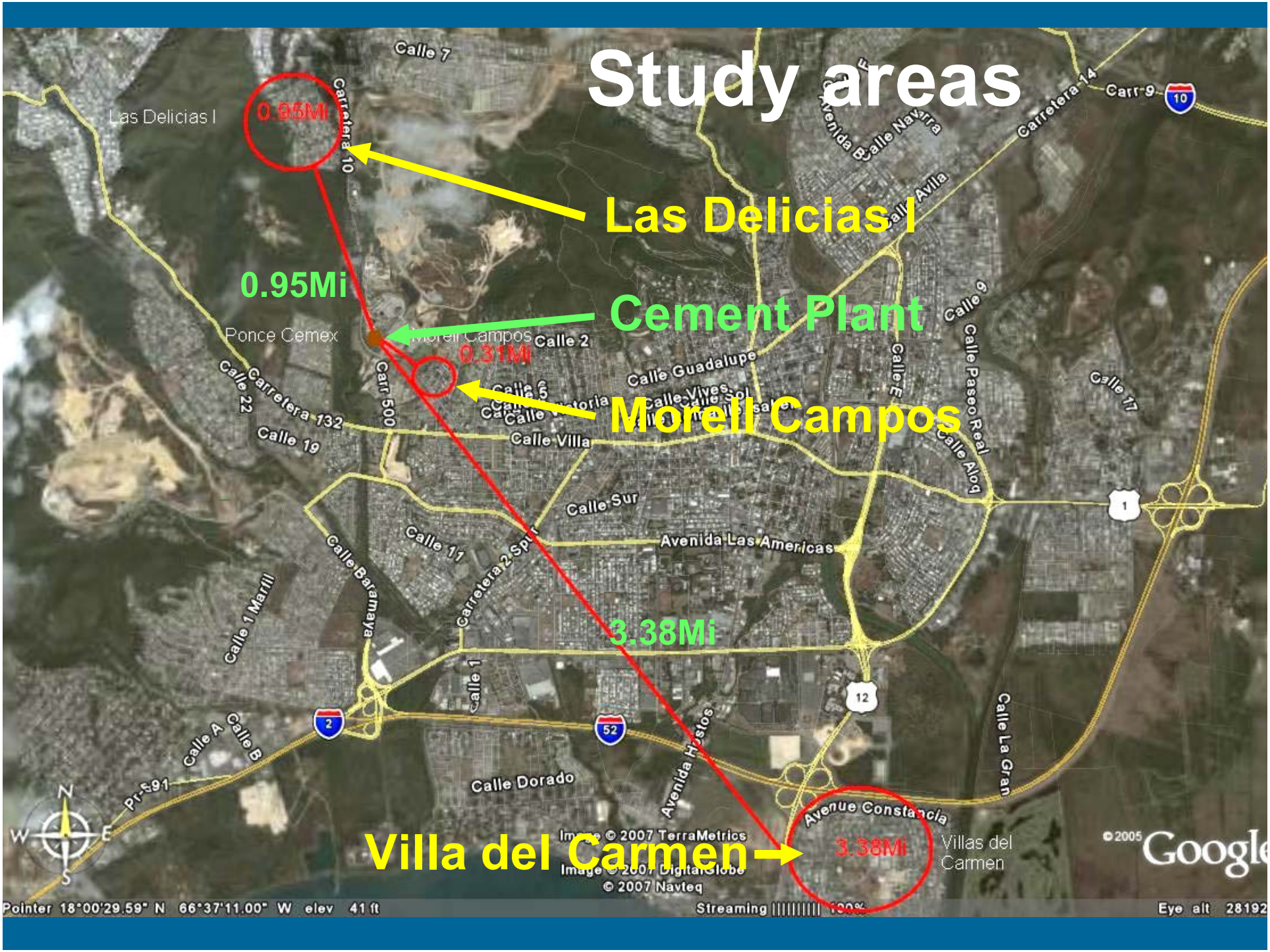
Design: Cross-sectional

Data collection: Standardized questionnaire; face to face interviews

