Trajectories in ADL disability among China's oldest-old

Zachary Zimmer (University of Utah)
Daniel S. Nagin (Carnegie Mellon)
Linda G. Martin (RAND)
Bobby L. Jones (Carnegie Mellon)

Introduction

* Disability a dynamic process

* Much research examines disability transitions (2 points in time)

* Transitions useful for determining ‘Active Life Expectancies’

* Transitions inadequate for comprehending the total dynamic

* Need to move to examining disability trajectories

* Examining disability trajectories challenging:

    a) Requires longitudinal data

    b) Requires different methodological approaches

Previous studies of disability trajectories

* Few

* Some rely on subjective groupings

* Tend to stratify analyses by survivor/decedents

Current study

* Investigate disability trajectories among the oldest-old in China

* China important setting due to rapid aging of its population

* Oldest-old (80+) interesting because changes likely to occur over short periods of time

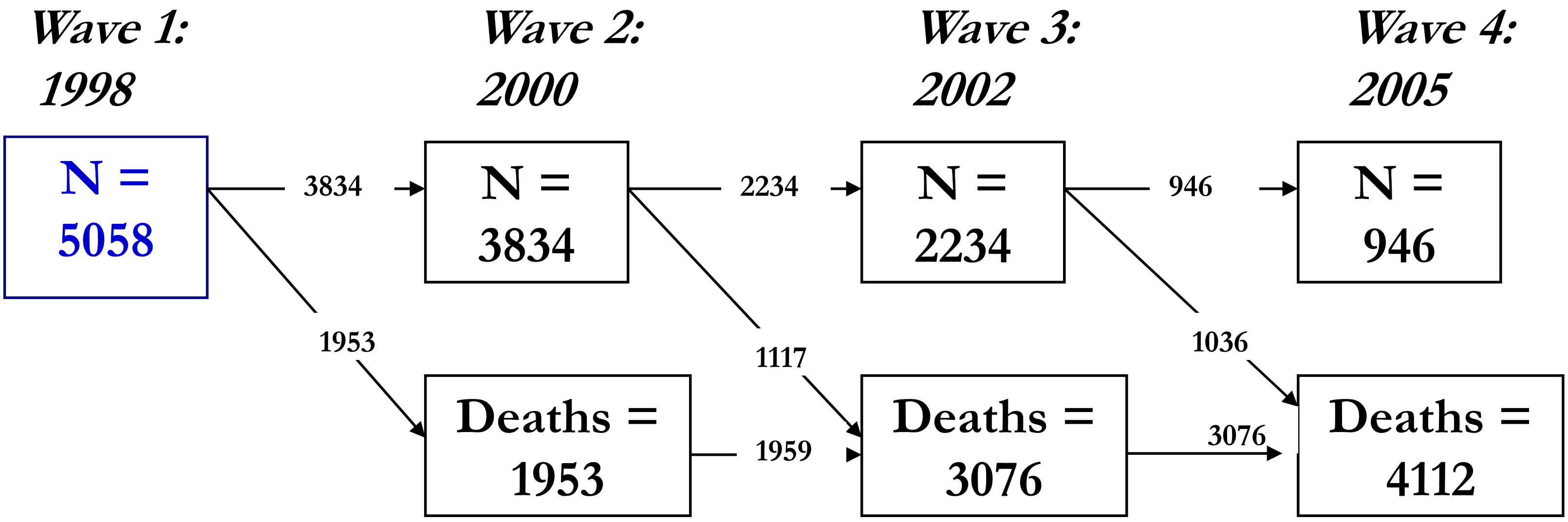
* Application of group-based trajectory modeling using software developed by co-authors (Nagin and Jones)

* Identify common trajectories and examine characteristics of people within trajectory groups

Dataset

- Chinese Longitudinal Healthy Longevity Survey
- Conducted in 22 Chinese provinces (of 34 provincial-level administrative units in China)
- Waves 1998, 2000, 2002 and 2005
- Age 80 to 105 at baseline (N=8805)
- Oversampling at oldest ages
- Results weighted

Study sample



Study sample:

* Aged 80 to 99

* Not lost to follow-up

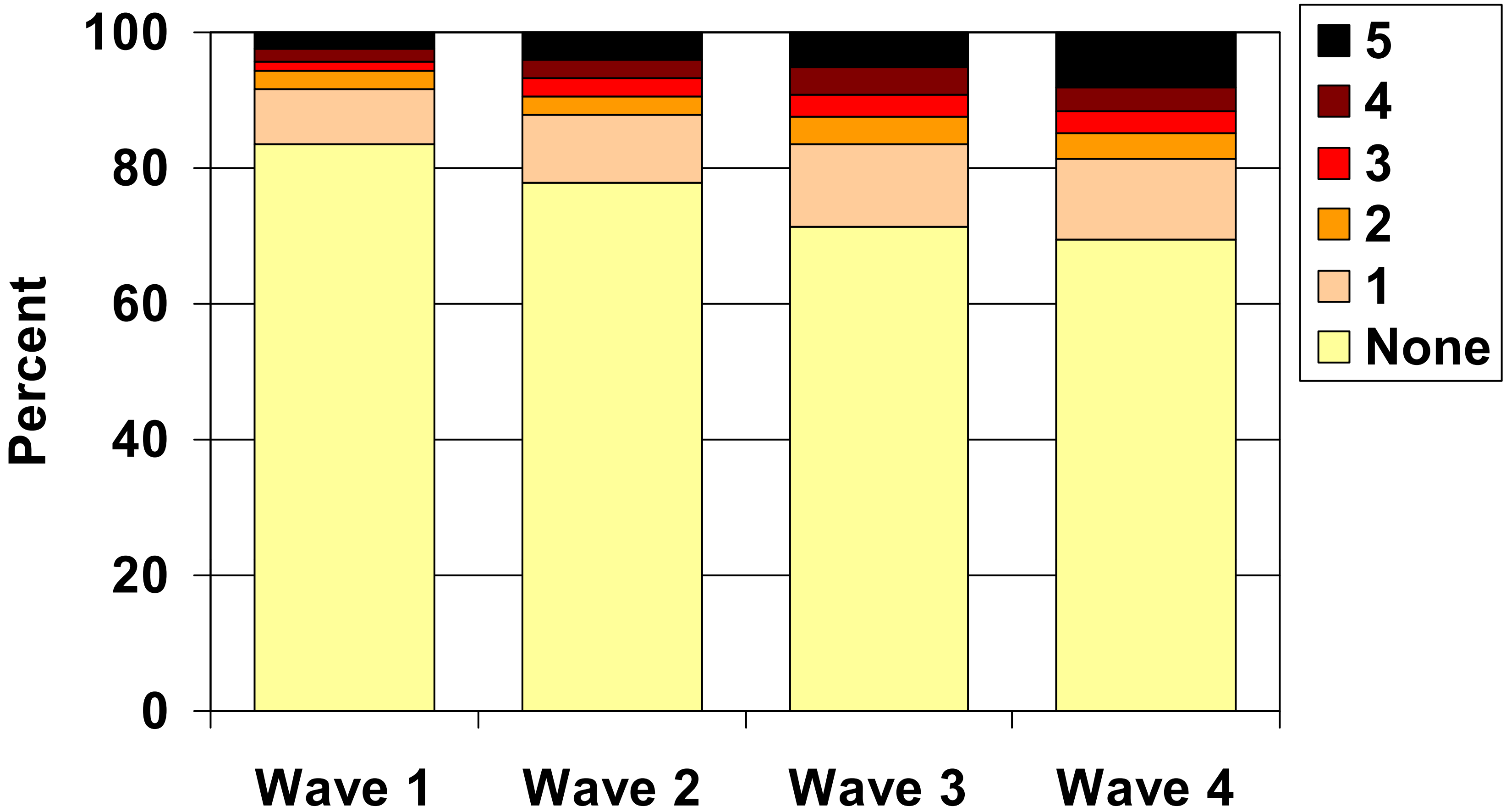
* Full disability information

Measuring disability

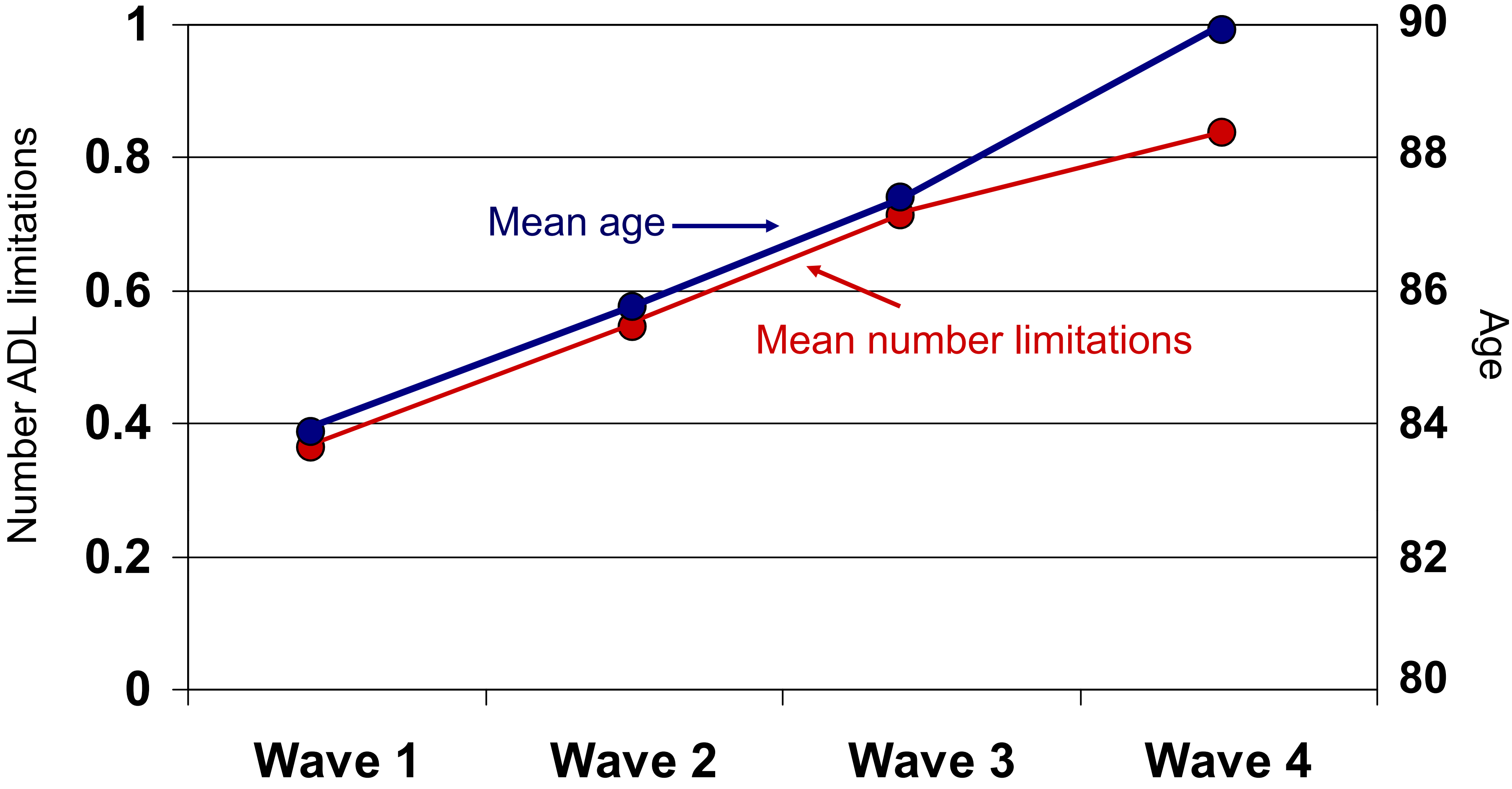
Disability defined as number of ADL limitations from the following list:

1. **Bathing**
2. **Moving inside the house**
3. **Feeding**
4. **Dressing**
5. **Using toilet**

