

# Pathways to Longevity: Health and Functioning Trajectories of Exceptional Survivors

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REVES

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# The “Longevity Revolution”

- “For everyone in his or her thirties and younger, especially children, life-spans of 95 or 100 years will be common.”

~ Vaupel, 2000

- “**100 Plus: How the coming age of longevity will change everything...**”

~ Arrison, 2011



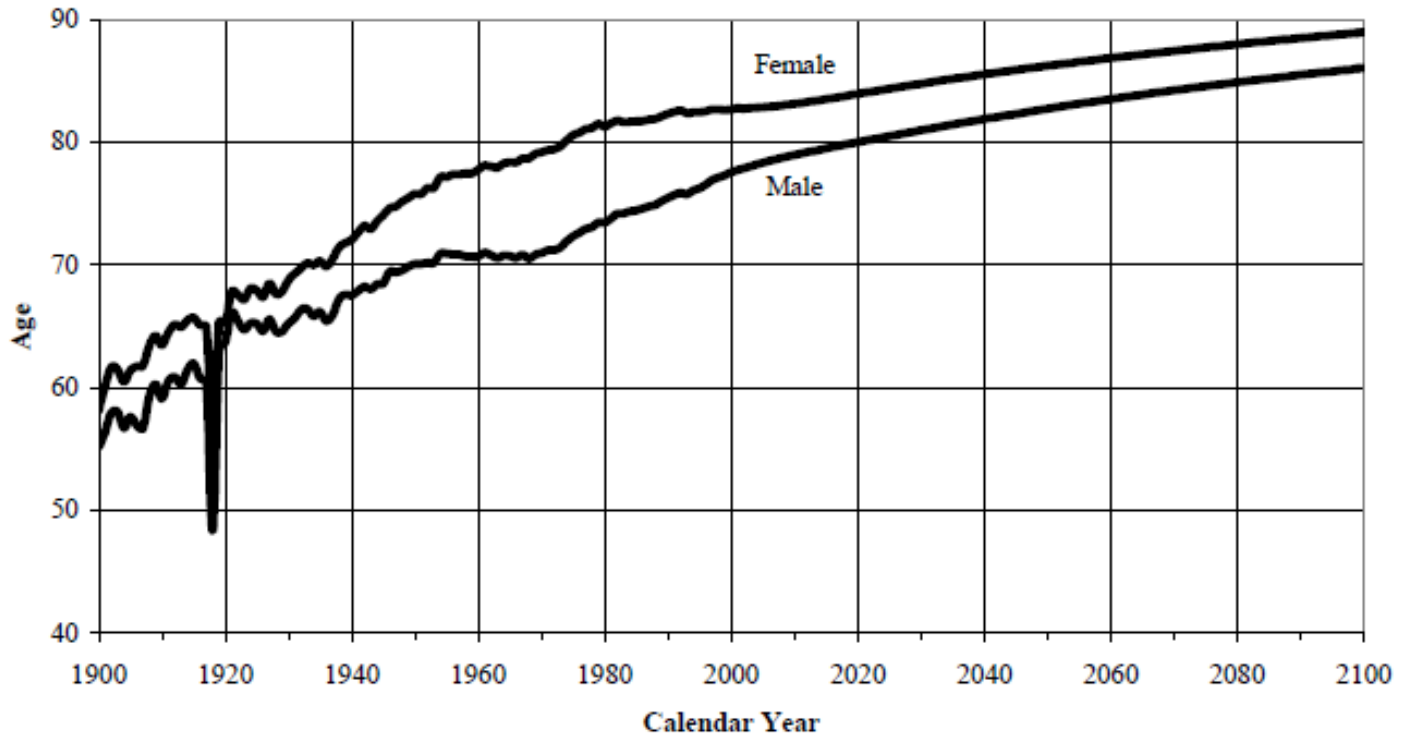
“90-Plus Is the New Old Age, Are You Ready?” ~ Forbes, 2011



“Living to 100 and Beyond” ~ Wall Street Journal, 2011

# Increasing Age at Death

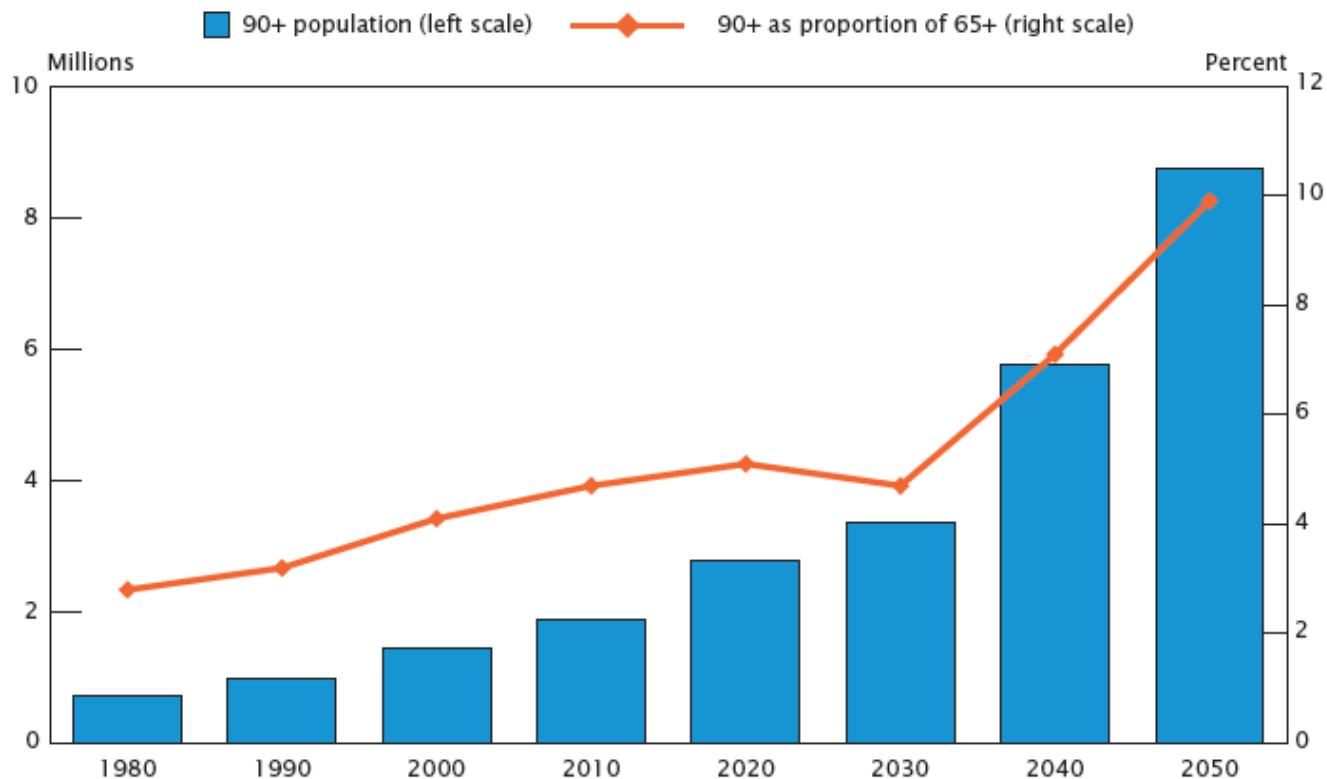
**Figure 4a—Median Age at Death ( $S(x) = .5$ )**  
by Sex and Calendar Year  
(Based on Period Tables)



Bell and Miller. 2005. Life Tables for the US SSA 1900-2100.