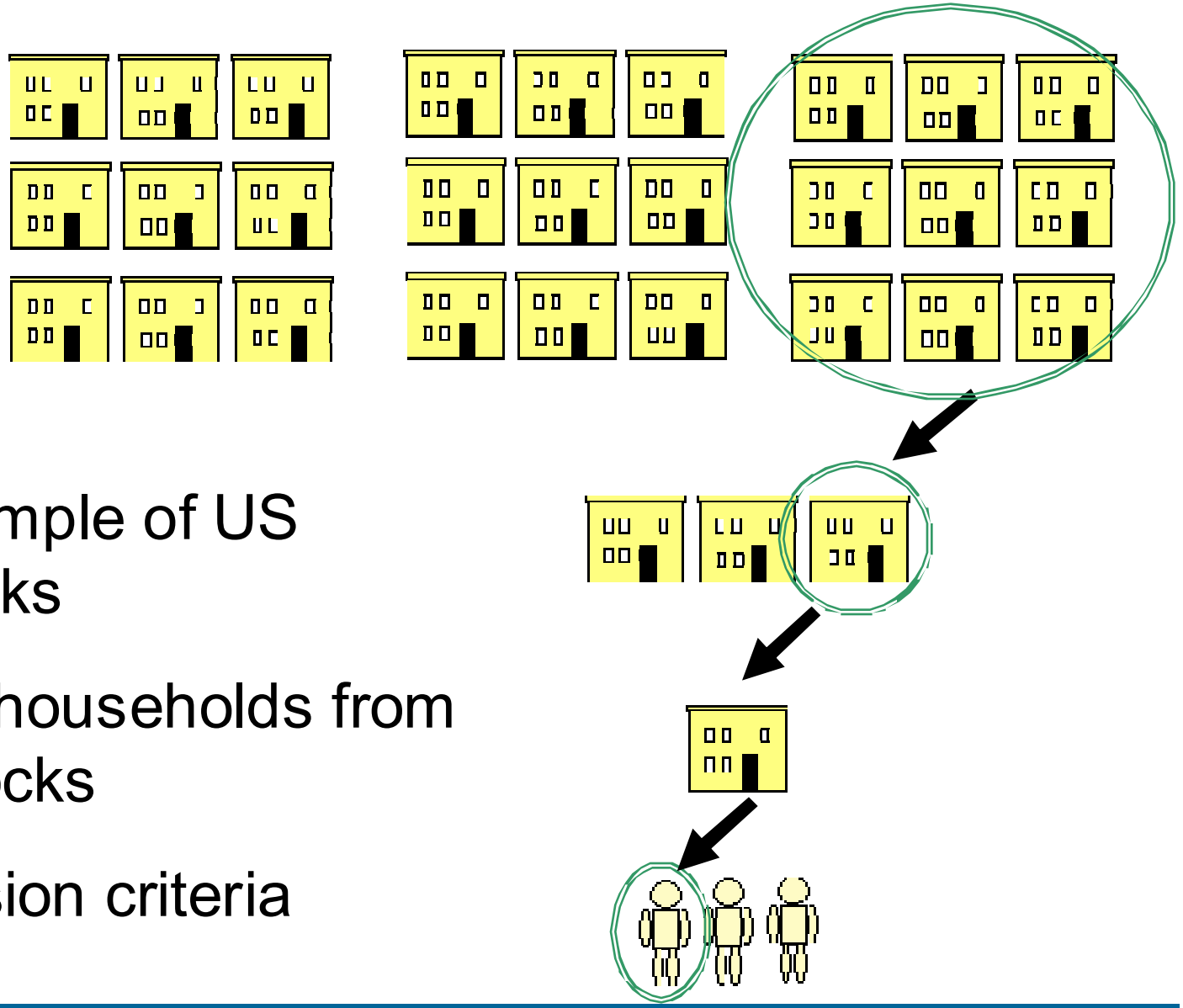
Sampling: Random selection of participants.

Inclusion criteria:

