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
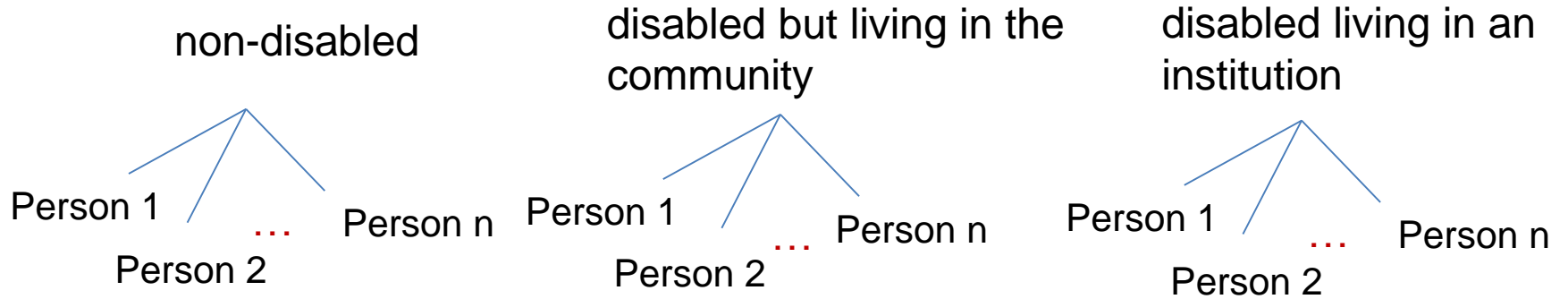 - N = 3257 residents within more than 493 homes

Spore D, Mor V, Larrat EP, Hiris J, Hawes C. Regulatory environment and psychotropic use in board-and-care facilities: results of a 10-state study. J Gerontol. 1996;51A:M131-M141.
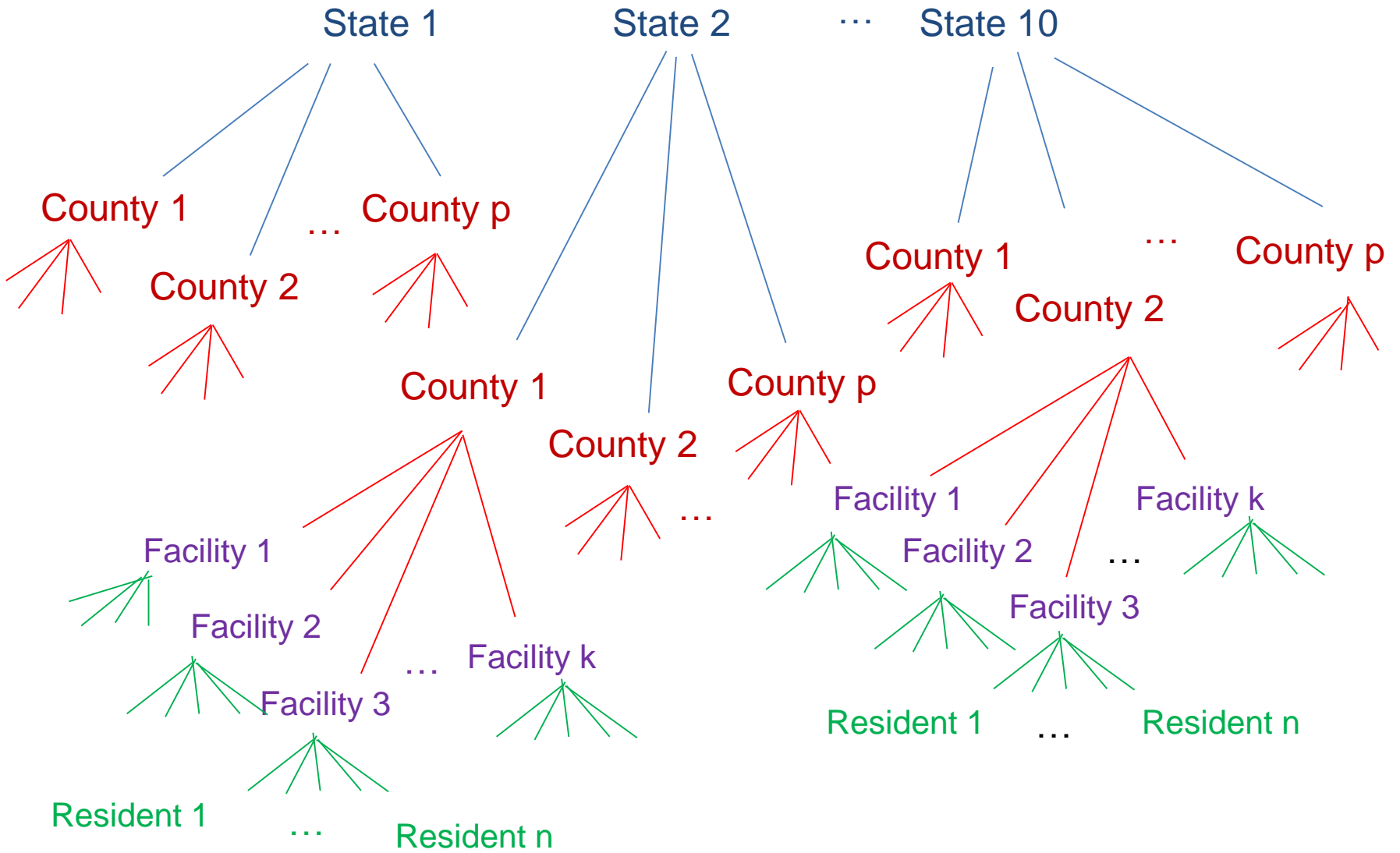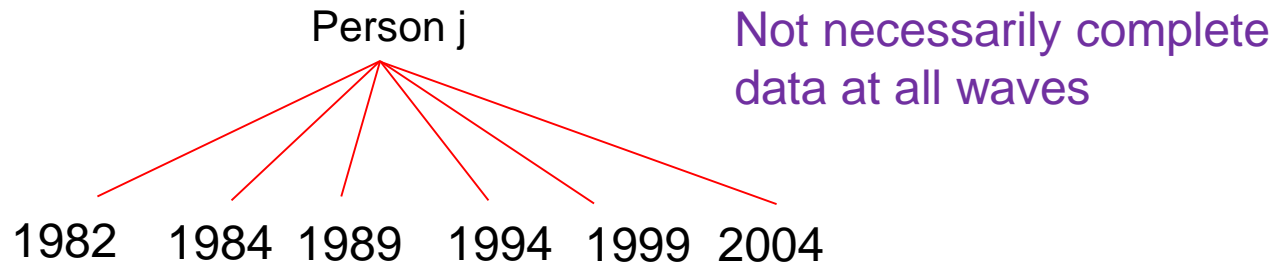
National Long-Term Care Survey: 1982, 1984, 1989, 1994, 1999, and 2004