# The Population of Exceptional Survivors (90+) in the U.S. is Growing

Figure 1.  
Population Aged 90 and Over: 1980 to 2050



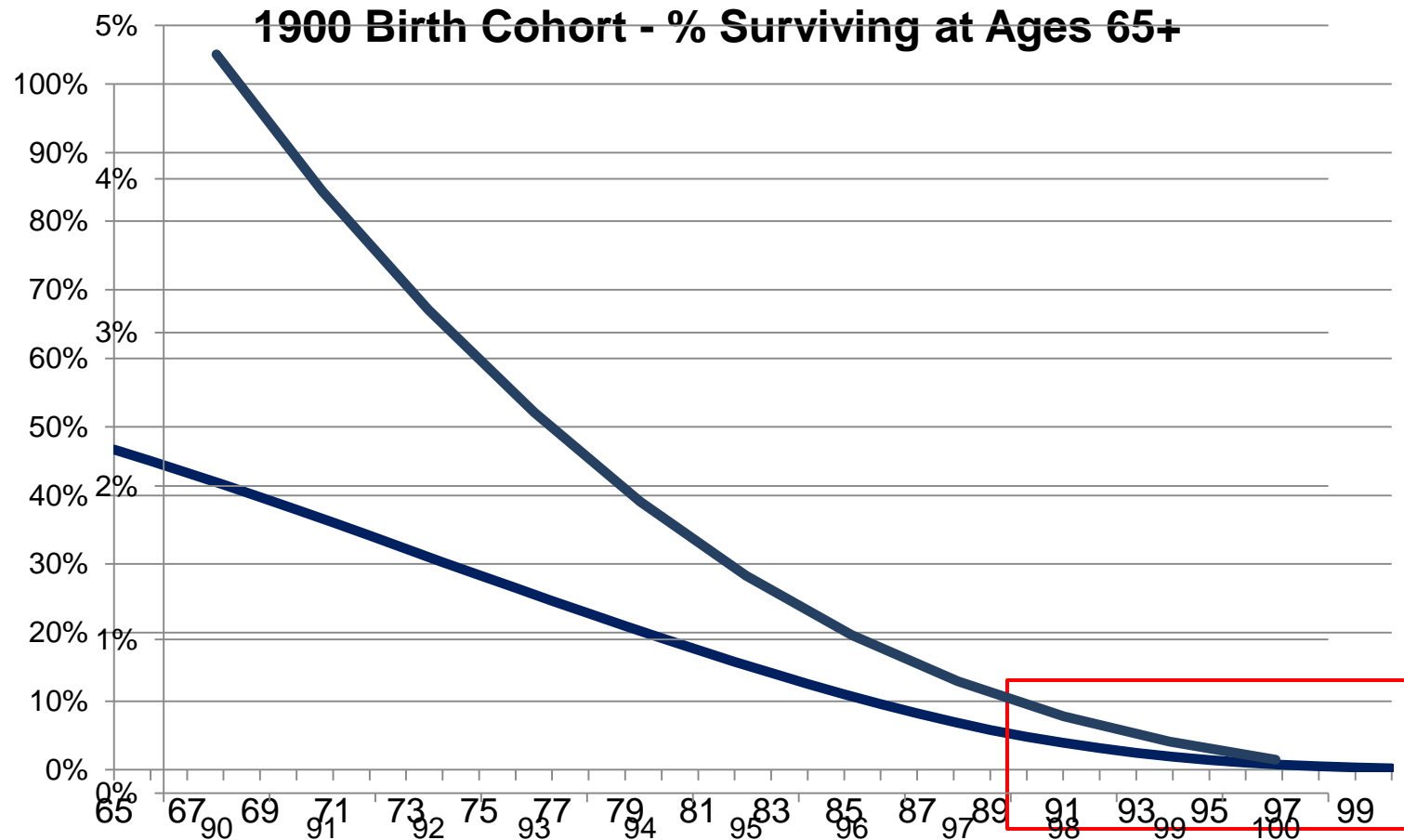
Note: The projections originate with a base population from Census 2000 and are not based on data from the 2010 Census.

Sources: U.S. Census Bureau. 1980: 1980 Census of Population, PC80-1-B1, Table 41; 1990: 1990 Census of Population, CP-1-1, Table 13; 2000: Census 2000, Summary File 2, PCT3; 2010: 2010 Census, Summary File 1, PCT12; 2020–2050: 2008 National Population Projections, Table 12.

# The longevity revolution raises questions about content/quality of added years

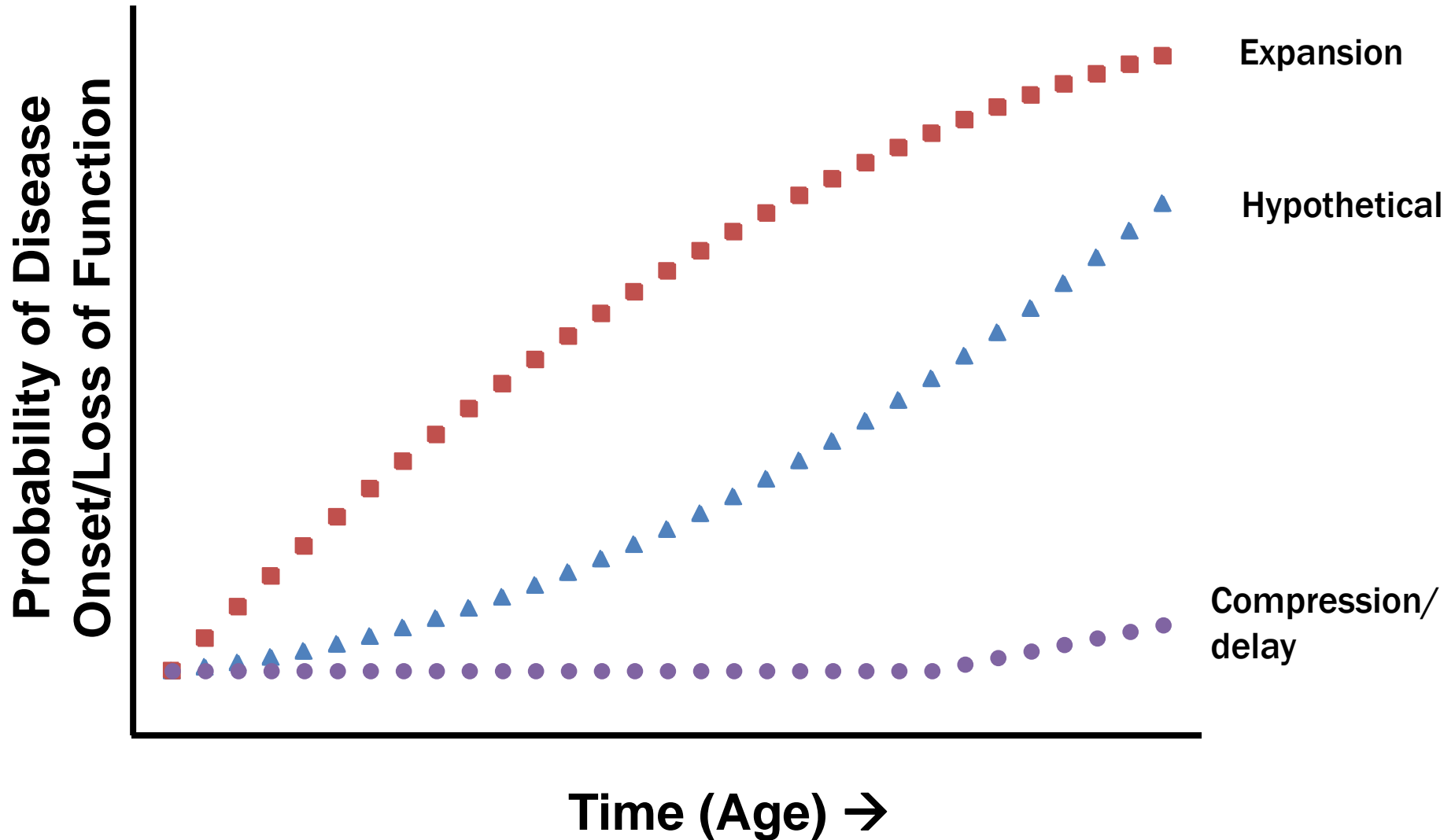
- “Increased longevity without quality of life is an **empty prize**” (World Health Organization 1997)
- Is longevity accompanied by healthy/unhealthy years?
  - What are the health and functioning profiles of the oldest-old?
  - What characteristics predict maintaining health and functioning into oldest-old age?

# What is “Exceptional Longevity”



Percent survival by age calculated from cohort-based life tables: Bell and Miller. 2005. “Life Tables for the United States Social Security Area 1900-2100.” Actuarial Report No. 120.

# PATHS TO LONGEVITY



# What does existing evidence say?

- Long-lived experience expansion of unhealthy years
  - High levels of frailty & dysfunction (e.g., loss of physical and cognitive function), multimorbidity<sup>1-3</sup>
- Longevity is predicated on compression
  - Increased resilience/decreased susceptibility to age-related diseases<sup>4,5</sup>
  - “The longer you live the healthier you’ve been”<sup>6</sup>
- ❖ Relatively less attention to within-population heterogeneity

<sup>1</sup>Anderson-Ranberg et al. 1999; <sup>2</sup>Anderson-Ranberg et al. 2001; <sup>3</sup>Baltes and Smith 2003; <sup>4</sup>Barzilai and Shuldiner 2001; <sup>5</sup>Cutler 1975; <sup>6</sup>Perls 1999



# The Health and Retirement Study (HRS)

- **Study description**
  - National study of U.S. adults 70+
  - Interviewed in 1993, 1995, 1998, every 2 years to 2010 (up to 18 years of follow-up)
- **Analytic sample**
  - Born 1921 or earlier (potential to survive to age 90)
    - Exceptional Survivors - survived to at least age 90 (N=2,740)
      - Baseline age: Mean= 81; Range =73-97 (99<sup>th</sup> percentile)
- **Death tracking through 2010**
  - Using exit interviews, NDI, SS Master Death File

# Baseline Demographic Characteristics by Survivorship

	<u>Non-Survivors</u>	<u>Survivors</u>
N	3,543	2,740
Age, years	77.1	80.9
Female	55.9	68.9
Race/Ethnicity		
White	86.7	88.4
Black	8.7	7.0
Hispanic	3.4	3.6
Other	1.3	1.0
Education, years	10.9	10.9

Survivorship differences in covariate distributions are significant at  $p < .05$