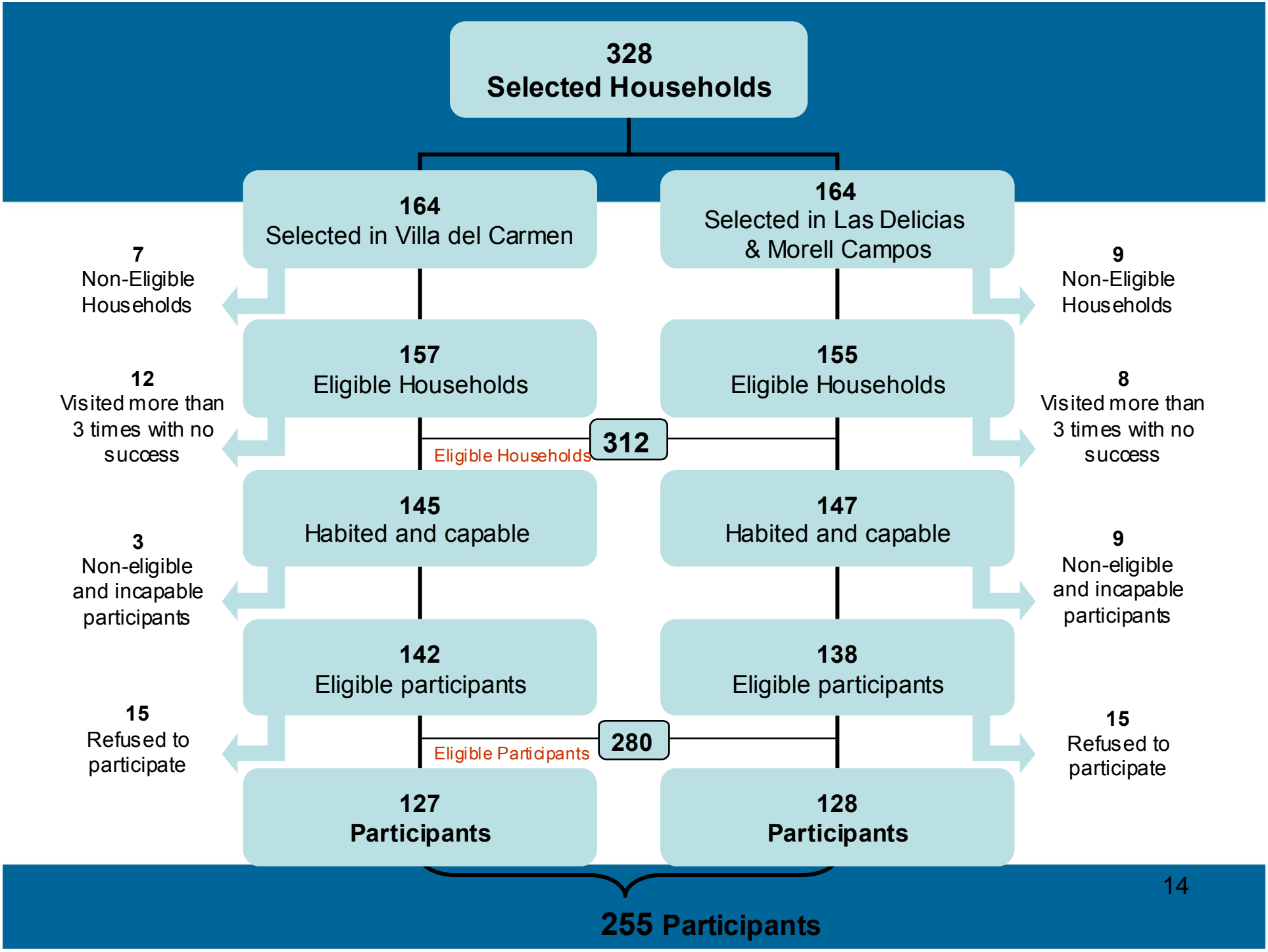
- **Age ≥ 21 years**
- **Minimum time of residence 4 months.**
- **Able to consent**



Sample



1. Random sample of US census blocks
2. Random of households from selected blocks
3. Apply inclusion criteria



Study variables

Predictor Variable
Residence area

→

Outcome Variable
Respiratory Diseases

Other predictor variables:
Age
Sex
Occupational History
Lifestyles

RESULTS

Characteristics	Las Delicias I & Morell Campos	Villa del Carmen	P value
Sex: Male	28.9%	37.0%	0.17
Mean age (years)	53.3(±17)	51.6(±16)	0.27
Education: ≤ 12 years	50.0%	39.4%	0.06
Average time (years) living in the community	20.8(±15)	22.4(±12)	0.93
Marital Status: Married	63.3%	68.5%	0.37