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

Person 1

Person 2

…

Person n

disabled but living in the community

Person 1

Person 2

…

Person n

disabled living in an institution

Person 1

Person 2

…

Person n

For each person, repeated measures:
1982, 1984, 1989, 1994, 1999, and 2004

Person j

Not necessarily complete data at all waves

1982   1984 1989   1994   1999 2004

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   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

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

- state FIXED

- county RANDOM

- facility RANDOM

- resident

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

- 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
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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
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- 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

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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
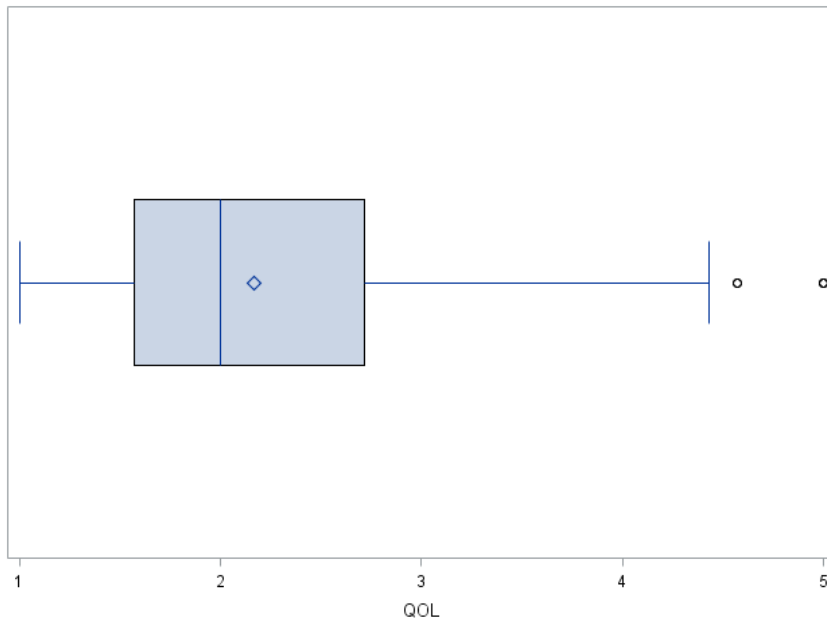
Resident Reports of Quality of Life
n = 968 residents
within 815 facilities