# Disease and Disability

## Count of doctor diagnosed diseases (0-6)

- “Has a doctor ever told you that you have...?”
  - 1) High blood pressure or hypertension
  - 2) Heart problems
  - 3) Diabetes
  - 4) Cancer
  - 5) Stroke
  - 6) Lung disease

## Count of ADL limitations (0-6)

- “Because of a health or memory problem do you have any difficulty with...?”
  - 1) Walking across a room
  - 2) Dressing
  - 3) Bathing
  - 4) Eating
  - 5) Bed transfers
  - 6) Toileting

# Group-Based Trajectory Model

- Novel approach for examining heterogeneity in the aging experience
- Identifies clusters of individuals who have similar aging trajectories
- Accounts for selective mortality

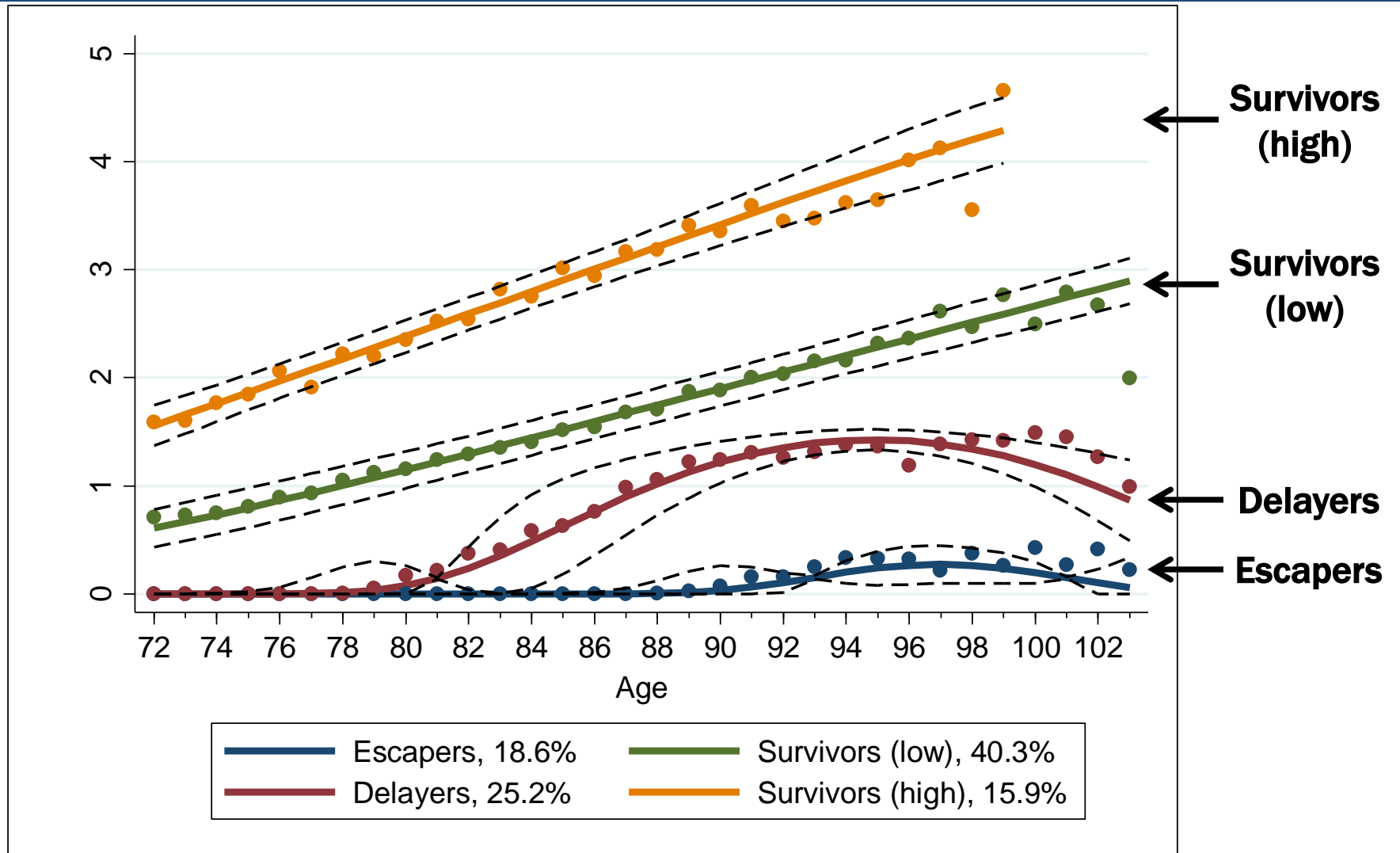
$$P(Y_i) = \sum_j \pi_j \prod^T p^{jt}(y_{it})$$



$$y_{it}^* = \beta_0^j + \beta_1^j \text{age}_{it} + \beta_2^j \text{age}_{it}^2 + \dots + \varepsilon_{it}$$

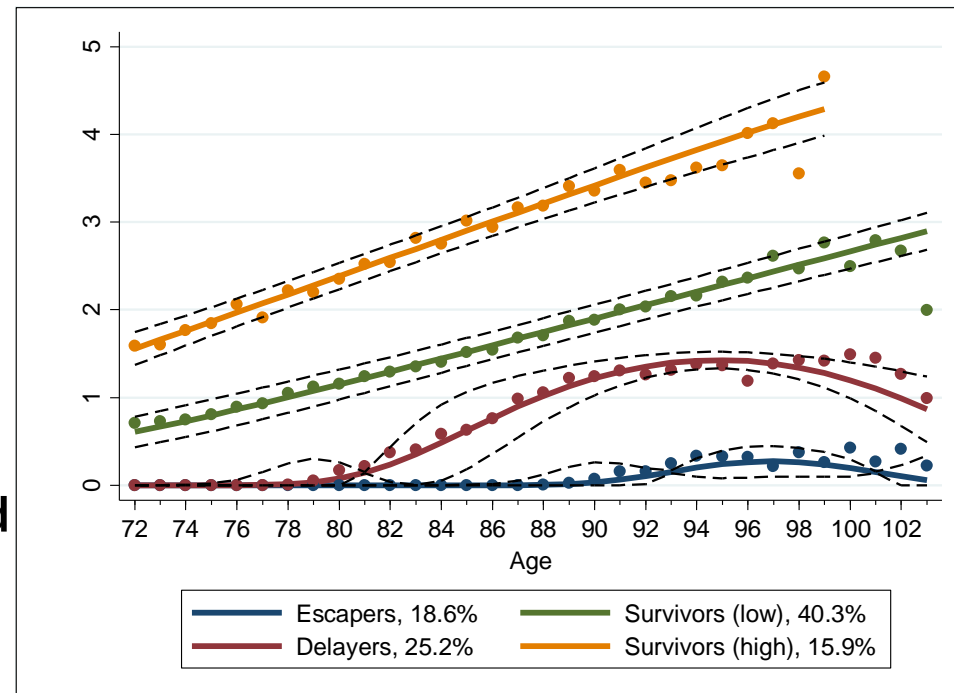
Each trajectory consists of an initial value  $\beta_0$ , linear age term  $\beta_1$ , quadratic age<sup>2</sup> term  $\beta_2$

# Predicted Disease Trajectories



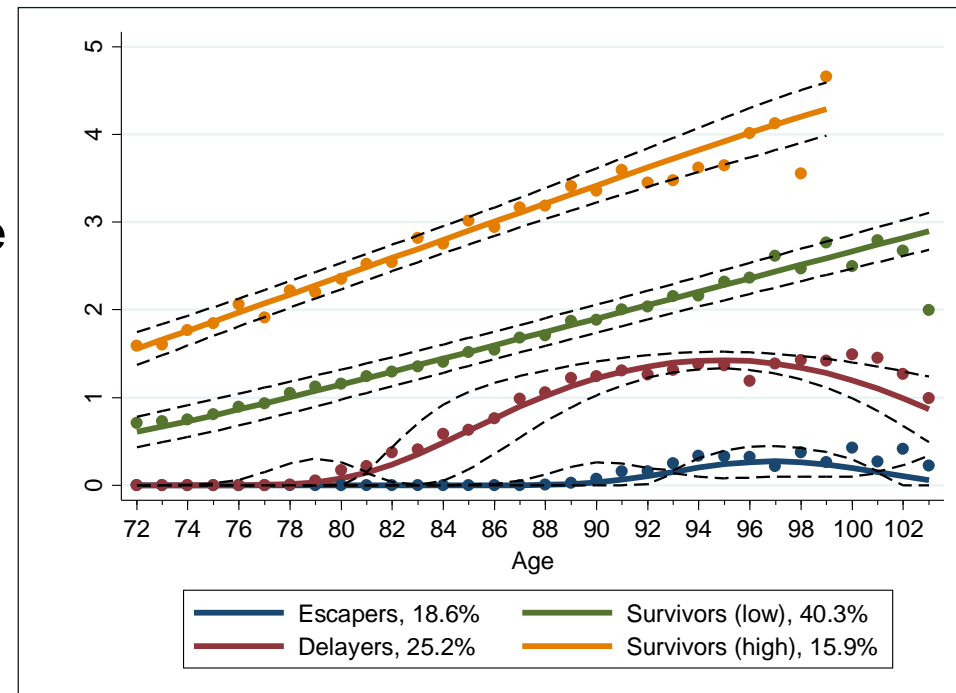
# Demographic and behavioral correlates of survival trajectories

- Women - survivors, delayers vs. Men - escapers
- Hispanics less likely to live with disease.
- No education or black-white differences.
- Former smokers more likely to live with disease compared to non-smokers.
- Overweight/obese have greater disease burden throughout oldest-old age compared to normal weight at baseline.