Results

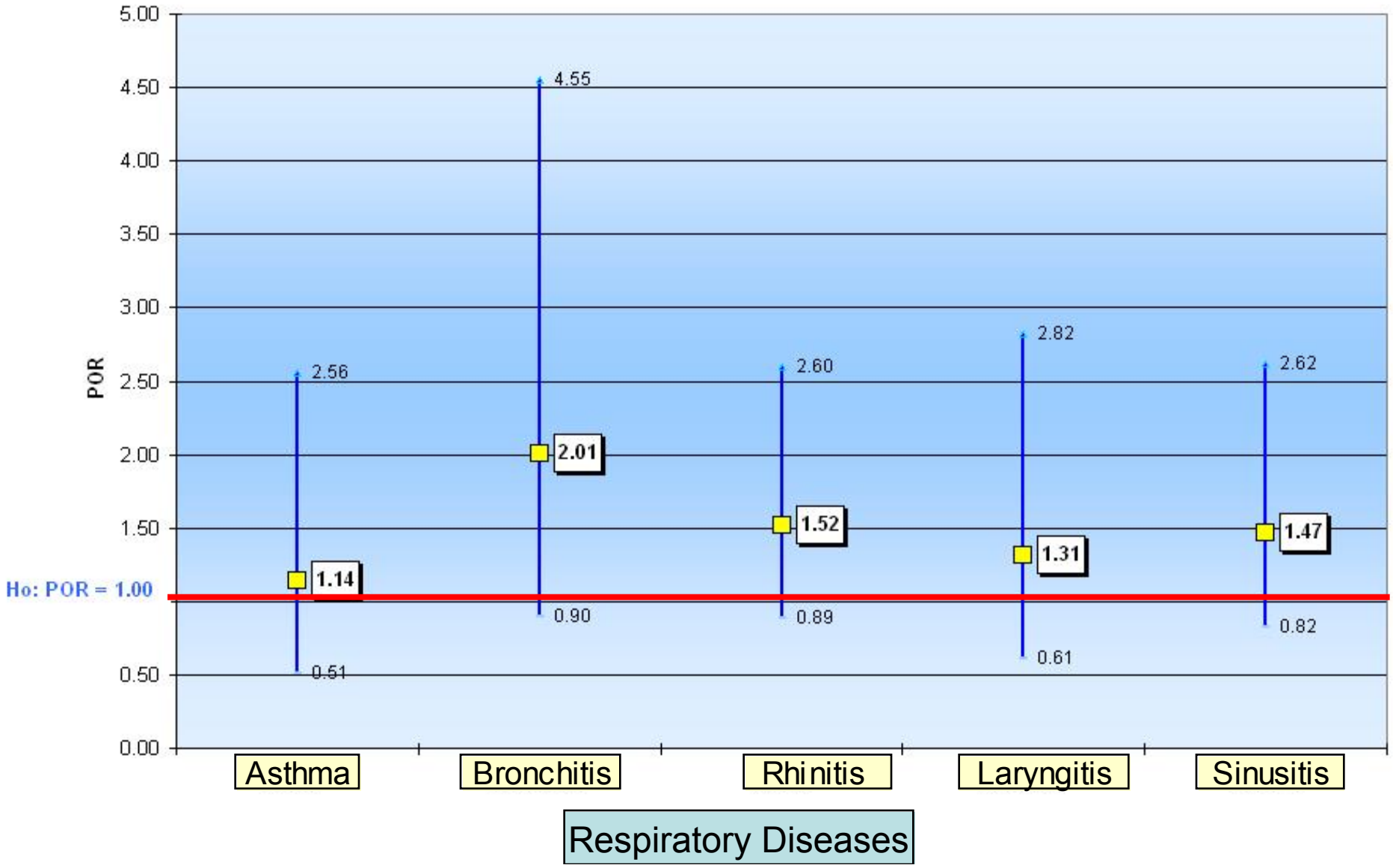
Lifestyle	Las Delicias I and Morell Campos	Villa del Carmen	P value
Smoking[a]	18.8%	29.1%	0.05
Physical Activity[b]	31.3%	34.6%	0.56
Occupation[c]	42.2%	48.0%	0.34

