Analyzing Data from Long-Term Care Facility Settings

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My background

Ph.D., University of Minnesota
Psychometrics and Statistics

– Multilevel models for complex data
– Longitudinal data analysis
– Missing data

– Health psychology, behavioral medicine
SAMPLING DESIGNS FROM STUDIES OF LONG-TERM CARE FACILITIES
Spore et al. 1996

• Targeted 10 states
  – Random sampling of counties within states
  – Within-counties, random sample of facilities, stratified by home size
  – Within facility, random sample of residents
  – N = 3257 residents within more than 493 homes


**PI:** Manton, Kenneth G., Duke University

- Nationally-representative sample both of the community and of institutionalized populations
- Longitudinal
  - sample persons join the survey once they reach 65 years of age and stay in the survey until they either die or are lost to follow-up
- At each wave, a screener questionnaire is used to divide the sample into three parts
  - non-disabled
  - disabled but living in the community
  - disabled living in an institution
non-disabled

disabled but living in the community

disabled living in an institution

Person 1  …  Person n

Person 2


Person j


Not necessarily complete data at all waves
A common theme in studies of long-term care facilities is a complex sampling design

- state
- county
- facility
- resident
A common theme in studies of long-term care facilities is a complex sampling design

- state \text{ FIXED}
- county
- facility
- resident
A common theme in studies of long-term care facilities is a complex sampling design

- state FIXED
- county RANDOM
- facility
- resident
A common theme in studies of long-term care facilities is a complex sampling design

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- state  FIXED
- county  RANDOM
- facility  RANDOM
- resident  RANDOM
A common theme in studies of long-term care facilities is a complex sampling design

- **Disability Status**
  1. non-disabled
  2. disabled but living in the community
  3. disabled living in an institution

- **Person**

- **Year**
A common theme in studies of long-term care facilities is a complex sampling design

- **Disability Status**  FIXED
  1. non-disabled
  2. disabled but living in the community
  3. disabled living in an institution
- **Person**
- **Year**
A common theme in studies of long-term care facilities is a complex sampling design.

- Disability Status  FIXED
  1. non-disabled
  2. disabled but living in the community
  3. disabled living in an institution
- Person  RANDOM
- Year
A common theme in studies of long-term care facilities is a complex sampling design

• Disability Status  FIXED
  1. non-disabled
  2. disabled but living in the community
  3. disabled living in an institution

• Person  RANDOM

• Year  RANDOM
Multilevel Data Structure

state FIXED
↓
county RANDOM
↓
facility RANDOM
↓
resident RANDOM

Disability Status FIXED
↓
Person RANDOM
↓
Year RANDOM
Nursing Facility Quality Review

• The Nursing Facility Quality Review
  – statewide measurement of the quality of care, quality of life, consumer satisfaction, and medication use in Texas Medicaid-certified nursing facilities
  – Principal Investigator: Dr. Tracie C. Harrison
Resident Reports of Quality of Life

n = 968 residents
within 815 facilities

- QOL is an average of responses to 7 items
- Each item was measured on a 5-point scale
  - Mean QOL = 2.2
  - SD = 0.83
Resident Reports of Quality of Life
n = 968 residents within 815 facilities

- A portion of the respondents lived in the same facility as other respondents
- If the context influences QOL, then QOL reported by residents who share the same facility may be correlated
Resident Reports of Quality of Life

n = 968 residents within 815 facilities

- Calculate the intraclass correlation coefficient
- 22% of the variation in QOL scores is attributed to the facility
  - Accounting for the nesting of residents within facilities is important in the statistical analysis
Predict QOL by Access to Outdoor Space

• Access to outdoor space
  – Residents rated on a 5-point scale
    • 1=always
    • 2=most of the time
    • 3=sometimes
    • 4=rarely
    • 5=never
Access to outdoors $\rightarrow$ QOL

- **Ignore** nesting of residents within facilities
- Account for nesting of residents within facilities
Access to outdoors → QOL

• **Ignore** nesting of residents within facilities

• Account for nesting of residents within facilities

The standard error is appropriately larger after accounting for the nesting of residents within facilities
Interpreting the effect of a resident-level predictor on the outcome