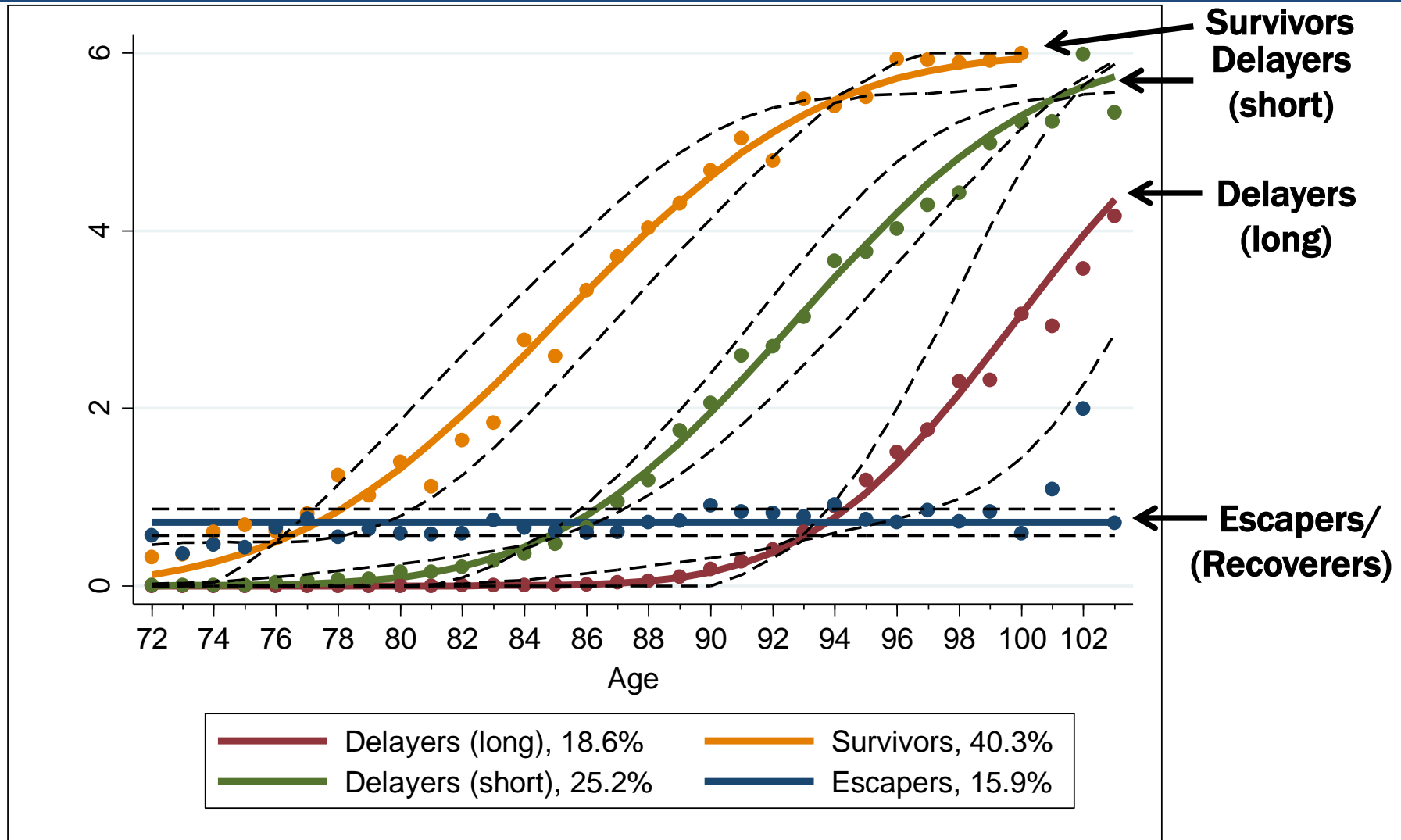


# Geographic differences in survival trajectories

- No differences by region.
- Older adults living in large metro areas at baseline more likely to escape disease.



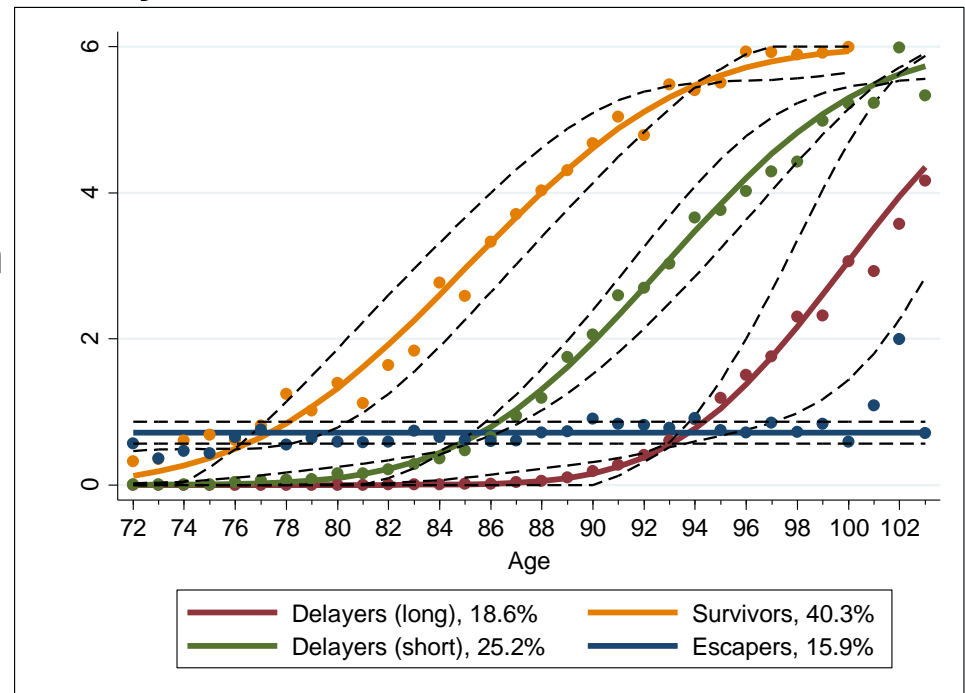
# Predicted Disability Trajectories





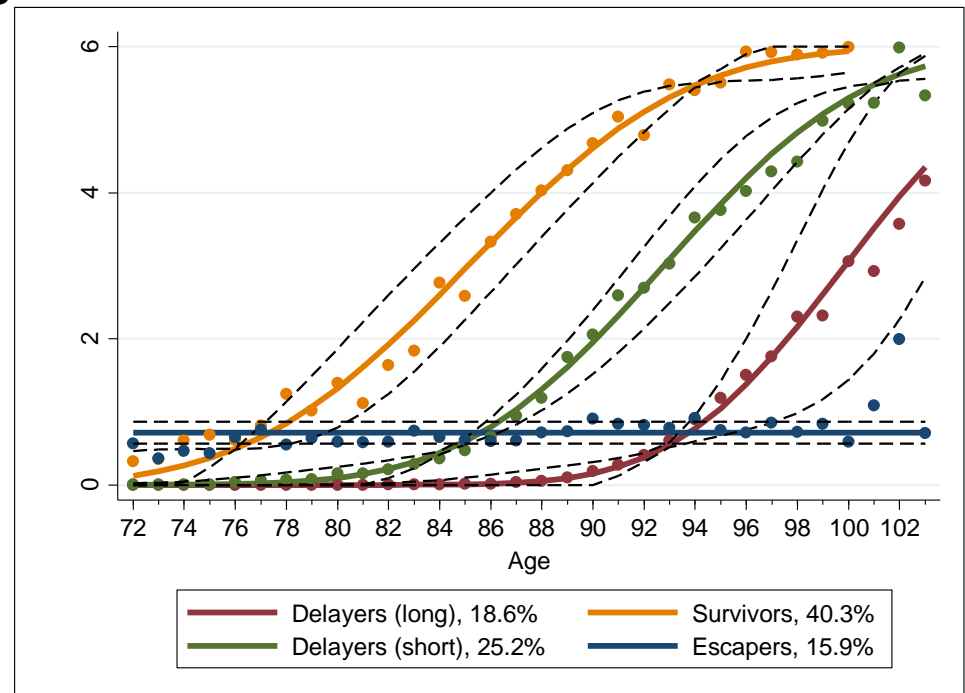
# Demographic and behavioral correlates of survival trajectories

- Women - live through very old age with increasing burden of disability vs. Men - delay disability into their 90's.
- Hispanics and less educated more likely to live with increasing disability through oldest-old age.
- No black-white differences.
- No differences by smoking status.
- Overweight/obese have much greater odds of living through oldest-old age with increasing disability burden.