Distribution of number of limitations by wave



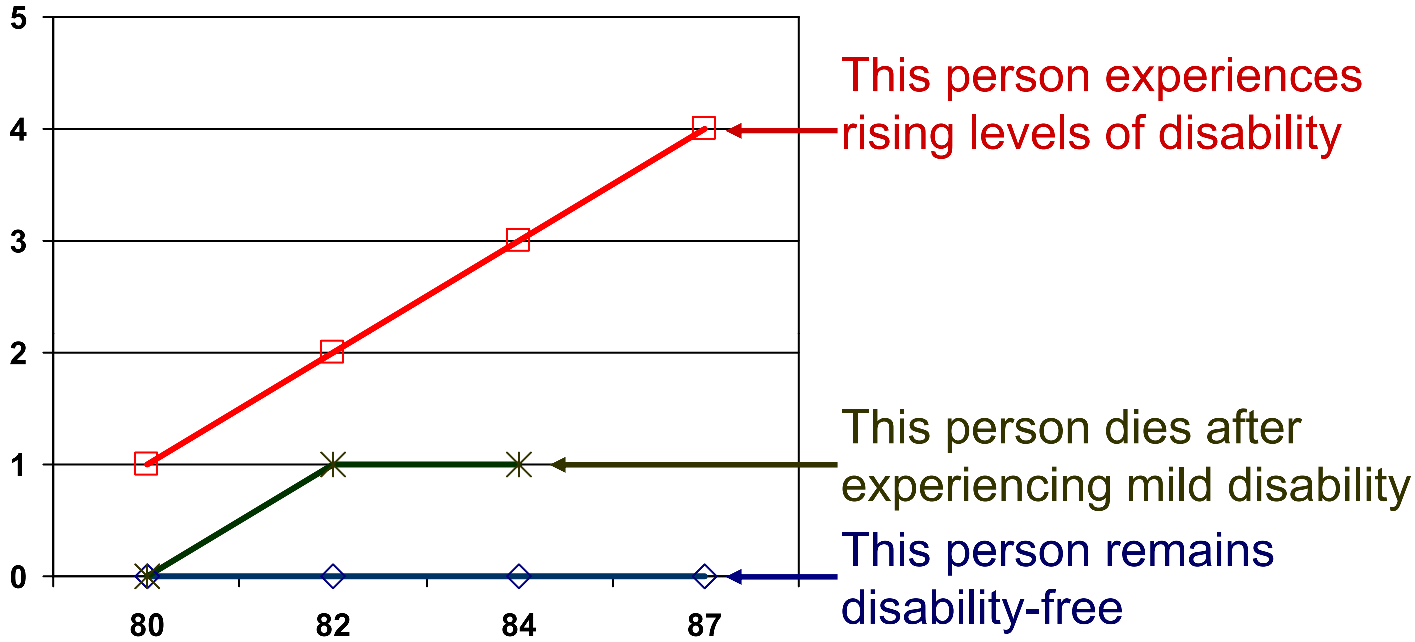
Mean number ADL limitations and mean age by wave



Examining disability trajectories

A disability trajectory is a pathway that describes the number of ADL limitations reported by individuals as they age from wave 1 to wave 4 for survivors or from wave 1 to death for decedents.

Example:



Distribution for most common pathways (0.5%+) among survivors (N=946)

wave 1	wave 2	wave 3	wave 4	Percent
0	0	0	0	56.7
0	0	0	1	7.1
0	0	0	5	2.9
0	0	1	0	2.8
0	0	1	1	2.2
0	0	0	2	1.9
0	1	0	0	1.9
0	0	2	0	1.6
0	0	0	3	1.4
0	0	0	4	1.3
0	0	3	0	0.8
1	0	0	0	0.8
0	0	1	5	0.6
0	1	1	1	0.5
1	0	1	0	0.5
2	0	0	5	0.5
0	0	1	4	0.5
2	0	0	0	0.5
0	0	1	3	0.5

TOTAL NUMBER POSSIBLE PATHWAYS = 1,296

Distribution for most common pathways (0.8%+) among decedents (N=4,112)

wave 1	wave 2	wave 3	wave 4	Percent
0	died	---	---	27.1
0	0	died	---	17.4
0	0	0	died	16.9
1	died	---	---	3.6
0	0	1	died	2.8
0	1	died	---	2.7
5	died	---	---	2.7
2	died	---	---	1.8
0	5	died	---	1.6
0	0	5	died	1.3
0	4	died	---	1.2
4	died	---	---	1.2
3	died	---	---	1.1
0	0	2	died	1.1
0	1	0	died	0.9
0	2	died	---	0.9
0	0	4	died	0.9
0	0	3	died	0.8

TOTAL NUMBER POSSIBLE PATHWAYS = 258

Challenges

* On average, number ADLs increase over time

* Not everyone is ‘average’ - people experience different individual trajectories

* In total, 1,554 possible individual trajectories

* Number of possible trajectories in a dataset shrink or grow depending on number of states being monitored and waves

* Goal of modeling to identify groups of people that follow distinctive ADL patterns

Group-based modeling

* ‘Group-based modeling’ designed to identify clusters of individuals following approximately the same trajectory as they age

* Technique specialized application of finite mixture modeling

* Software a modification of PROC TRAJ (developed by co-authors Nagin and Jones)

* Basic software downloadable at: www.andrew.cmu.edu/user/bjones/index.htm

Groups estimated using a likelihood function

$$P(Y_i) = \sum_j \pi_j(x_i) P^j(Y_i)$$

$P^J(Y_i)$ = probability of Y_i given membership in group j

π_j= probability of membership in group j

$$\pi_j(x_i) = e^{x_i \theta_j} \Big/ \sum e^{x_i \theta_j}$$

$$L = \prod^N P(Y_i).$$

Predicted number ADLs estimated using a zero-inflated Poisson model for counts

$$p(x) = \begin{cases} 0 \; with \;\; probabilit \;\; y \;\; \rho \\ Poisson \; (\lambda) \; with \;\; probabilit \;\; y \; 1 - \rho \end{cases}$$

$$\ln(\lambda) = \beta_0 + \beta_1 age + \beta_2 age^2 + \beta_3 age^3$$

$$\rho = \frac{e^{\alpha_0 + \alpha_1 age + \alpha_2 age^2 + \alpha_3 age^3}}{1 + e^{\alpha_0 + \alpha_1 age + \alpha_2 age^2 + \alpha_3 age^3}}$$

Outputs for each ADL trajectory group

Number of distinct trajectories that define the expected number of ADLs as a function of age

Proportion of the sampled population following each trajectory

Probability of loss due to death by age for each group (latest innovation)

Key references

Jones, B. and D.S. Nagin. 2007. "Advances in Group-based Trajectory Modeling and a SAS Procedure for Estimating Them," *Sociological Research and Methods,* 35: 542-571.

Jones, B., D.S. Nagin. And K. Roeder. 2001. "A SAS Procedure Based on Mixture Models for Estimating Developmental Trajectories." *Sociological Research and Methods,* 29: 374-393.

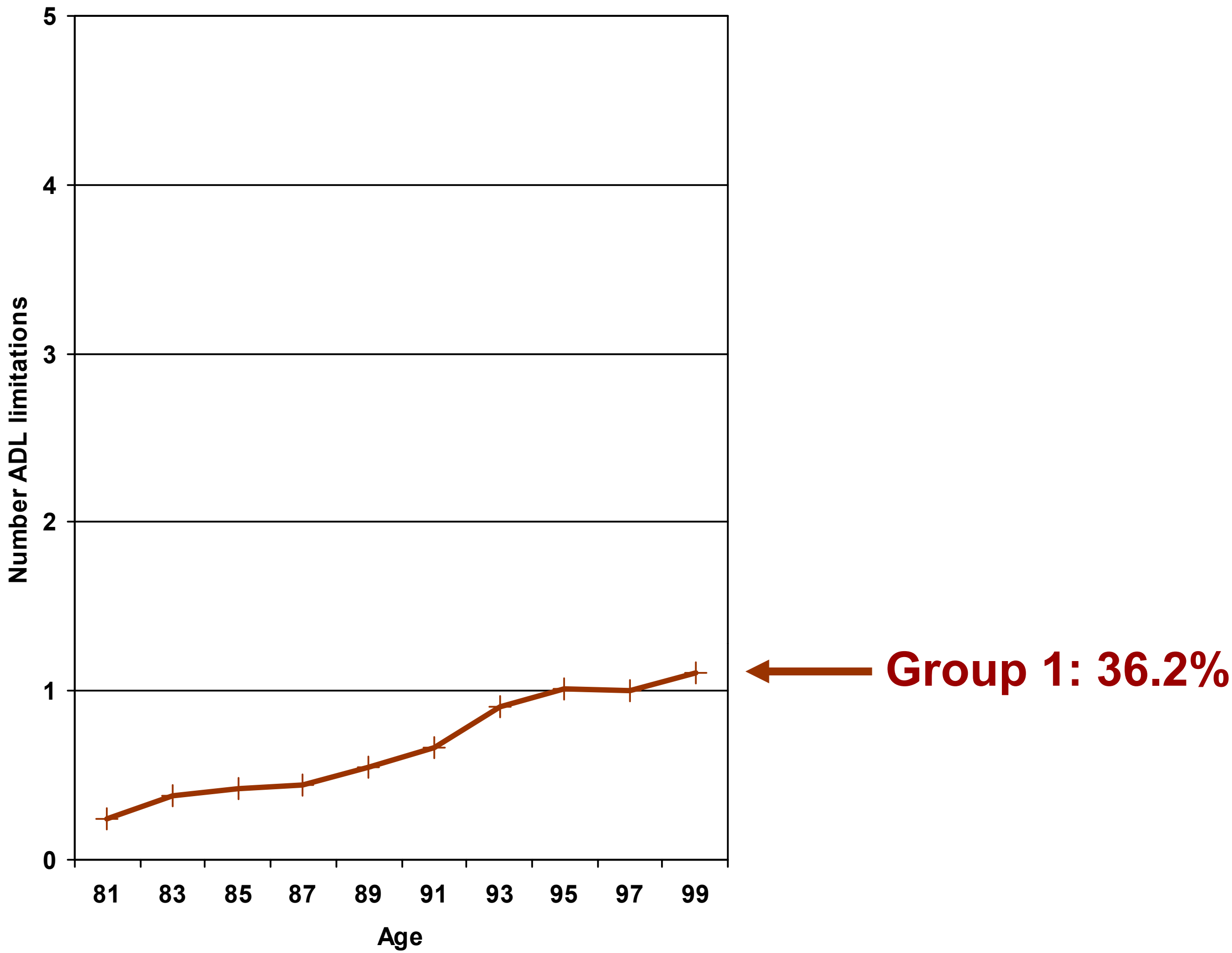
Nagin, D. S. 2005. *Group-based Modeling of Development*. Cambridge, MA.: Harvard University Press.

Nagin, D. S. 1999. "Analyzing Developmental Trajectories: A Semi-parametric, Group-based Approach." *Psychological Methods*, 4: 139-177.

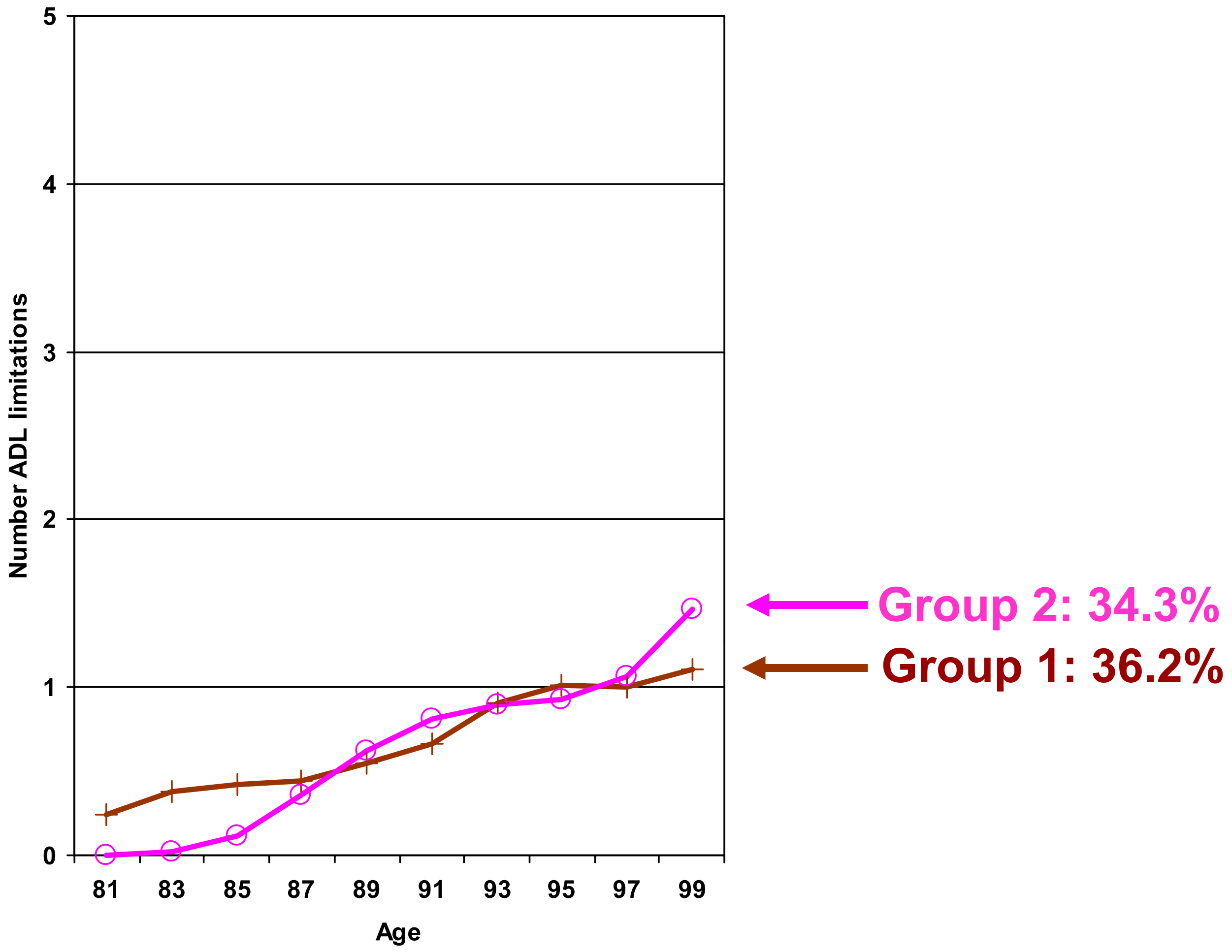
Nagin, D.S. and R. E. Tremblay. 2005. "Developmental Trajectory Groups: Fact or a Useful Statistical Fiction?." *Criminology,* 43:873-904.