- 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
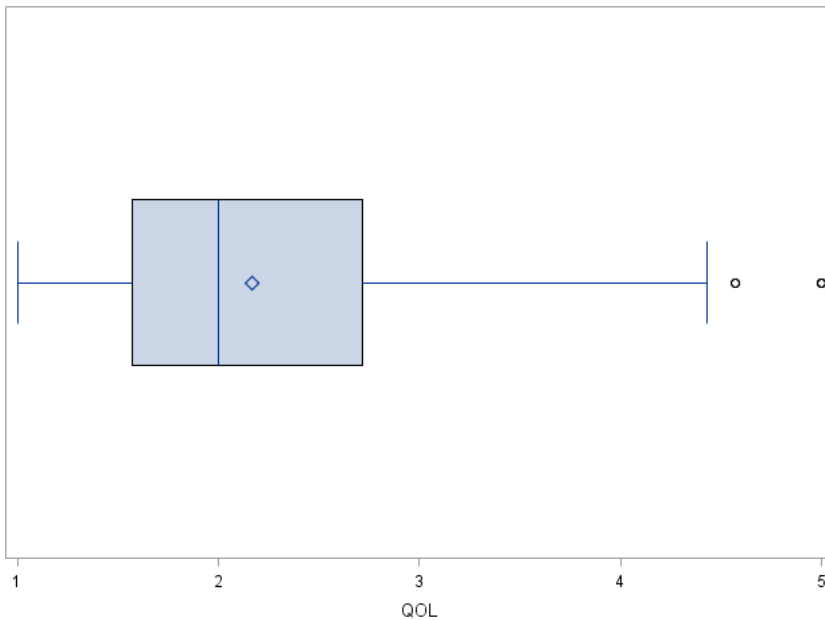
Resident Reports of Quality of Life
n = 968 residents
within 815 facilities

- 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 <u>intraclass correlation coefficient</u>

- 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
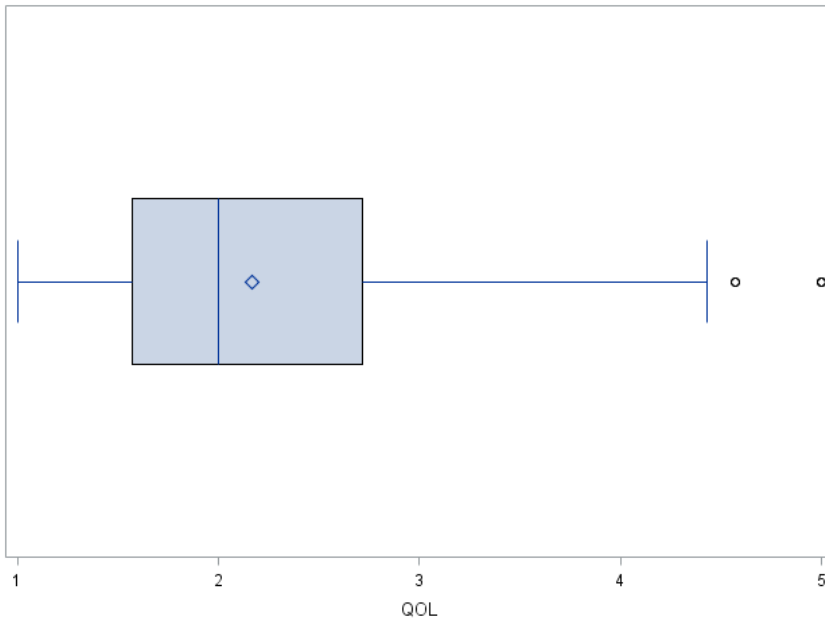
Predict QOL by
Access to Outdoor Space

- 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 → QOL

- **Ignore** nesting of residents within facilities

- Account for nesting of residents within facilities

Solution for Fixed Effects					
Effect	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept	2.1597	0.02602	967	83.00	<.0001
outdoorC	0.2265	0.03255	967	6.96	<.0001

Solution for Fixed Effects					
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

Access to outdoors → QOL

- **Ignore** nesting of residents within facilities

- Account for nesting of residents within facilities

Solution for Fixed Effects

Effect	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept	1.7210	0.04507	967	38.19	<.0001
Q_17_14	0.2239	0.01916	967	11.69	<.0001

Solution for Fixed Effects

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

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

Solution for Fixed Effects					
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 <u>mean of QOL</u> between two facilities that differ by one point in "MeanOutdoor"

	Solution for Fixed Effects				
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

Contextual Effect

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

Solution for Fixed Effects					
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   Facility size → Mean QOL

Resident level   Access to outdoors → QOL

Facility level   Facility size → Mean QOL

Resident level   Access to outdoors → QOL

(Simultaneous estimation of the effects)

Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
outdoorC	1	378	66.73	<.0001
FacilitySize_CMS_Cat	3	535	0.47	0.7018

Does Facility Size <u>moderate</u> 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 <u>resident-level</u> predictor on QOL and <u>facility-level</u> predictor on QOL, we can test whether a facility-level variable MODERATES a resident-level relationship

Type 3 Tests of Fixed Effects				
Effect	Num DF	Den DF	F Value	Pr > F
outdoorC	1	373	4.43	0.0359
FacilitySize_CMS_Cat	3	535	0.47	0.7020
outdoorC*FacilitySiz	3	373	2.90	0.0351

This is called a <u>cross-level interaction</u>

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 facilties

  - 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
  - Kreft, I., & de Leeuw, J. (1999). *Introducing multilevel modeling*. Thousand Oaks, CA: Sage.
- Software
  - R, SPSS, SAS, Stata, Mplus, HLM, LISREL, SUDAAN

Thank you