# Geographic differences in survival trajectories

- More delayers in South. Less probability of survivors living in Western U.S. (mountains).
- More short delayers in non-metro urban areas. More survivors in small urban/rural areas.



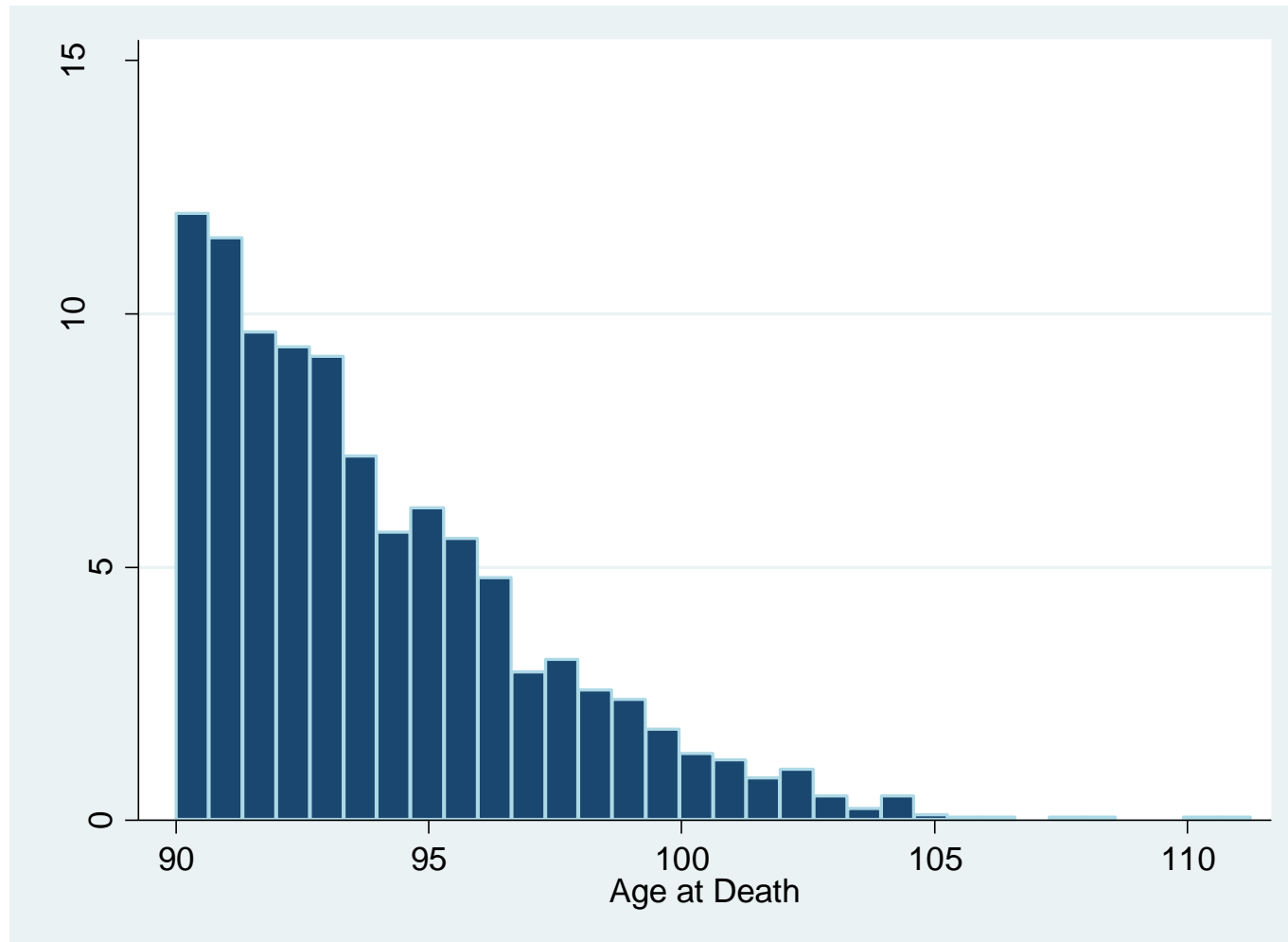
# Conclusions

- As we march towards longer life spans, what are we marching towards?
- Longevity is a prize... for some
- Potential modifiable risk factors associated with poor health and loss of function in very late life
  - Excess body weight
- Behaviors of exceptional survivors not necessarily what we would expect (e.g., smokers)
- Not much social patterning in health and functioning