Nagin, D. S., and R. E. Tremblay. 2001. "Analyzing Developmental Trajectories of Distinct but Related Behaviors: A Group-based Method." *Psychological Methods*, 6(1): 18-34.

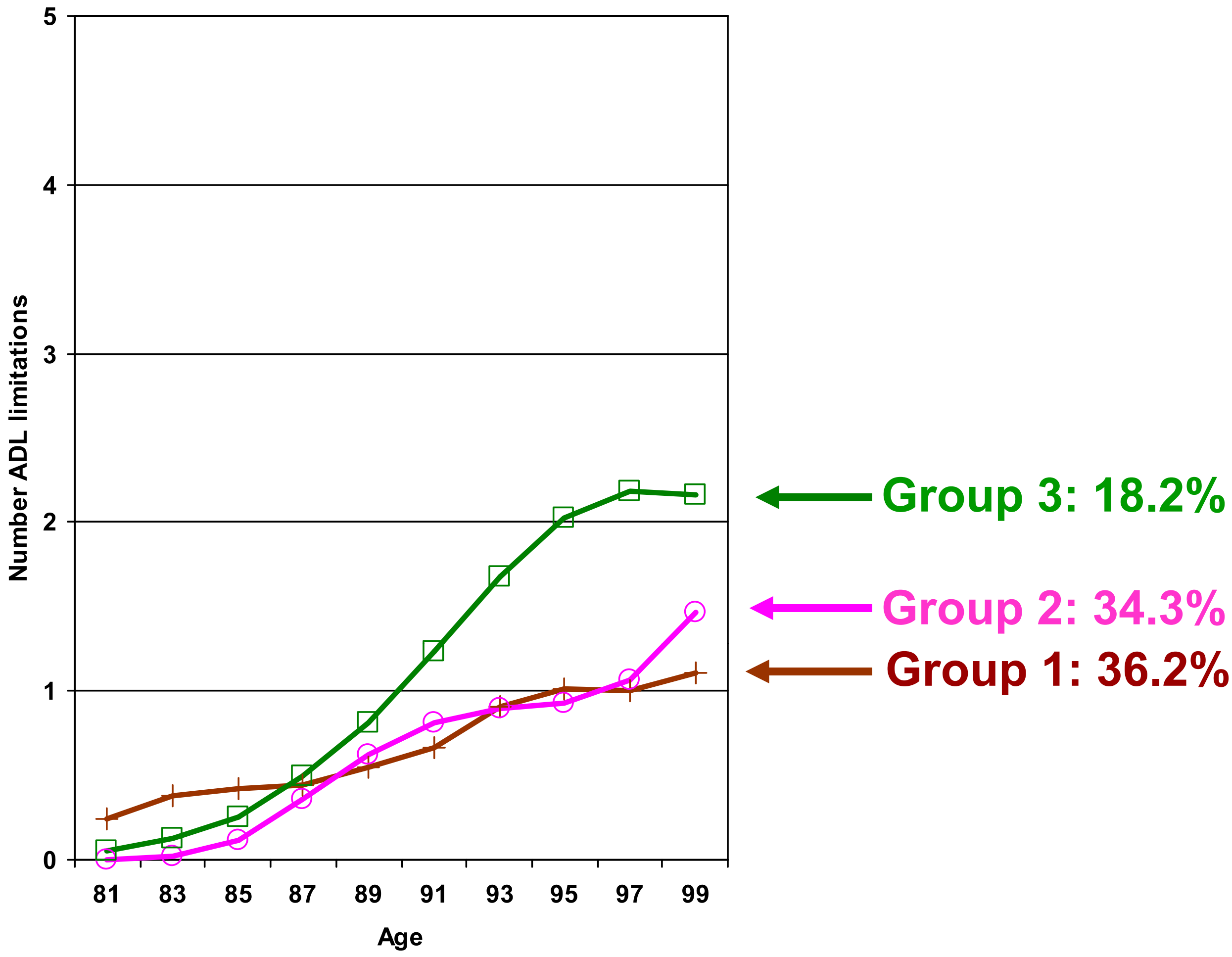
Predicted trajectories - Females



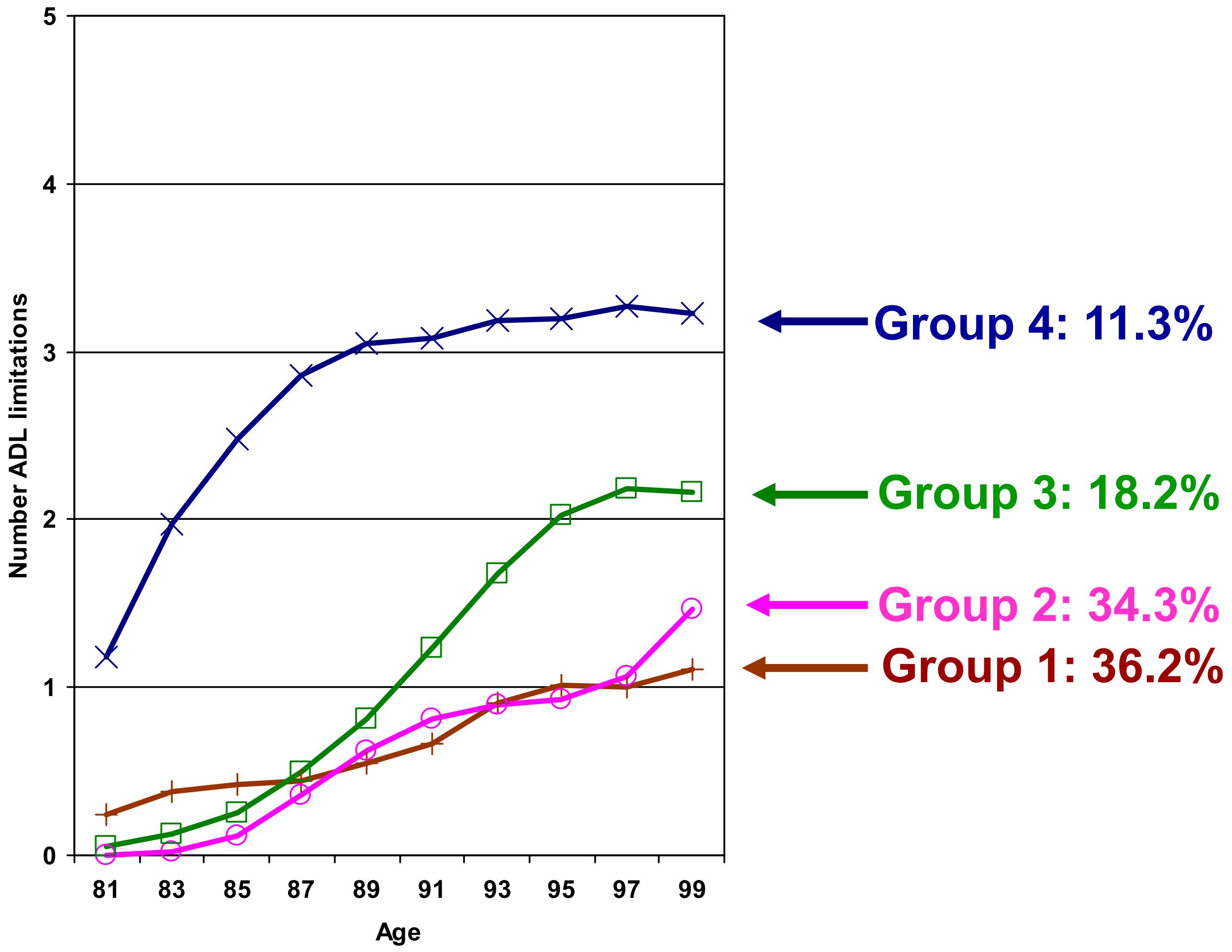
Predicted trajectories - Females



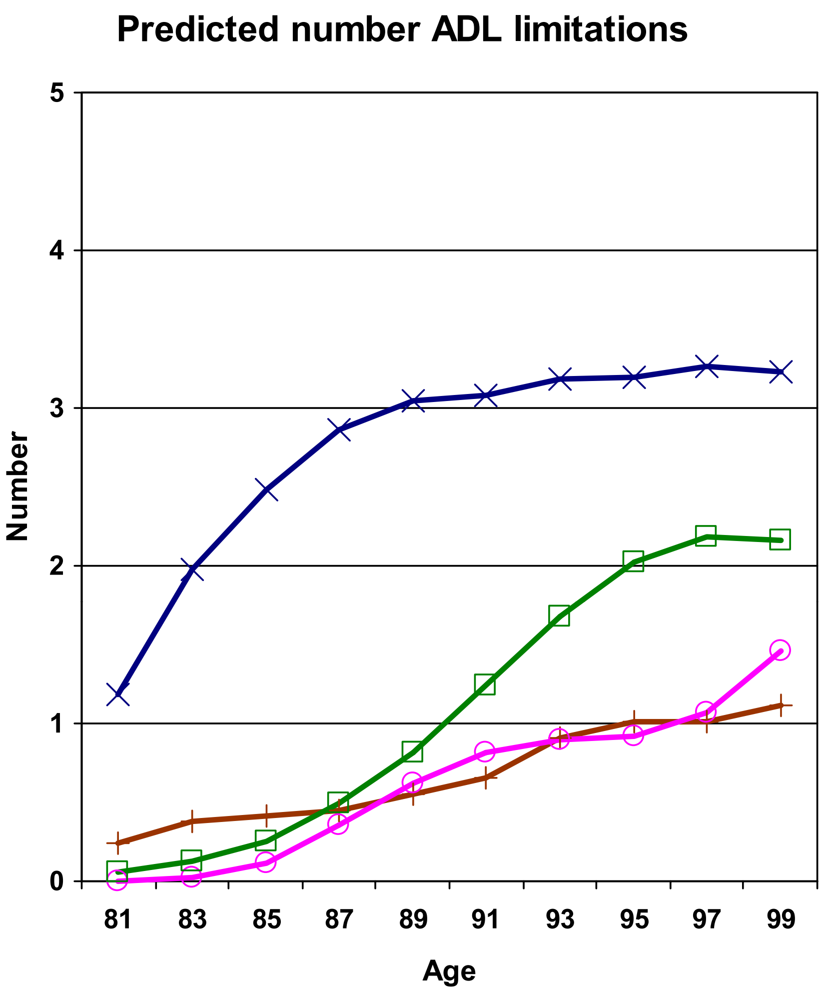