[a] Smoker = More than 100 cigarettes in the lifetime

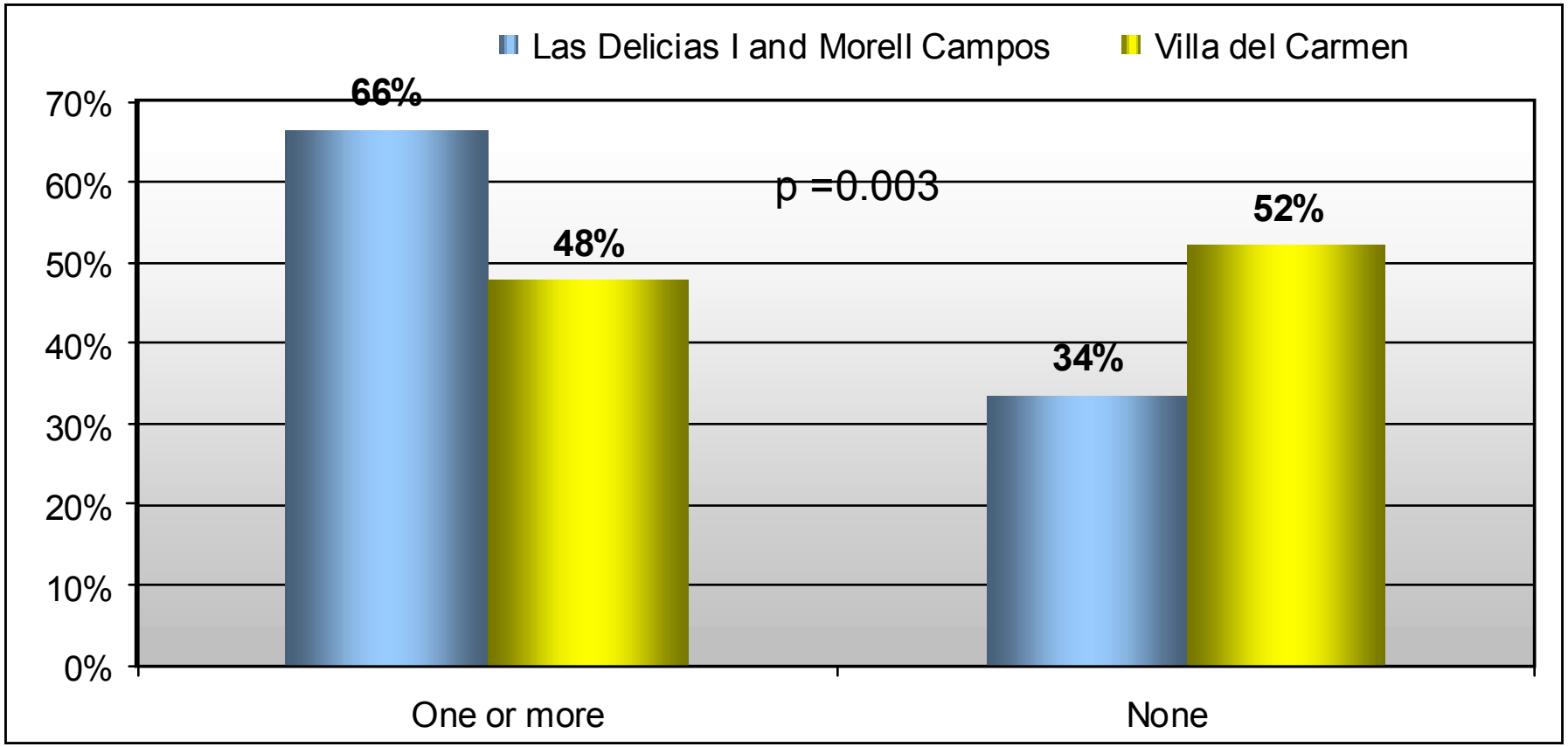
[b] PA ≥ 3 times per week

[c] Longest held occupation associated with respiratory diseases

Respiratory Diseases by Geographical Area



FREQUENCY OF RESPIRATORY DISEASES[a] DURING THE PAST TWELVE MONTHS BY GEOGRAPHICAL AREA



[a] at least one of the selected respiratory diseases during the past 12 months

Logistic Regression Model

Variable	POR	P value
Residence area (Las Delicias I & Morell Campos)	2.60	<0.001
Smoking	2.02	0.027
Education (>12)	1.69	0.055
Age (≥65 years)	0.59	0.064

Strengths

- **Participation rate: 91.1%.**
- **High statistical power : $p<0.001$**
- **Comparison community had similar socio-demographic characteristics.**
- **Study participants were randomly selected to minimize bias.**
- **Data collection and data analysis followed strict quality control procedures.**

Limitations

- Persons less than 21 years of age were excluded, even though this age group is susceptible to asthma (Badash, 2007). Therefore, the prevalence of respiratory diseases could have been underrepresented in this study.
- The comparison community had contamination problems (i.e., exposure to pesticides, dust from a construction site, air contamination from the expressway) as expressed by residents of Villa de Carmen. Thus, the high prevalence of respiratory diseases reported by residents biased the POR towards the null.

Conclusions

Factors that support study results:

- **Biological plausibility**: Inhalation of particulate matter has been associated with respiratory conditions as well as with cardiovascular disease (Bai et. al, 2007). Cement production has been associated with exposure to particulate matter to residents of communities near the plant. (EPA, 2005)

- **Consistency of the observation**: Other studies have observed an increasing risk of respiratory diseases in residents near cement plants (Schuhmacher et. al, 2004) .

- **Strength of the association:** POR= 2.60 ($p<0.001$).

Recommendation

Regulators need increasingly refined information about the sources of pollutants contributing to adverse effects to establish cost-efficient and more focused control strategies.

Evaluation of the public health impact of air quality regulation –accountability research- is a necessary component of responsible governmental policy intervention.

Dominici et al, AJE, 2007