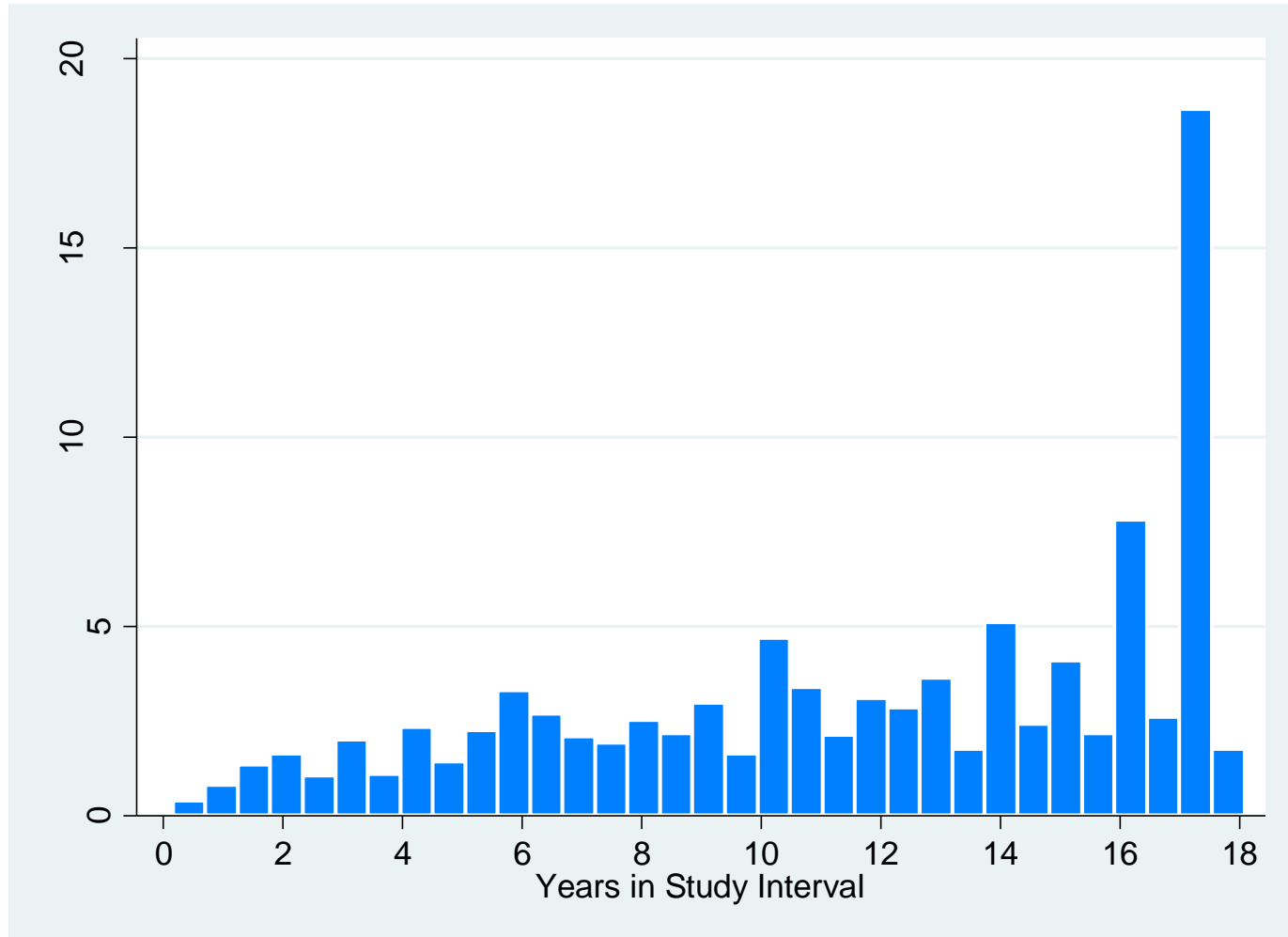


# EXTRA SLIDES

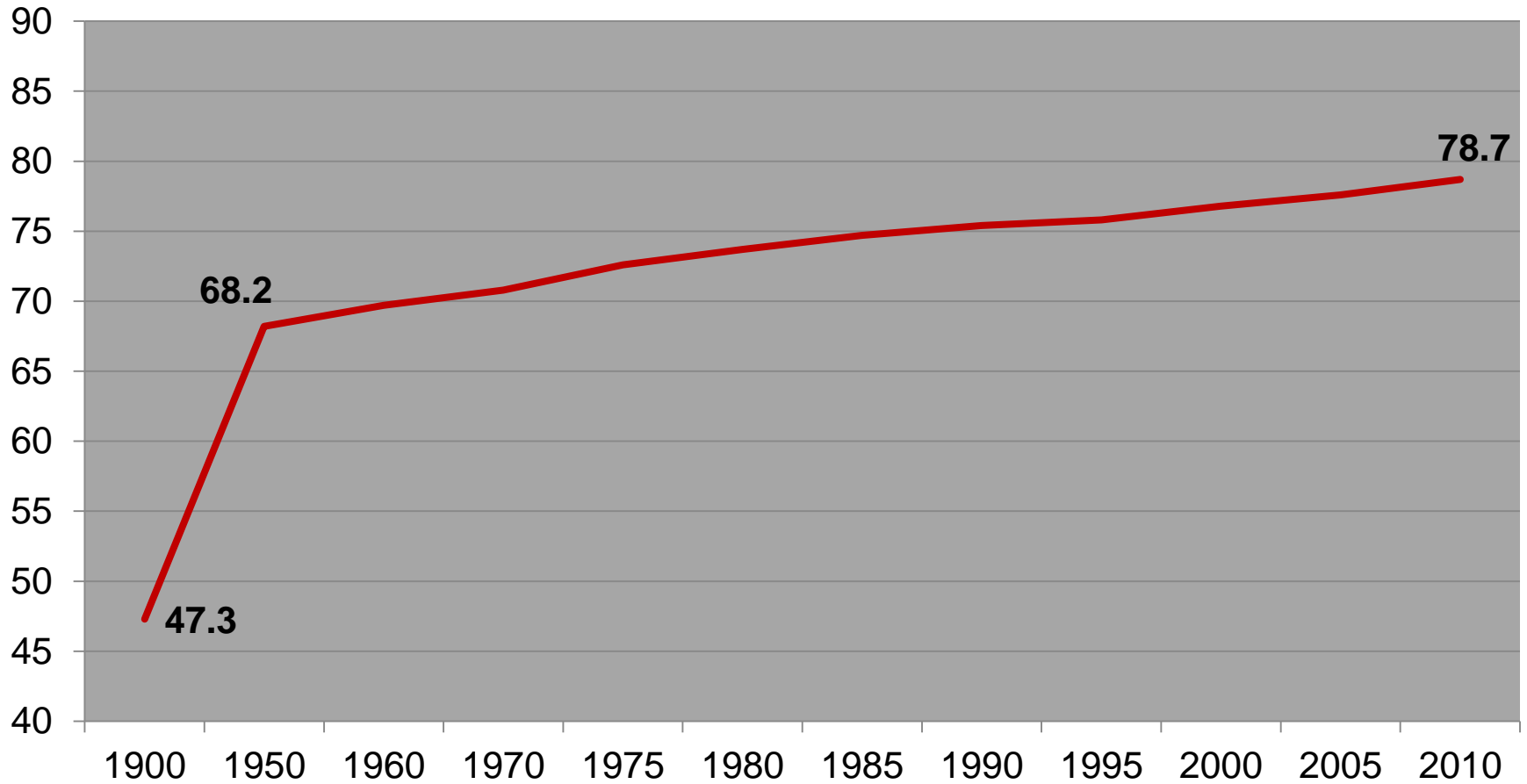
# Age at death of 90+ survivors



# Time in Study 90+ survivors



# Life Expectancy at Birth 1900-2010



# Heterogeneity in Health Patterns of Survivorship to Extreme Old Age

- **Example: Morbidity profiles of oldest-old members in New England Centenarian Study (ages 97-119):**
  - **Paths to longevity (N = 424)**

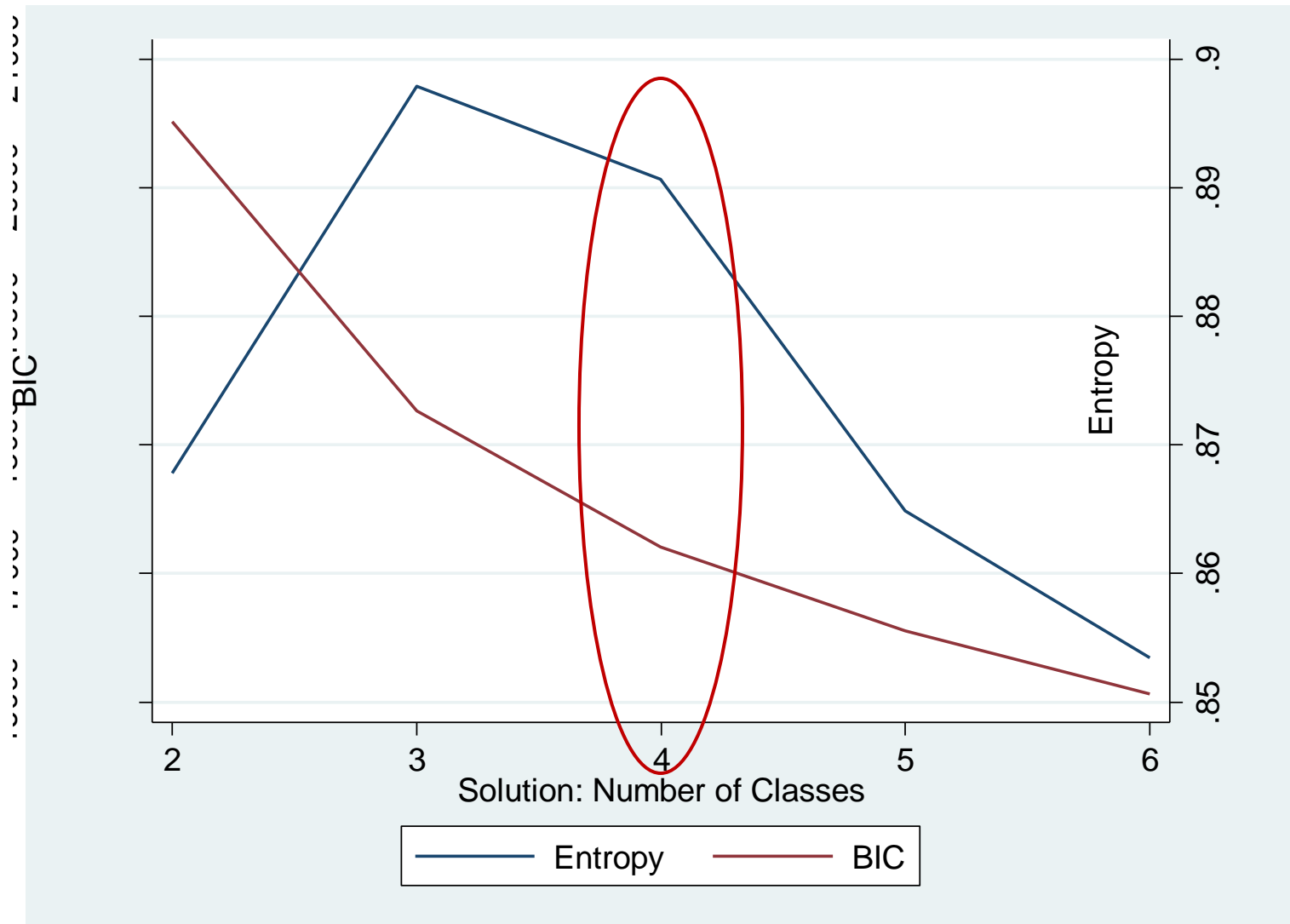
	<b>Age of Disease Onset</b>	<b>Men (%)</b>	<b>Women (%)</b>
Escapers	100+ OR never	24	43
Delayers	80-100	44	42
Survivors	<80	32	25

(Evert et al. 2003)