Predicted trajectories - Females

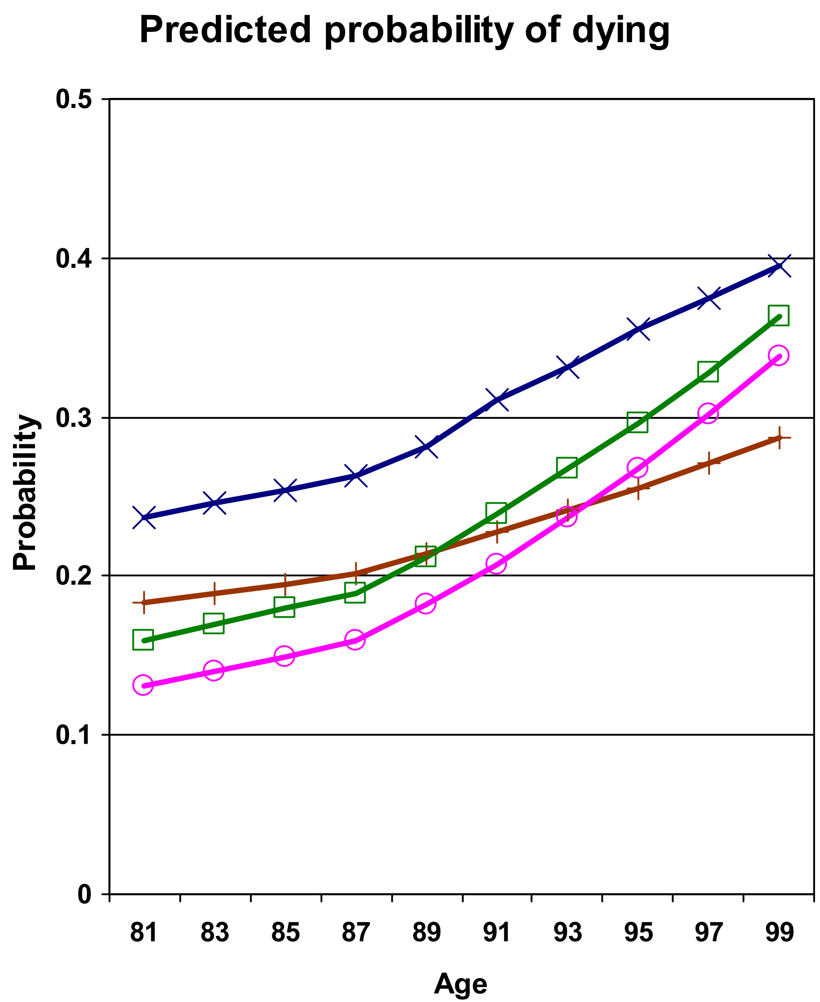


Predicted trajectories - Females

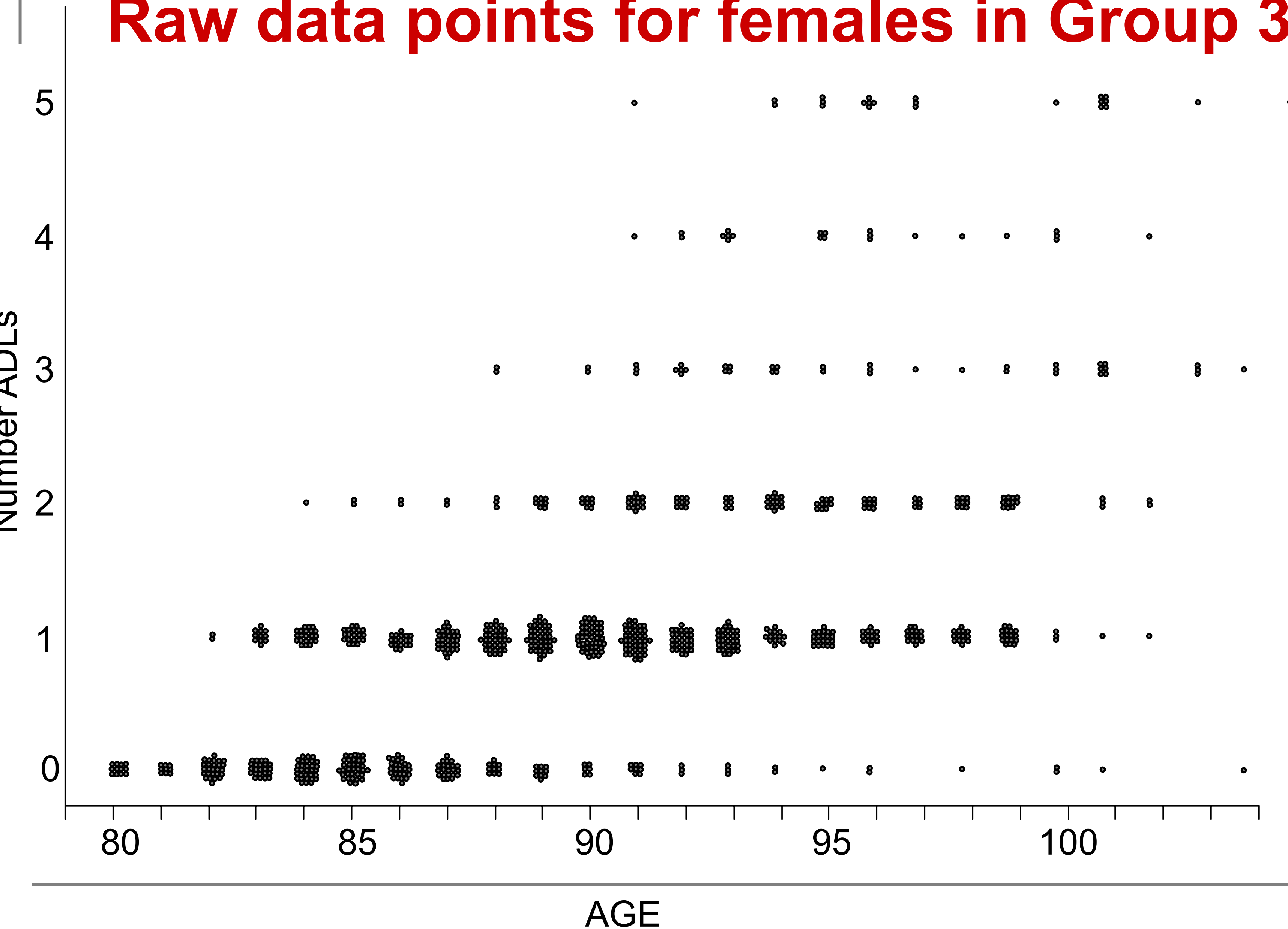


Predicted trajectories and probability of dying - Females

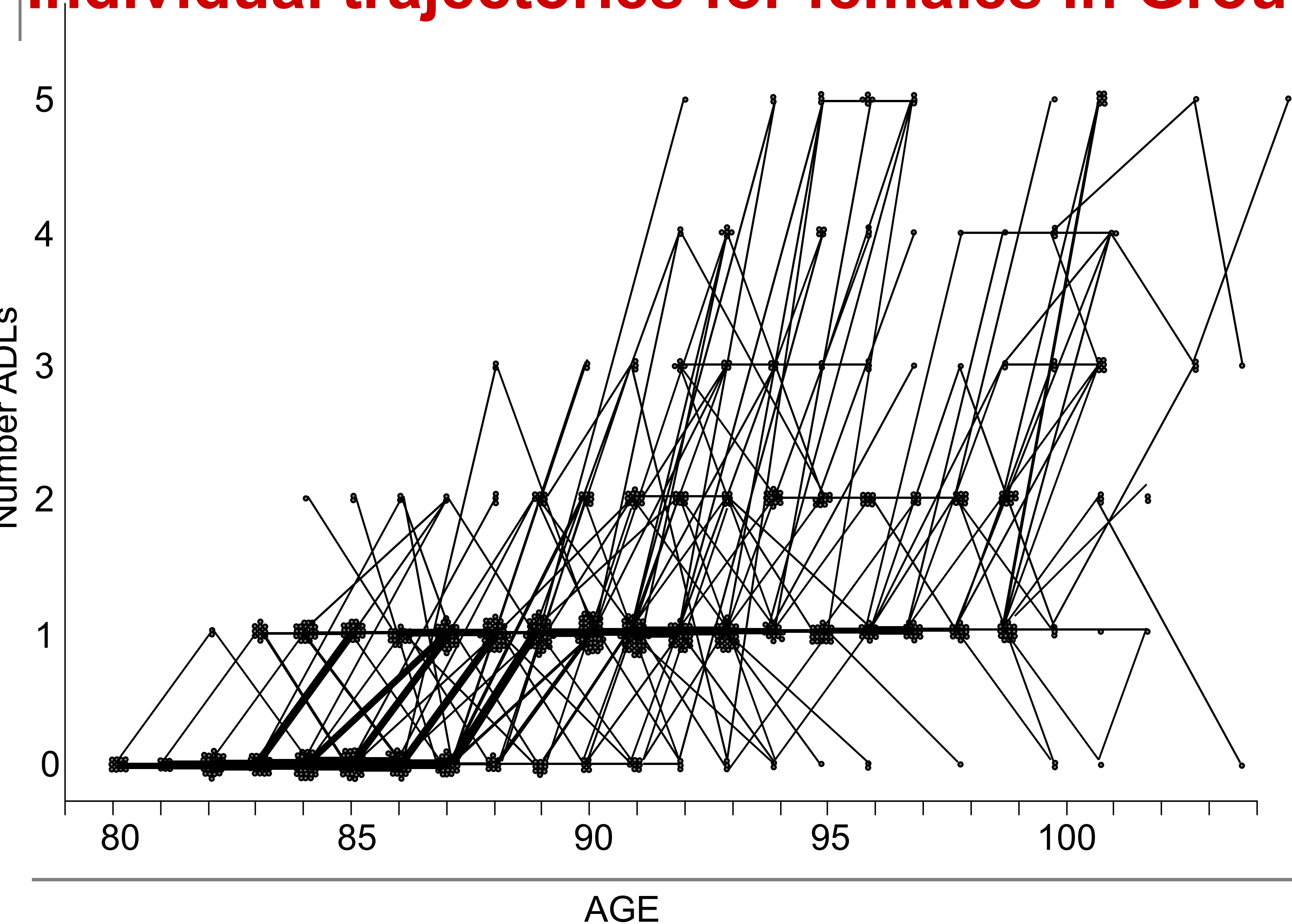




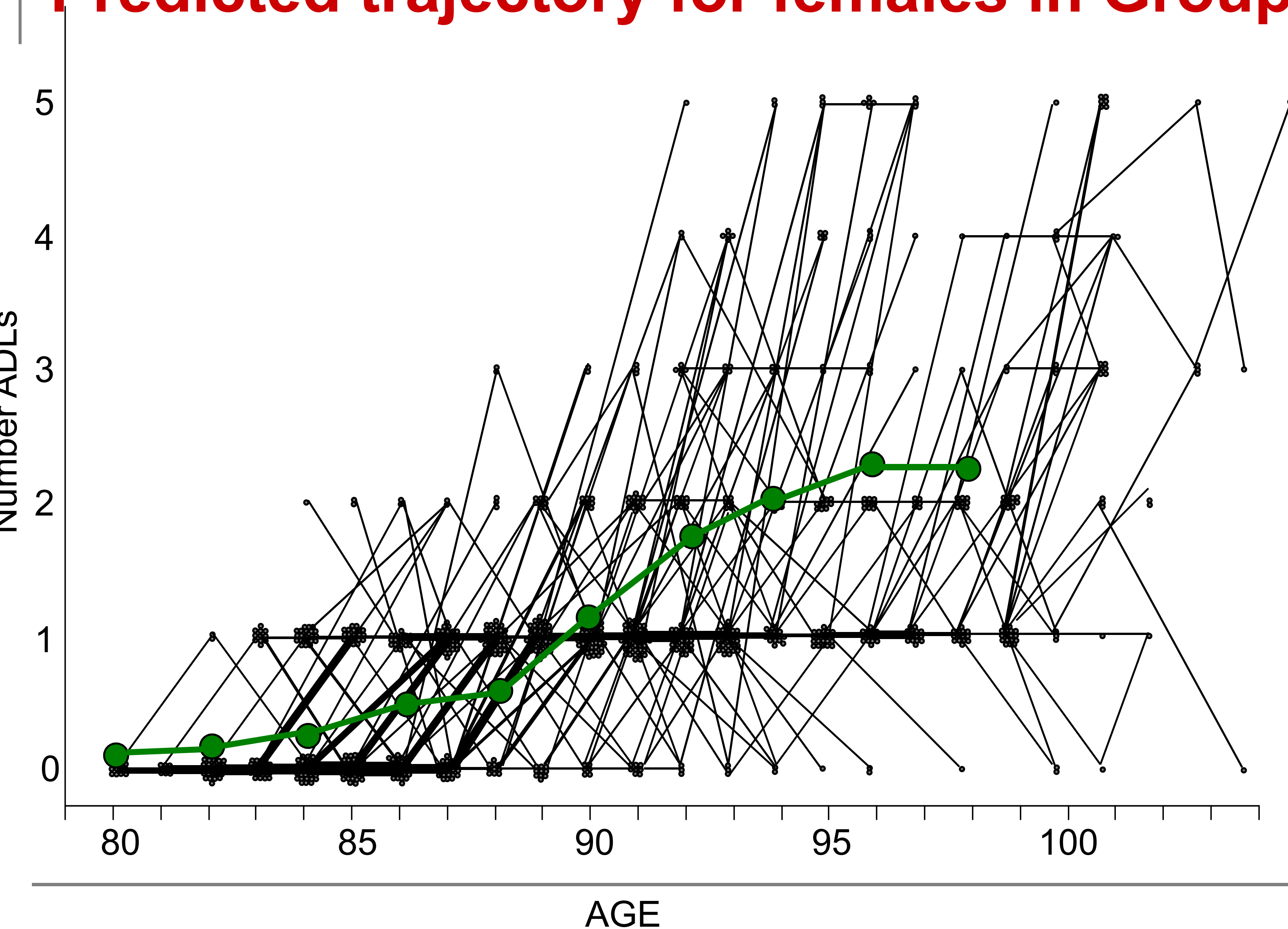
Raw data points for females in Group 3