Access to outdoors → QOL

- **Within-facility effect** of “access to outdoors”
  - Expected difference in QOL between two residents in the same facility who rating of “access to outdoors” differ by one point

| Effect   | Estimate | Standard Error | DF  | t Value | Pr > |t| |
|----------|----------|----------------|-----|---------|-------|
| Intercept| 2.1597   | 0.02874        | 551 | 75.15   | < .0001|
| outdoorC | 0.2265   | 0.02773        | 378 | 8.17    | < .0001|
We can also estimate the between-facility effect of “access to outdoors”

• Calculate a facility average of “access to outdoors”
  – “MeanOutdoor”

• Between-facility effect of “access to outdoors”
  – Expected difference in the mean of QOL between two facilities that differ by one point in “MeanOutdoor”

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<thead>
<tr>
<th>Solution for Fixed Effects</th>
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<tbody>
<tr>
<td>Effect</td>
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<tr>
<td>Intercept</td>
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<tr>
<td>outdoorC</td>
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<tr>
<td>meanoutdoor</td>
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</tbody>
</table>
Contextual Effect

• Within-facility effect
• Between-facility effect
• Contextual effect
  – A difference: Between-facility effect – Within-facility effect

| Effect       | Estimate | Standard Error | DF  | t Value | Pr > |t| |
|--------------|----------|----------------|-----|---------|------|---|
| Intercept    | 1.7122   | 0.05723        | 609 | 29.92   | <.0001 |
| outdoorC     | 0.2265   | 0.02723        | 357 | 8.32    | <.0001 |
| meanoutdoor  | 0.2303   | 0.02589        | 357 | 8.89    | <.0001 |

-.2303 - .2265 = .0038

– Interpretation
  • Expected difference in QOL between two residents who have the same value of “access to outdoors” but who live in facilities that differ in MeanOutdoor by one point
  • The benefit of living in facility j versus facility k
A multilevel LTC data set affords opportunities to study resident-level AND facility-level effects on an outcome

• Resident level: Access to outdoors → QOL

• Facility level: Facility size
  – Small (<50 beds)
  – Medium (50-99 beds)
  – Medium-Large (100-199 beds)
  – Large (> 199 beds)
Facility level

Resident level

Facility size $\rightarrow$ Mean QOL

Access to outdoors $\rightarrow$ QOL
Facility level  Facility size → Mean QOL

Resident level  Access to outdoors → QOL

(Simultaneous estimation of the effects)
Does Facility Size moderate the relationship between a resident’s “access to outdoors” and QOL?

**Facility level**

Facility size → Mean QOL

**Resident level**

Access to outdoors → QOL

In addition to testing resident-level predictor on QOL and facility-level predictor on QOL, we can test whether a facility-level variable MODERATES a resident-level relationship.

This is called a cross-level interaction.
The methodology

• Multilevel models
  – A.k.a. mixed-effects models, random coefficient models, random-effects models, hierarchical models

• Provide opportunities to study predictors at all levels of the hierarchy

• Recall 1st example:
  – state
  – county
  – facility
  – resident
Questions by Study Type

• Cross-sectional multilevel data
• Residents nested within LTC facilities
  – To what extent do resident outcomes vary across facilities?
    • 20% of variation in QOL scores was attributable to the facilities
  – Do facility-factors, such as size, affect resident outcomes?
  – Do facility-level factors moderate the relationship between resident-level predictors and outcomes?
    • E.g., Does the resident-to-staff ratio moderate the relationship between a patient’s sense of control and their QOL?
Questions by Study Type

• Longitudinal data
  – Repeated measures for residents observed over time
  – Residents are nested within different LTC facilities
    • Does QOL change over time?
    • To what extent do characteristics of change in QOL (e.g., rate of change) vary across residents? across facilities?
    • Do resident-level factors, such as gender, moderate the level of QOL or the rate of change in QOL?
Resources

• Books

• Software
  – R, SPSS, SAS, Stata, Mplus, HLM, LISREL, SUDAAN
Thank you