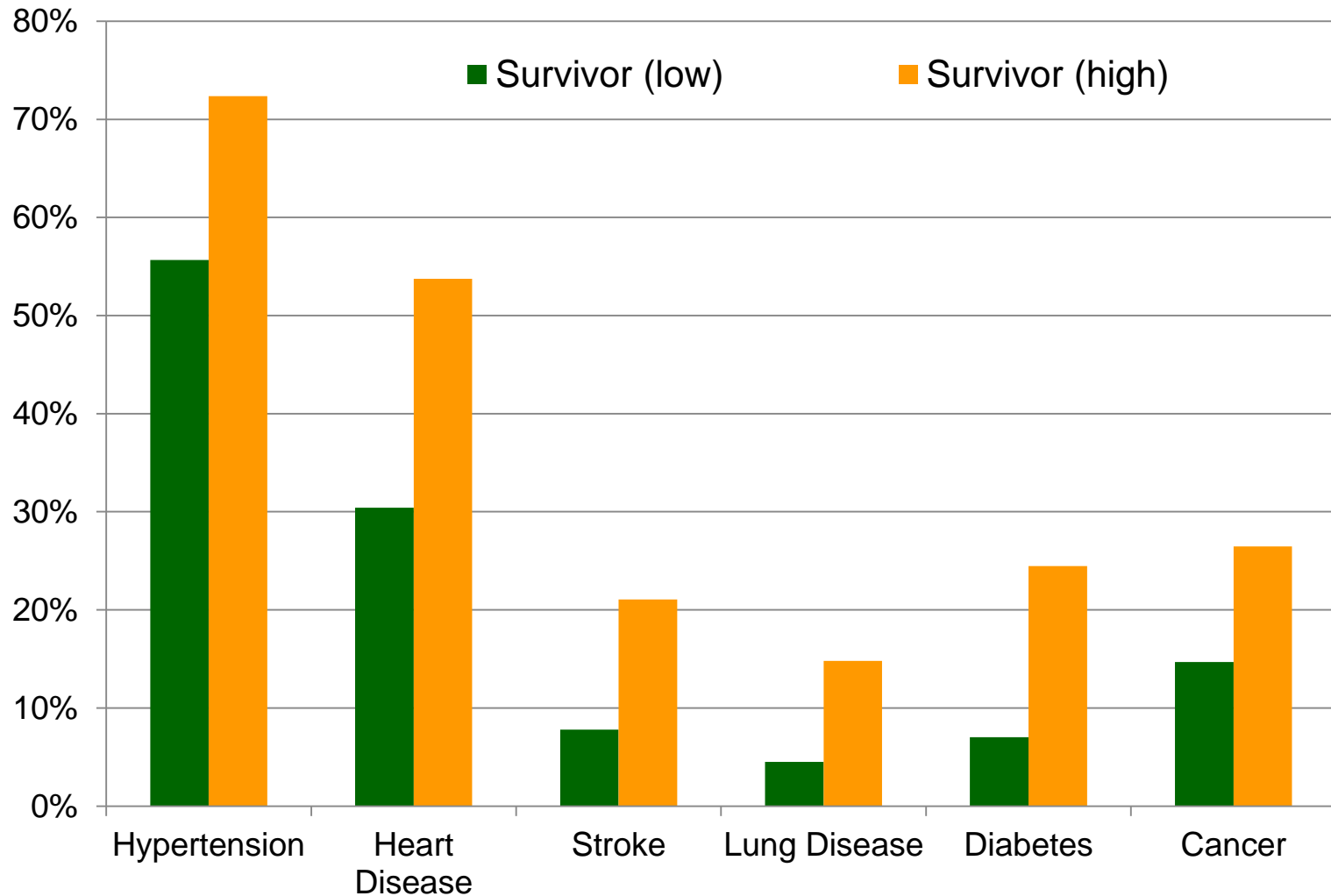
- **Categorization is ad hoc; unclear if patterns represent larger U.S. population**
- **Focused only on age of disease onset**



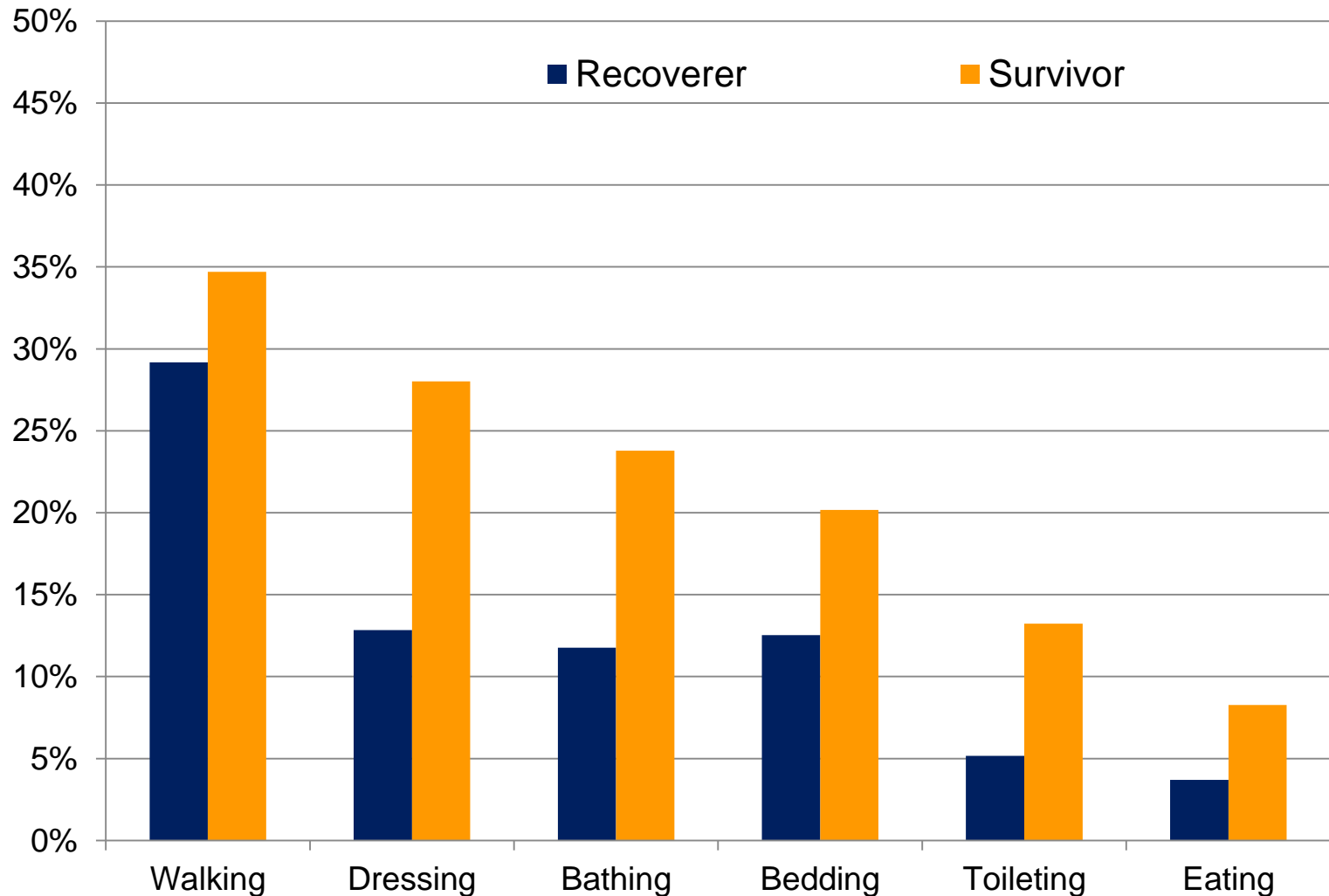
# Determining Number of Classes



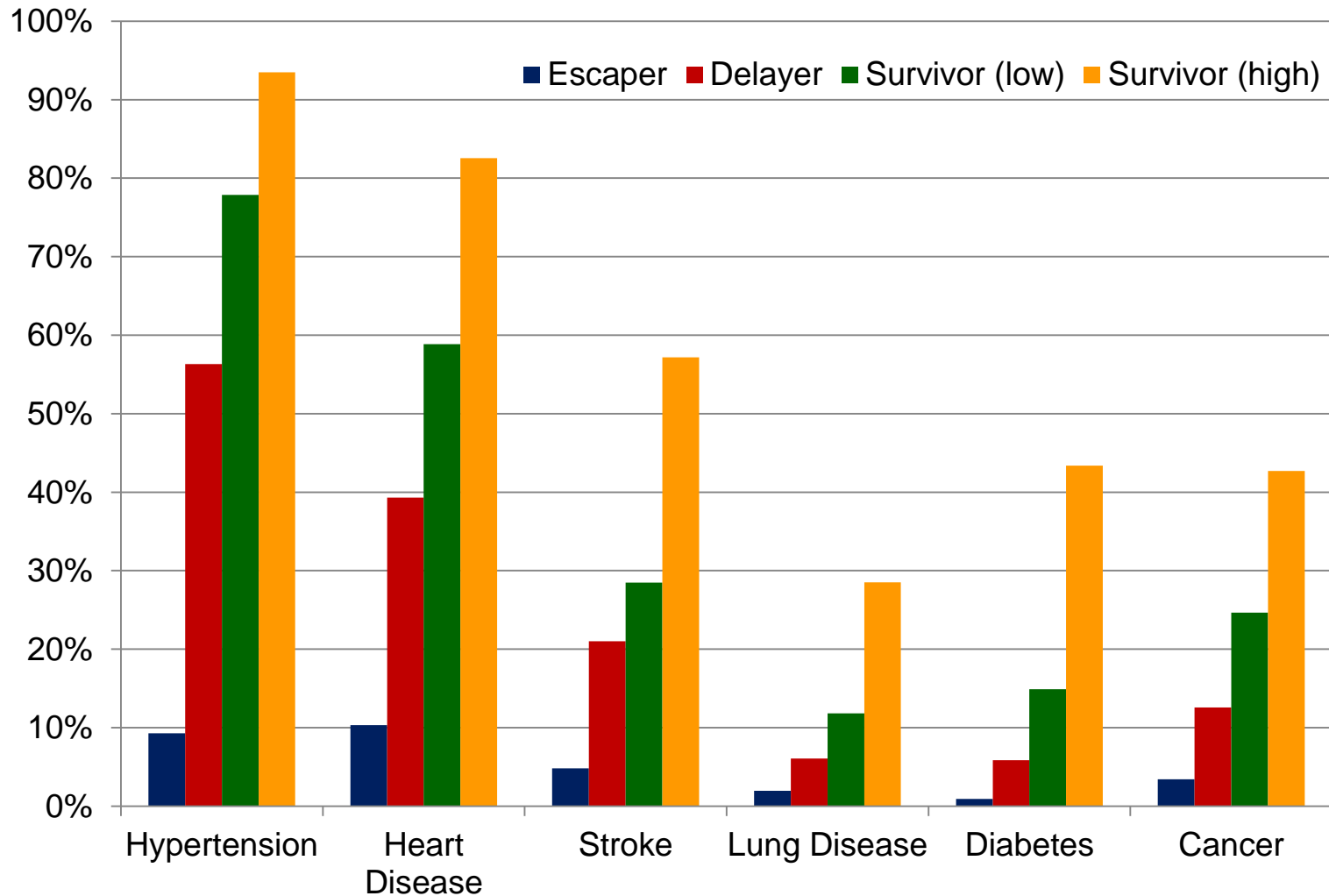
# Baseline Disease Prevalence by Morbidity Pathway