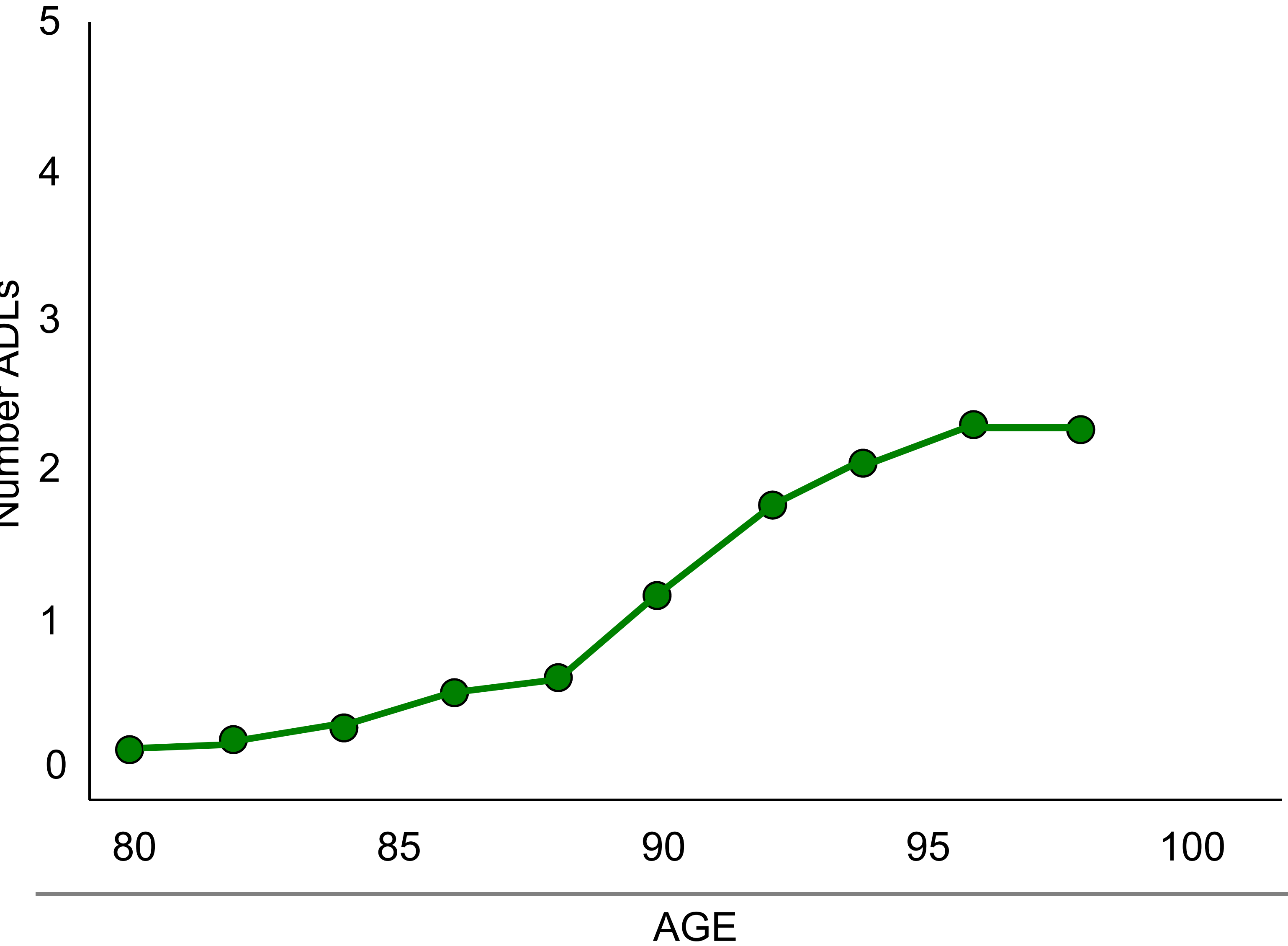
Individual trajectories for females in Group 3



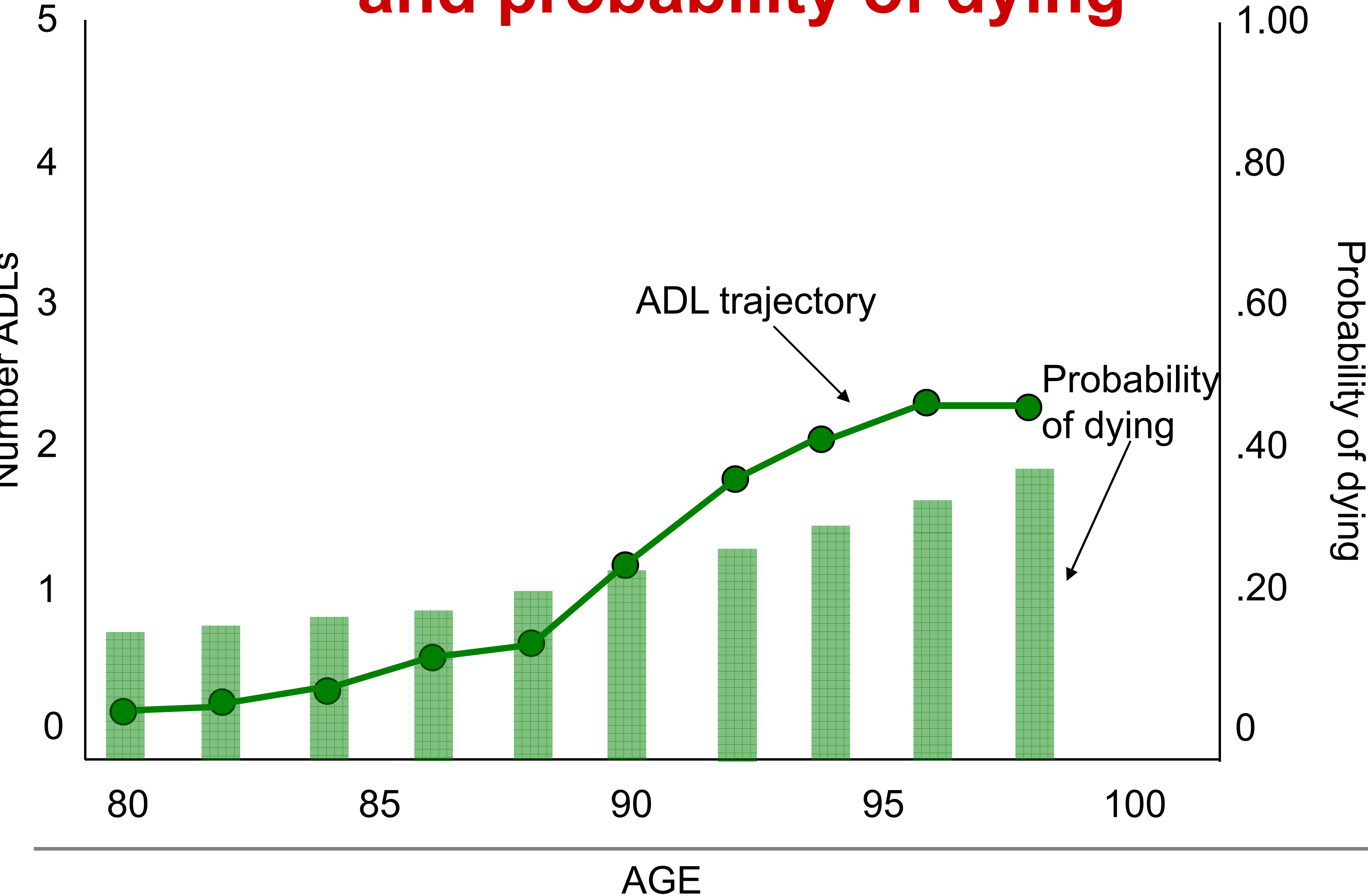
Predicted trajectory for females in Group 3



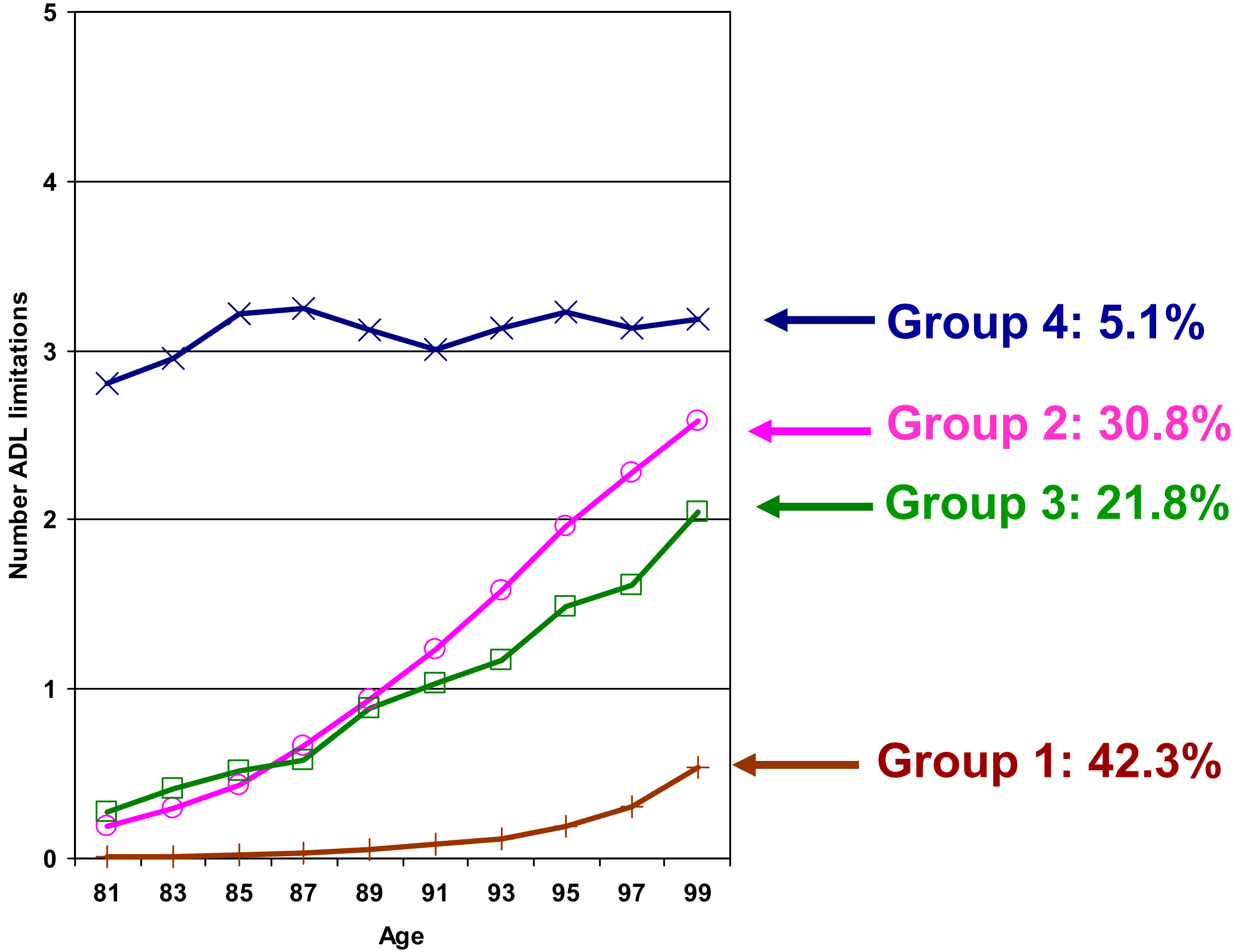
Predicted trajectory for females in Group 3



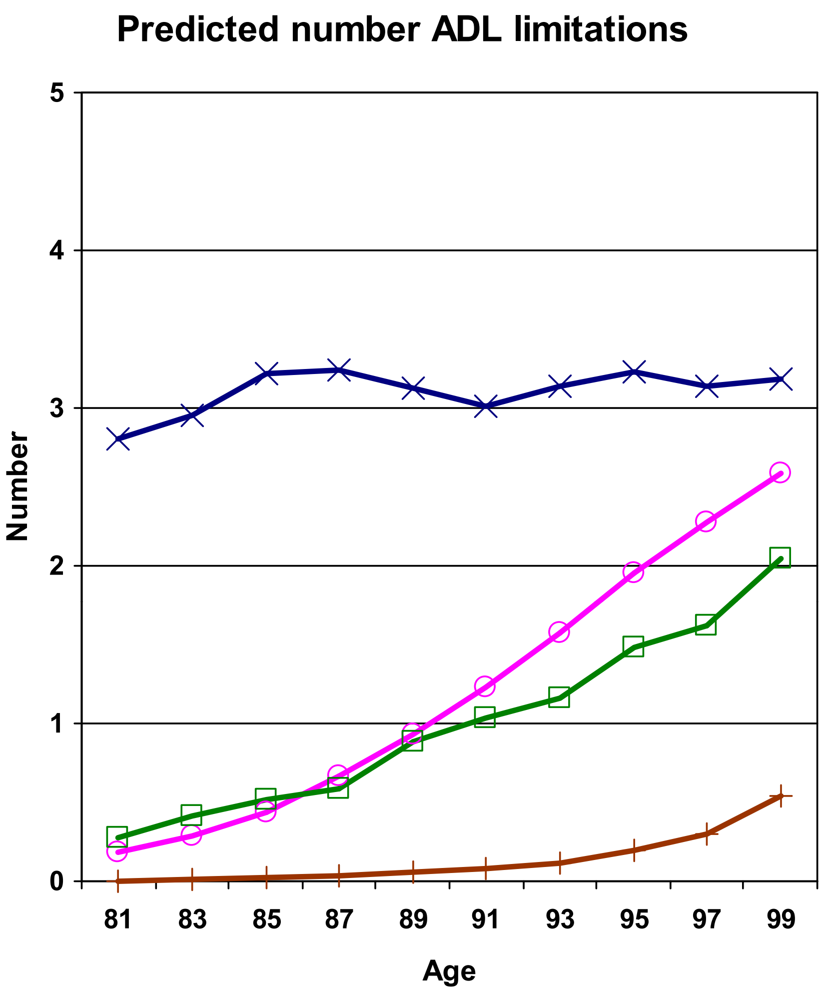
Predicted trajectory for females in Group 3 and probability of dying

