Challenges of Sub-County Surveillance: Massachusetts' Experience with Population Estimation

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1. Why do we need sub-county population estimates?

2. University of Mass. Donahue Institute
   1. UMDI Method
   2. Challenges / Limitations
   3. National Feasibility?

3. Evaluation and Implementation
In Massachusetts, Sub-County Estimates are Essential to Stakeholders

• Local Health is Overseen by Municipalities
• Often, Local Health planning requires sub-municipal measures
  • Community Needs Assessment
  • Health Impact Assessment
  • Emergency Preparedness
  • Identifying Health Disparities and Vulnerable Populations
• Interest in sub-county life expectancy estimates only adds to the need for reliable population data
Post-Censal Population Estimation Options

• Simple linear extrapolation of U.S. Census data
  • Inherently biased as population change is not constant
  • Assumes a constant rate of growth or decline, producing larger error as the decade progresses

• Commercial products
  • MA found large unexplained flaws with previously purchased estimates
  • Methods descriptions are vague

• The American Community Survey
  • 5-year running sample
  • Rate calculation using ACS small areas is not recommended due to large margins of error
  • Does not offer single-year age groups
UMDI – Strengths of the Methodology

• Commonly employed projection method
• Requires Census data products only
• Annually adjusted for improved performance
• Capable of producing race, ethnicity, sex, and single-year age stratum
• Replicable
UMDI Product for MA

• Municipal and Census Tract level data
• Sex-Age-Race/Ethnicity break downs

Age:
  • Single year ages 1 – 20yrs
  • 5-years ages under 5 to 85+

Race:

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UMDI Methodology – Aging Forward

- Standard Hamilton-Perry Methodology
  - Cohort Change Ratio – “Ages” age-sex cohorts forward from one census to the next
  - Ratio is applied to base population to create future estimate.

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UMDI Methodology – Accounting for Births

Standard Hamilton-Perry Methodology:
• For unborn groups, Child to Women Ratios (CWRs) are a proxy for birth information

Modification to Hamilton-Perry Method:
• Ratios shifted, reflecting fertility at older age ranges compared to US average
UMDI Methodology – Shift in CWRs

Birth Rate by Maternal Age Group, U.S. and Massachusetts

- **35 to 50 years**
  - United States: 25
  - Massachusetts: 31

- **20 to 34 years**
  - United States: 95
  - Massachusetts: 75

- **15 to 19 years**
  - United States: 21
  - Massachusetts: 10

Birth rate per 1,000 women

U.S. Census Bureau American Community Survey 5-year dataset 2010-2014
UMDI Methodology – Outliers and Updated Data

Standard Hamilton-Perry Method:
• After projection, years between 2010 and 2020 are interpolated.

Modifications to Hamilton-Perry Method:
• Ceilings developed to contain “runaway” CCR’s
• Estimates updated annually, controlled to newest releases of Census County Estimates. These incorporate death, birth, and migration data.
### Controlling Estimates to Annual Census County Population Estimates

**Example:** Asian Non-Hispanic Males 15-19

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<th>Uncontrolled Estimate</th>
<th>% of Uncontrolled County Total</th>
<th>County Estimate of Asian Non-Hispanic Control Estimate</th>
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<td><strong>2,000</strong></td>
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UMDI Methodology - Assigning Error

- Projected 2010 estimates from 10 and 20-year Cohort Change Ratios compared to 2010 Census
- Population estimate error was generally best explained by age and cohort size
- Population estimate errors were assigned to estimates based on base population cohort size and age
- As with estimates, errors were projected to 2020 and applied in equal parts across intervening years.
UMDI Projected Population Estimate Error, by Geography

Absolute Percent Error by Town for 10-Year Cohort Change Ratio Estimates

Average Absolute Percent Error for all MCDs: 8.6%
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</tr>
</tbody>
</table>

MAPE by age and cohort-size: 10-year CCR estimates

UMASS DONAHUE INSTITUTE
ECONOMIC & PUBLIC POLICY RESEARCH
UMDI Projected Population Estimate Error by Age

- 0-4: 22.5%
- 5-9: 24.2%
- 10-14: 16.8%
- 15-19: 15.1%
- 20-24: 20.3%
- 25-29: 27.6%
- 30-34: 27.4%
- 35-39: 21.4%
- 40-44: 14.2%
- 45-49: 11.3%
- 50-54: 11.7%
- 55-59: 12.1%
- 60-64: 13.1%
- 65-69: 13.9%
- 70-74: 15.0%
- 75-79: 16.4%
- 80-84: 17.8%
- 85+: 26.6%

10 yr CCR
Special Cases to Consider in Developing Small Area Estimates

- Geographies in which **student housing** or enrollment changes significantly
- Geographies in which an assisted living or nursing home residence or some other **large group quarters** facilities is opened or closed
- Geographies that have undergone **major new construction or demolition** of residential housing that is out-of-trend
- Geographies that include concentrations of shifting seasonal or international workers
- Geographies for which **post-census count corrections** have been made
Feasibility for Application to other States?

**Most easily applied where:**
- Geographies remain fairly stable from Census to Census and/or
- Have excellent correspondence files across time 1990-2010.

**Difficulty presented when:**
- Boundaries have changed or annexations have taken place from Census to Census
  - Would require efforts to document changes
  - Helpful if records available (e.g. correspondence files)
- Sub-county population sizes are small
  - A higher geographic level may be needed (i.e. not municipality)
  - More uncertainty in the estimates may occur

*Nothing is IMPOSSIBLE, but it can be much more time-consuming (i.e. COSTLY).*
MA Evaluation and Implementation Work

1. Review of impacts to EPHT’s rates for specific years and datasets (completed)
2. Comparison with ACS (in progress)
3. Update messaging and metadata to include description of methods and error (on deck)
Lead Screening Rates (age 9-47 months)
UMDI method vs. Linear method

Town:
- A-town
- B-land
- C-ville
- D-boro

Calculated Using:
- Linear Method
- UMASS Method

[Graph showing lead screening rates for different towns using UMDI and Linear methods over the years 2010 to 2015.]
Lead Screening Rates >100%
UMDI method vs. Linear method

Number of Towns

UMDI (3.1%)
Linear (10.3%)

Town population
- 10,000-74,999
- <10,000
Comparing Error
UMDI method vs. ACS method

Comparing the coefficient of variation (CV) for UMDI and ACS population estimates for 5-year age groups, stratified by community-based cohort size.

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QUESTIONS?

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Supplemental Slides
Applying Cohort Change Ratio Ceilings

CCR for Individual Cohorts 0-10 size in base year