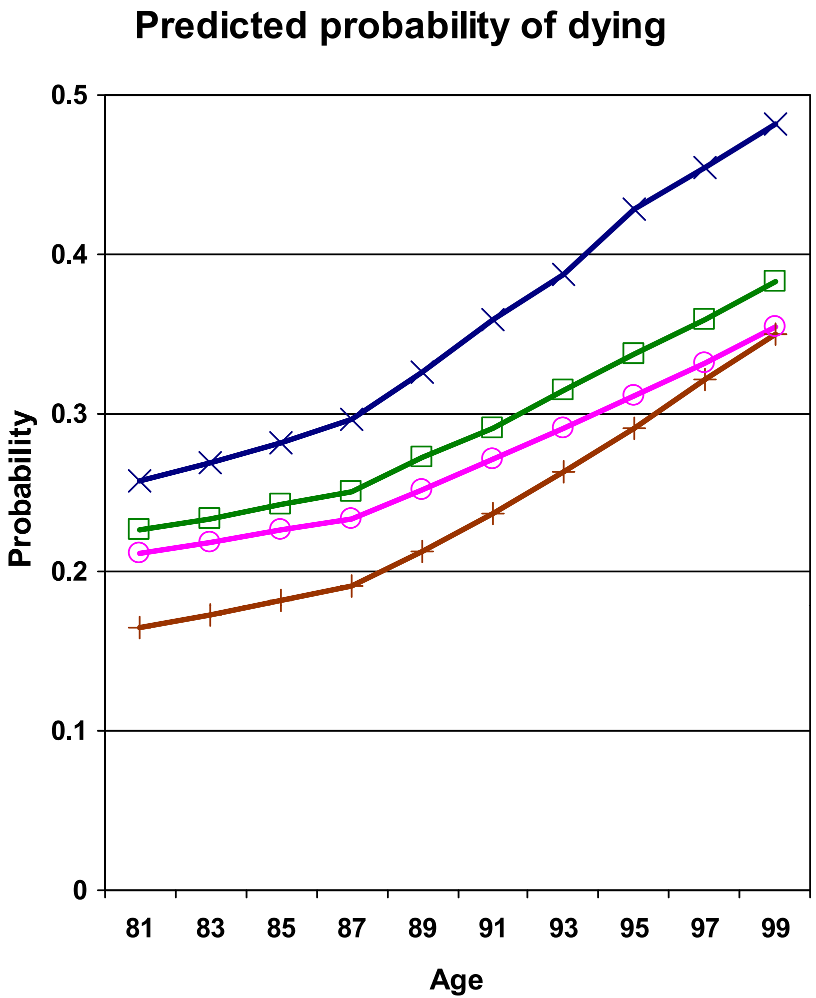


Predicted trajectories - Males

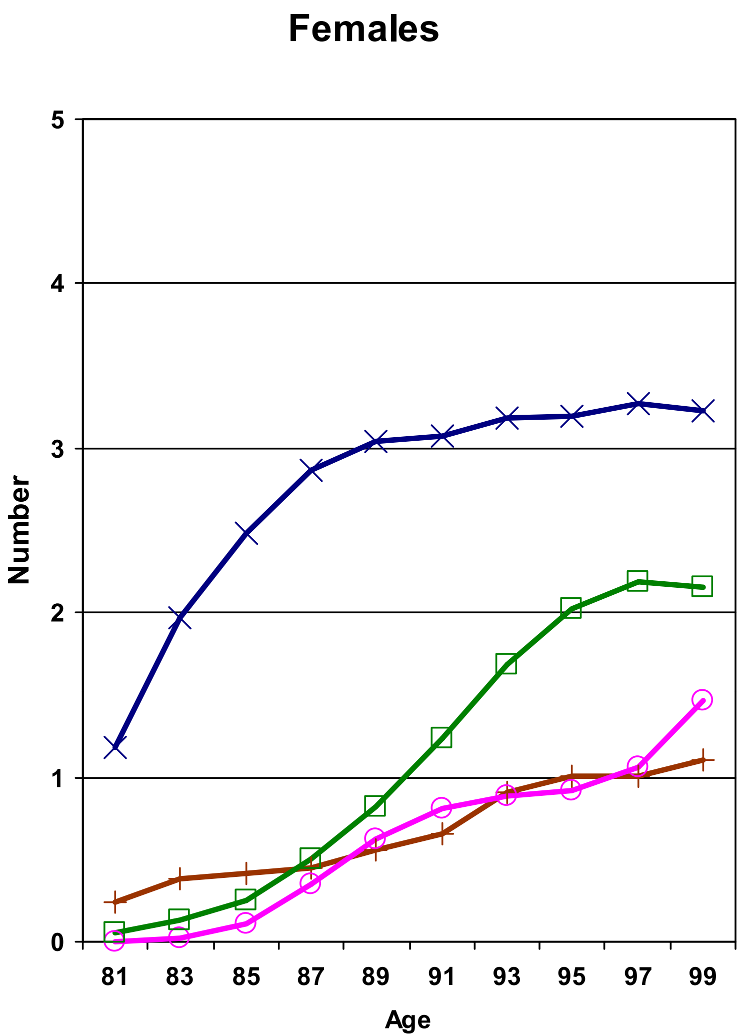


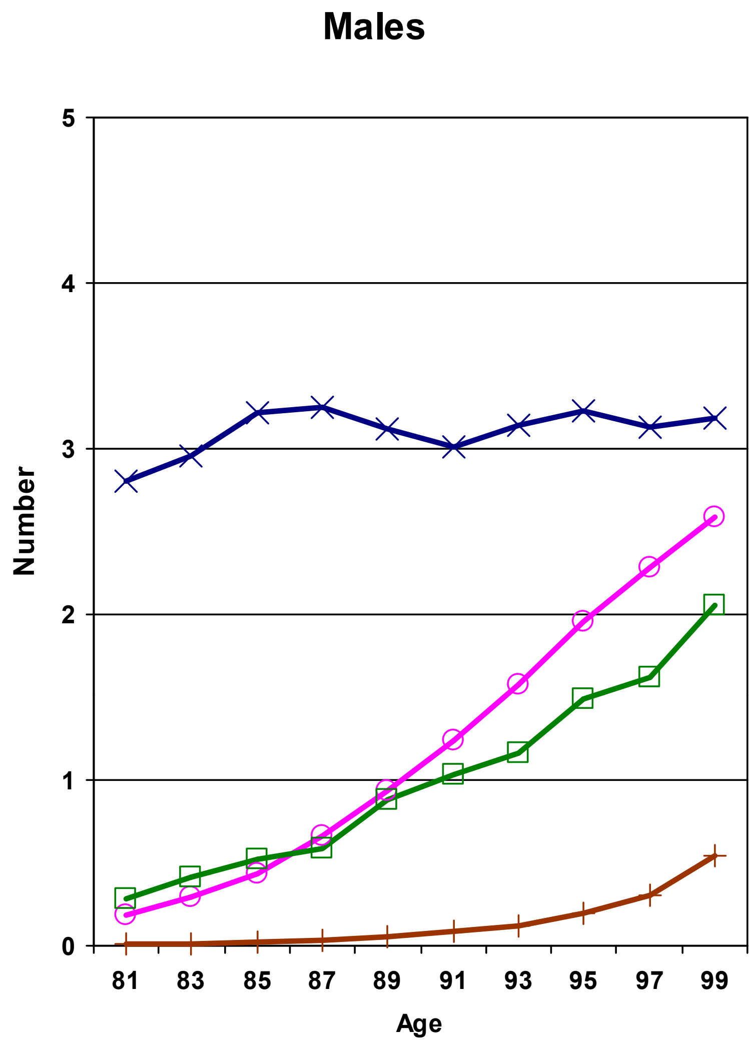
Predicted trajectories and probability of dying - Males



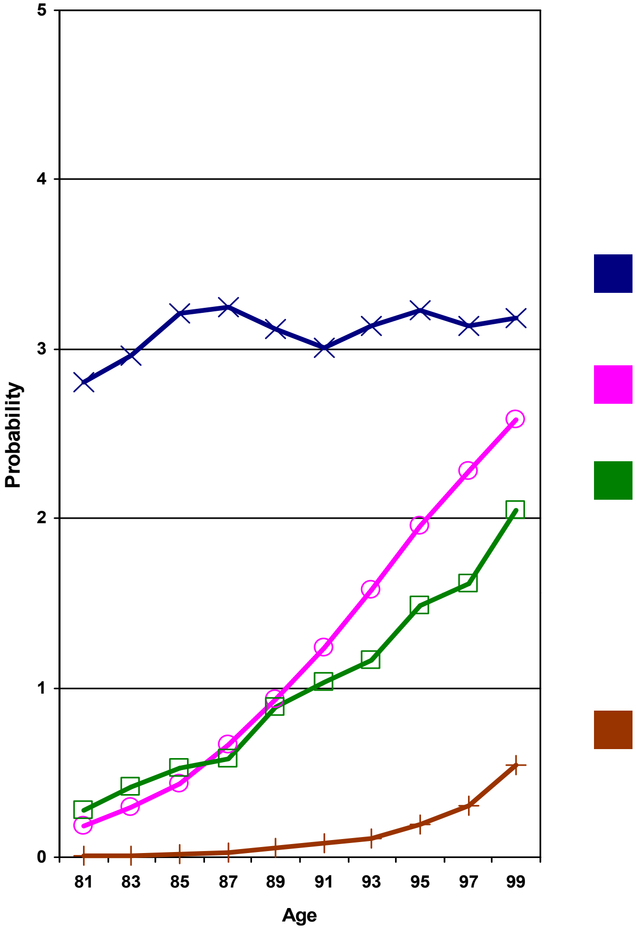


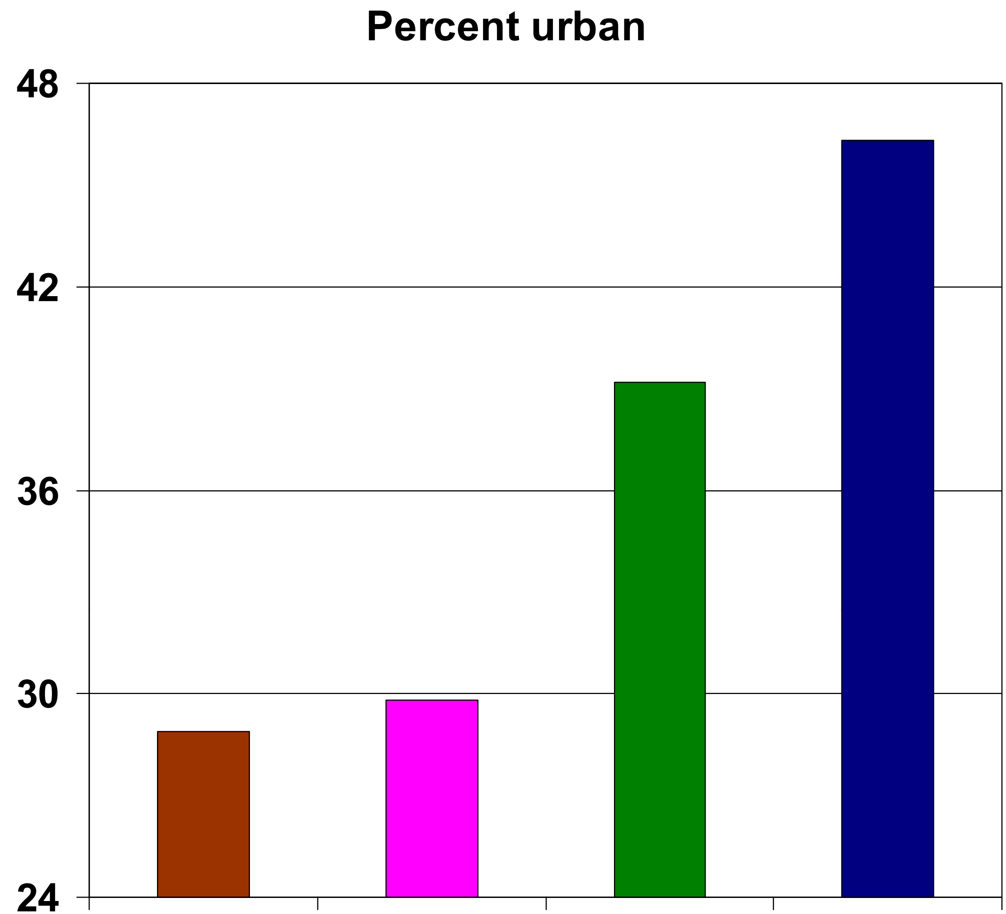
Comparing predicted trajectories



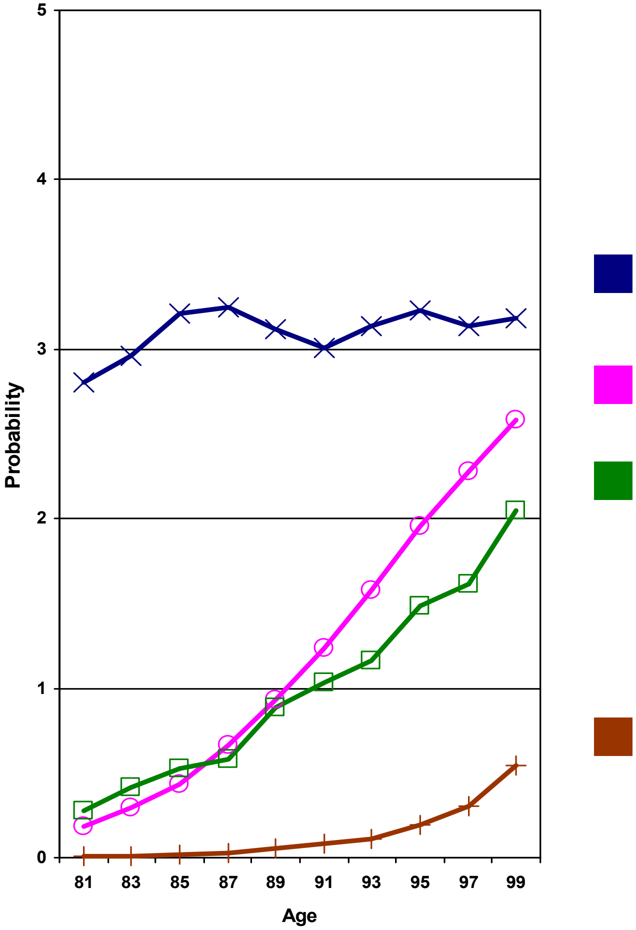


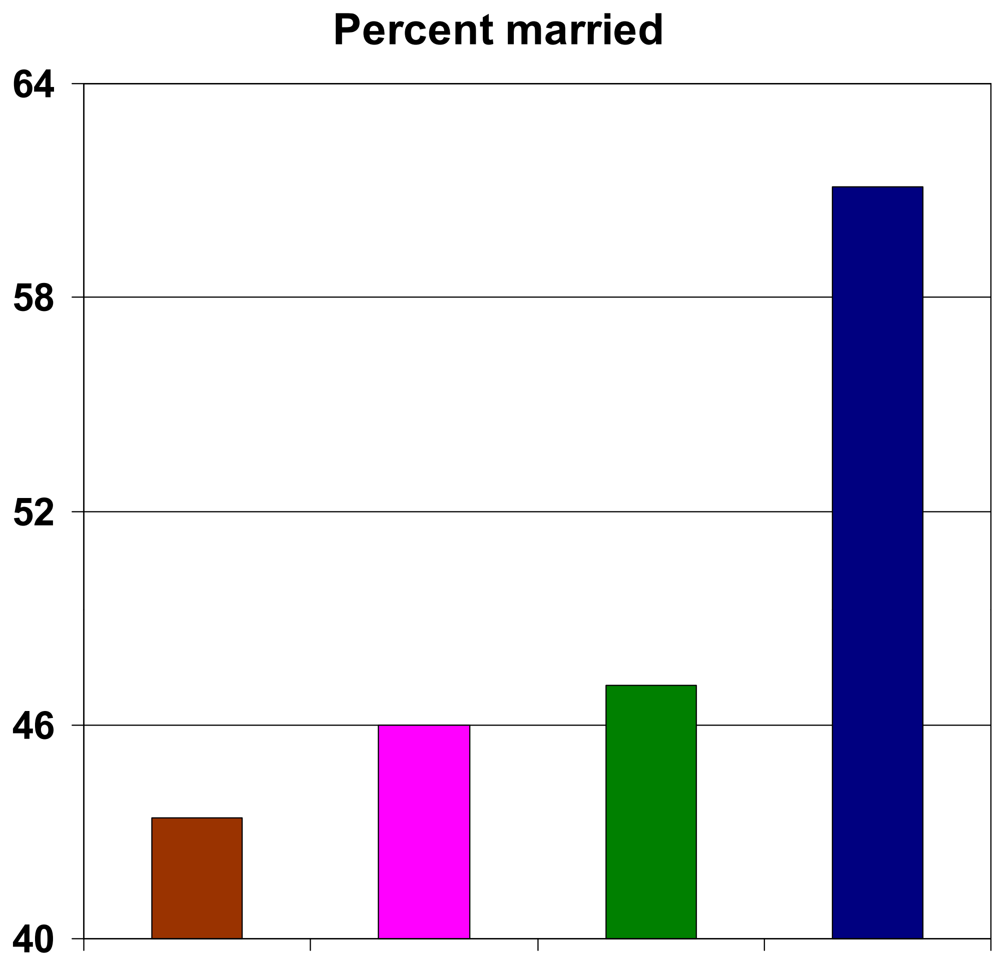
Selected characteristics of trajectory groups – males



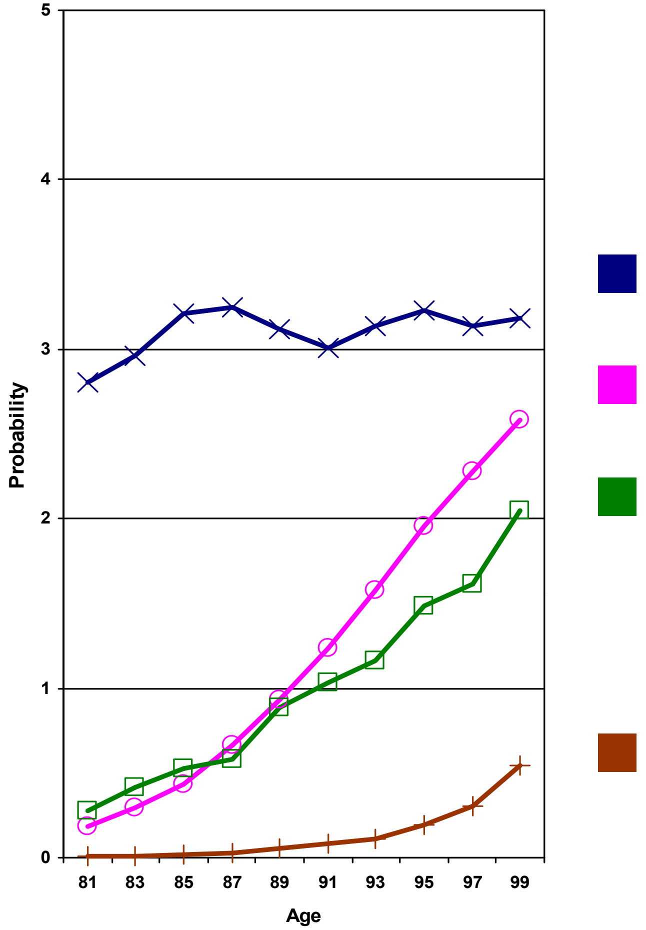


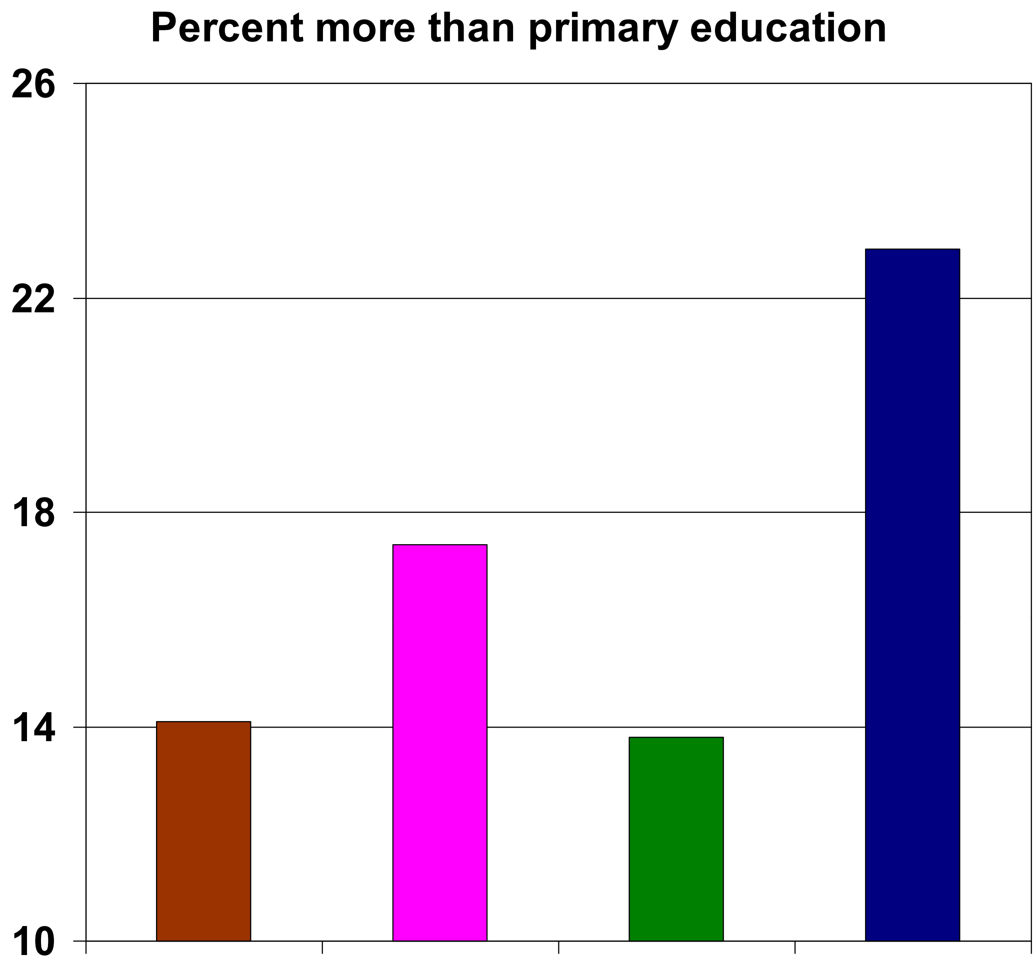
Selected characteristics of trajectory groups – males



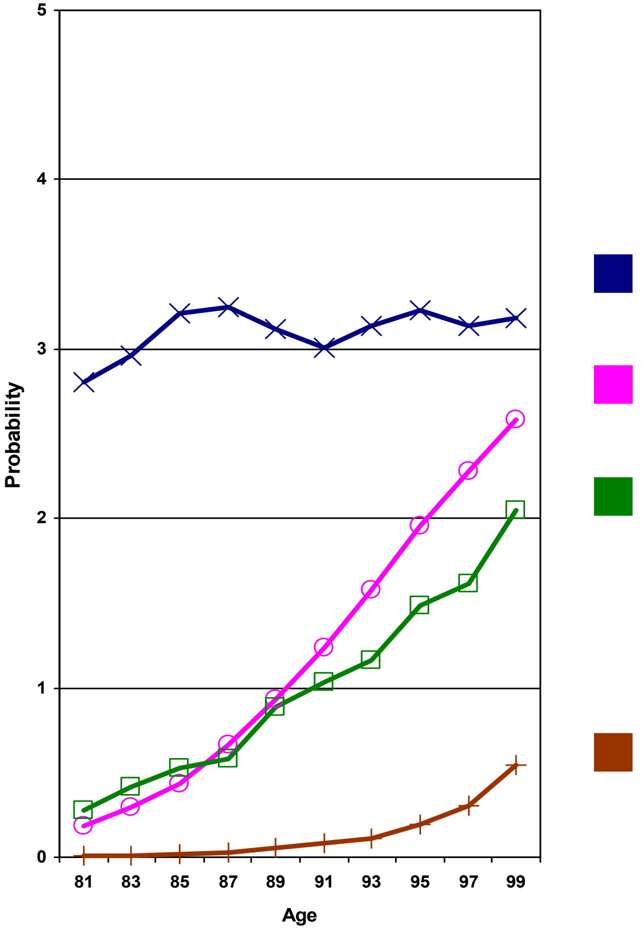


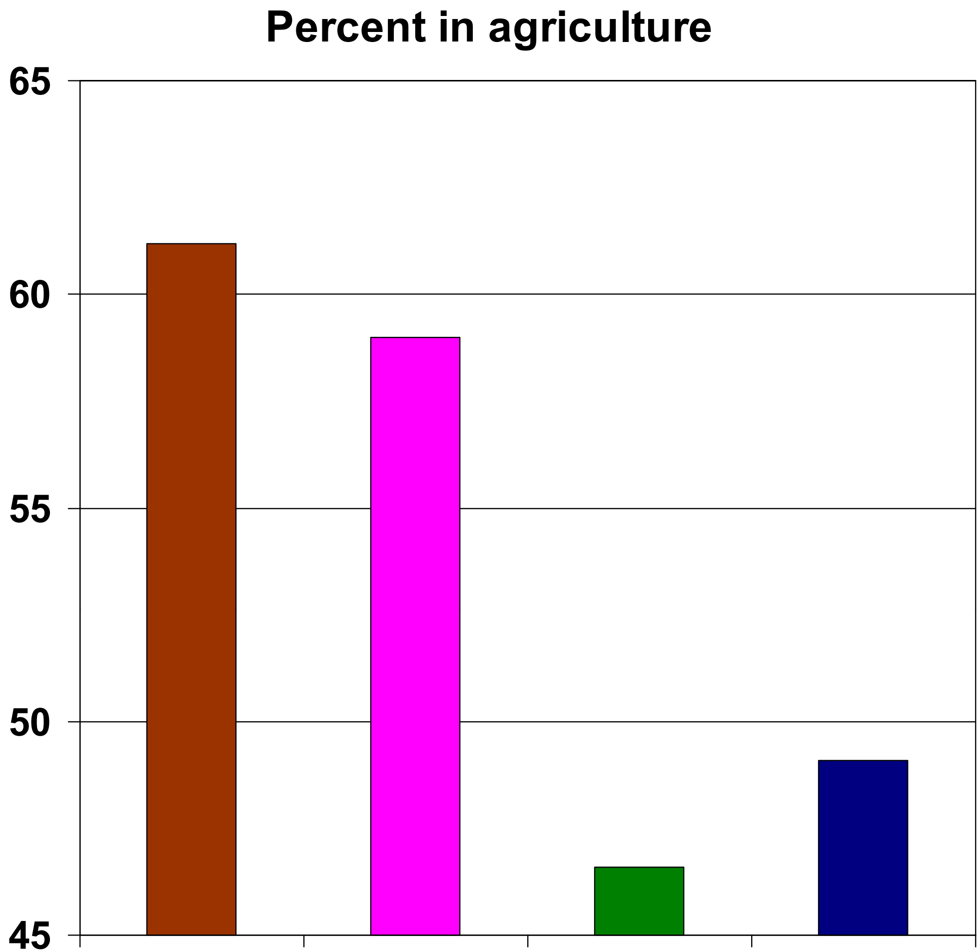
Selected characteristics of trajectory groups – males



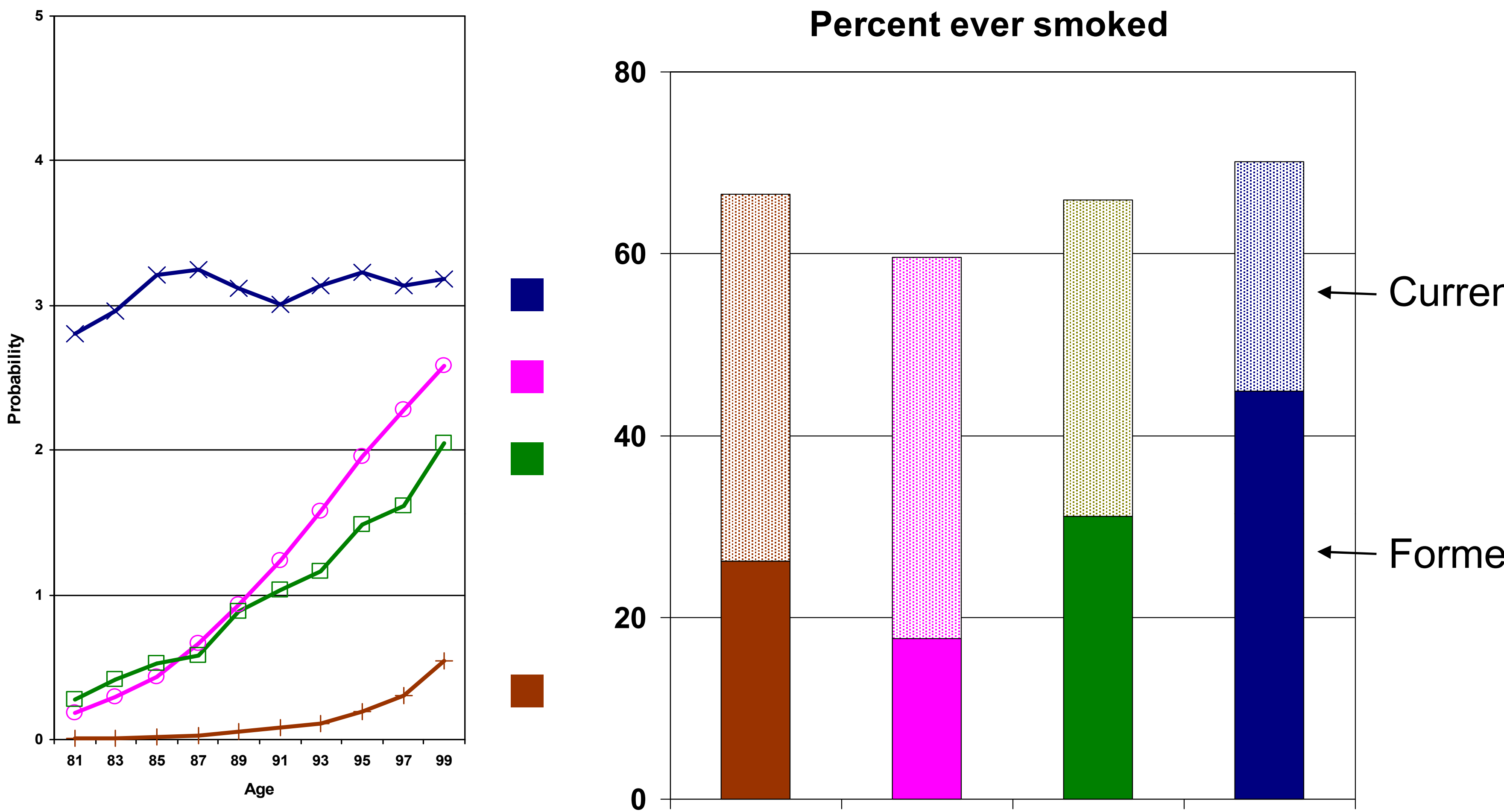


Selected characteristics of trajectory groups – males

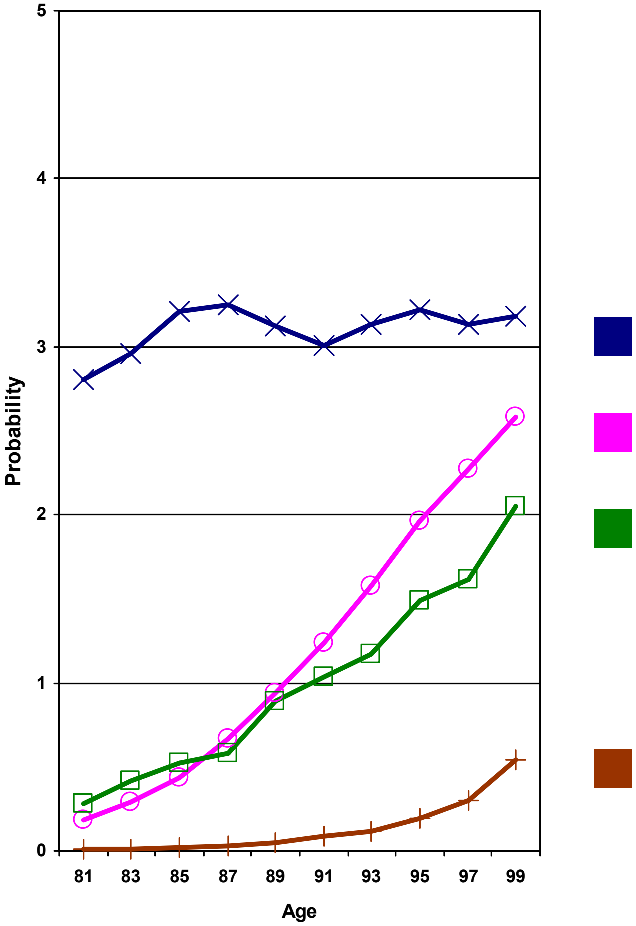


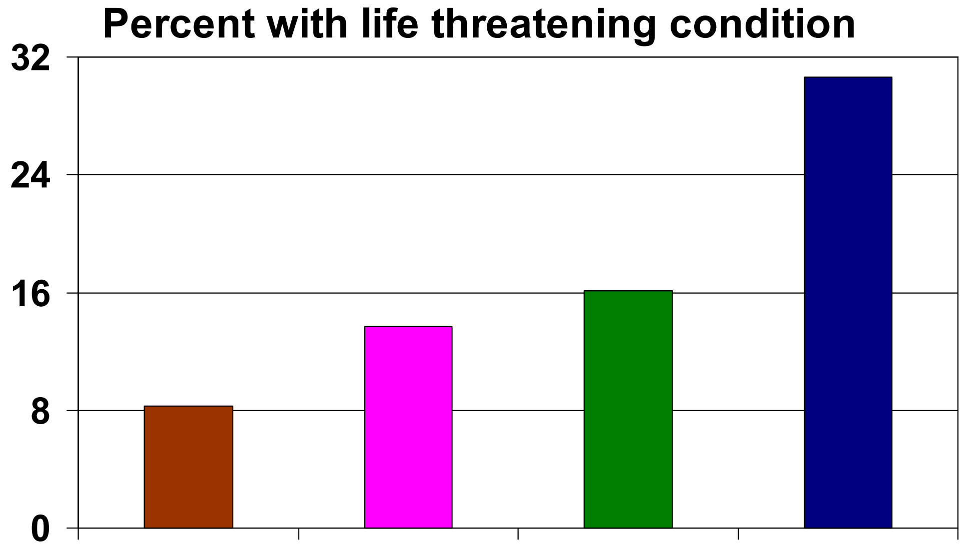


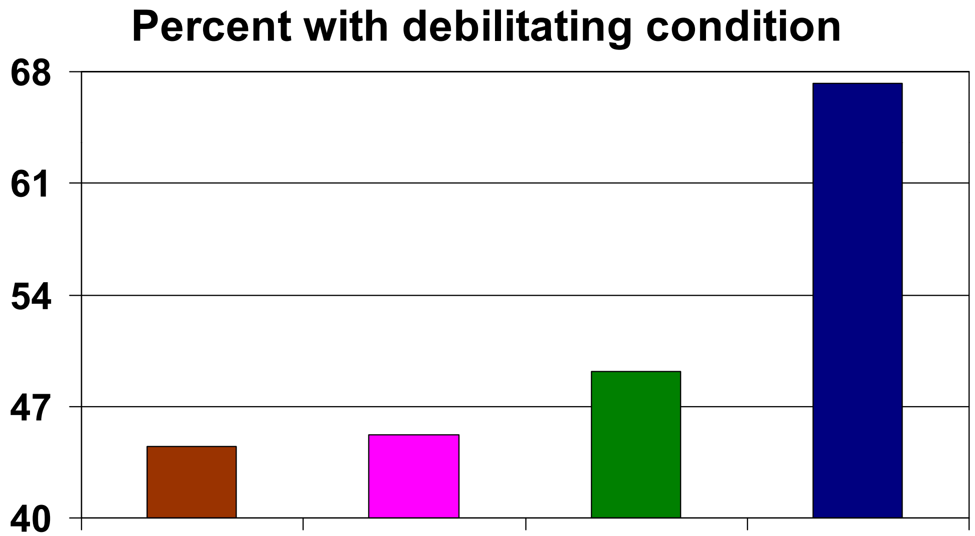
Selected characteristics of trajectory groups – males



Disease profiles of trajectory groups – males







Summarizing characteristics

For men, those in the ‘higher’ disability trajectory grouping more likely to:

- be urban
- be married
- have high education
- be in non-agricultural professions
- be former smokers
- have life threatening and debilitating conditions

Results (not shown) fairly similar for women

Conclusion

* Group-based modeling using modified PROC TRAJ allows determination of trajectory types

* Analysis suggests several distinct trajectory patterns

* Key differences between men and women:

  - Large group of men remain stable with little disability

  - Small group of men highly disabled throughout

  - All female trajectories include increasing disability

* Trajectories indicating ‘higher’ disability show greater probability of mortality

* Characteristics of ‘high’ disability trajectories include urbanites, married, former smokers, high educated, life threatening and debilitating conditions

Work in progress

* Inclusion of other variables in predicting group membership

* Multivariate analysis of group characteristics

* Sensitivity analysis of loss to follow-up