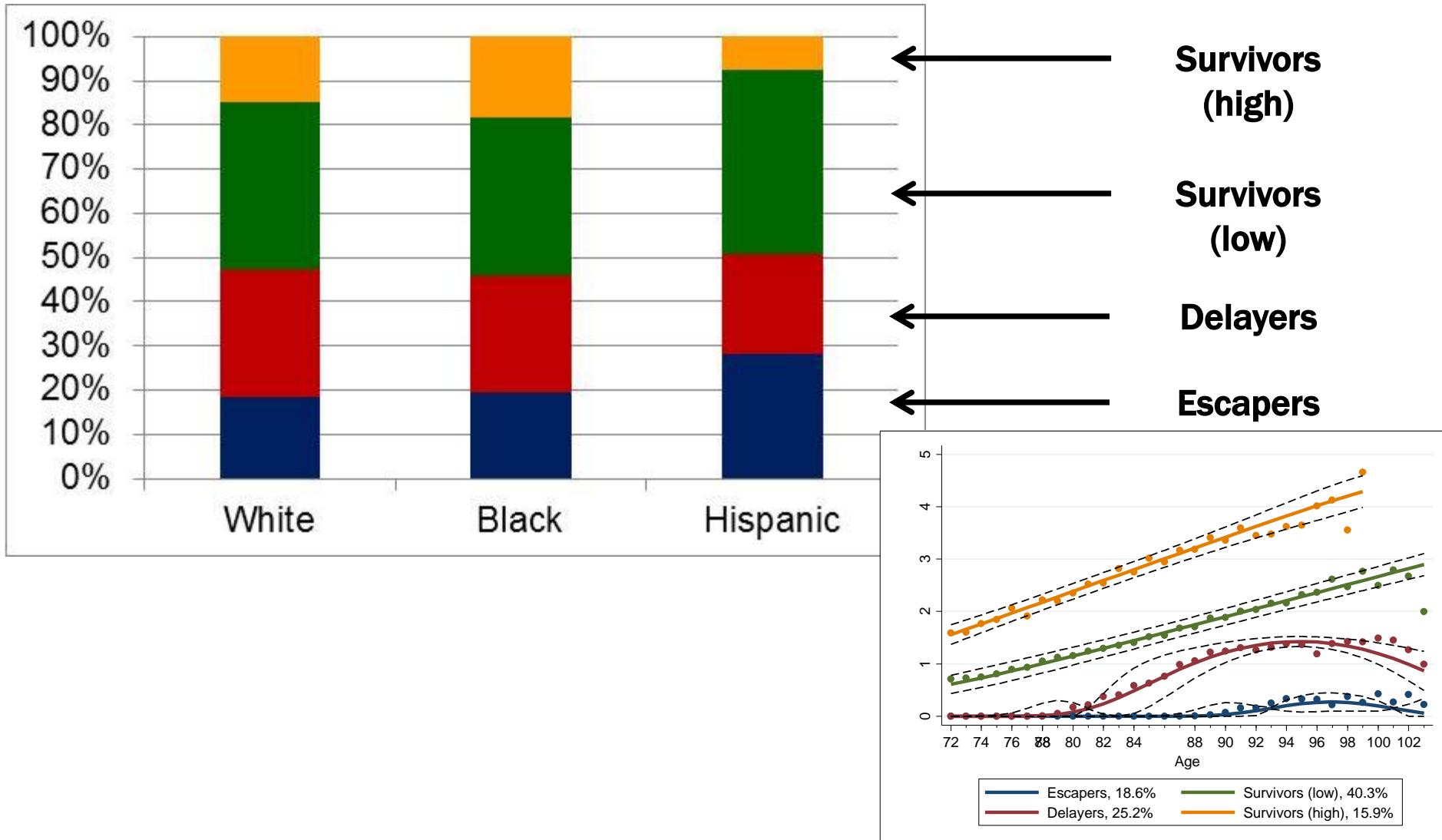
# Baseline ADL Prevalence by Disability Pathway



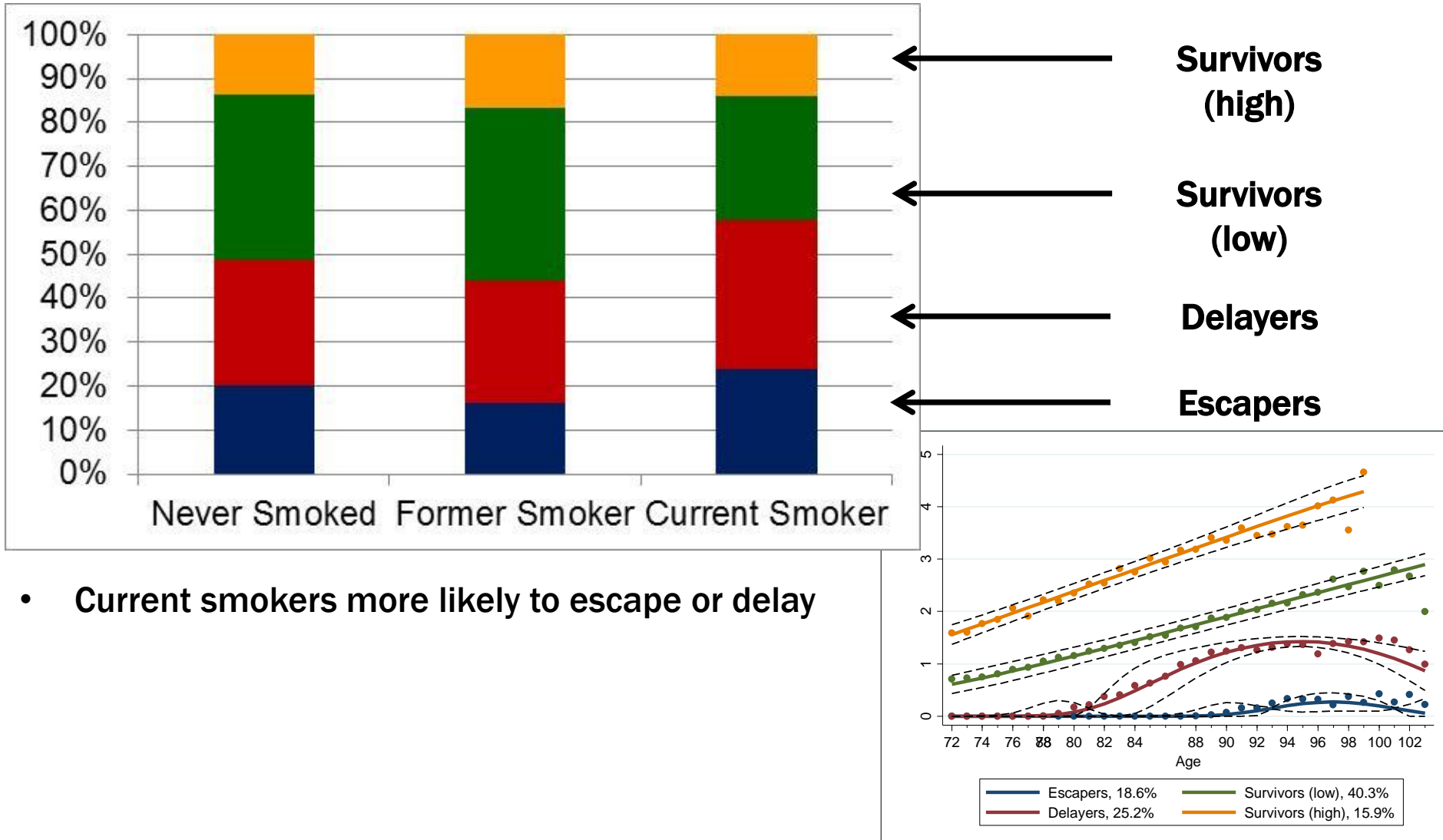
# Lifetime Disease Prevalence by Morbidity Pathway



# Race/Ethnic Composition

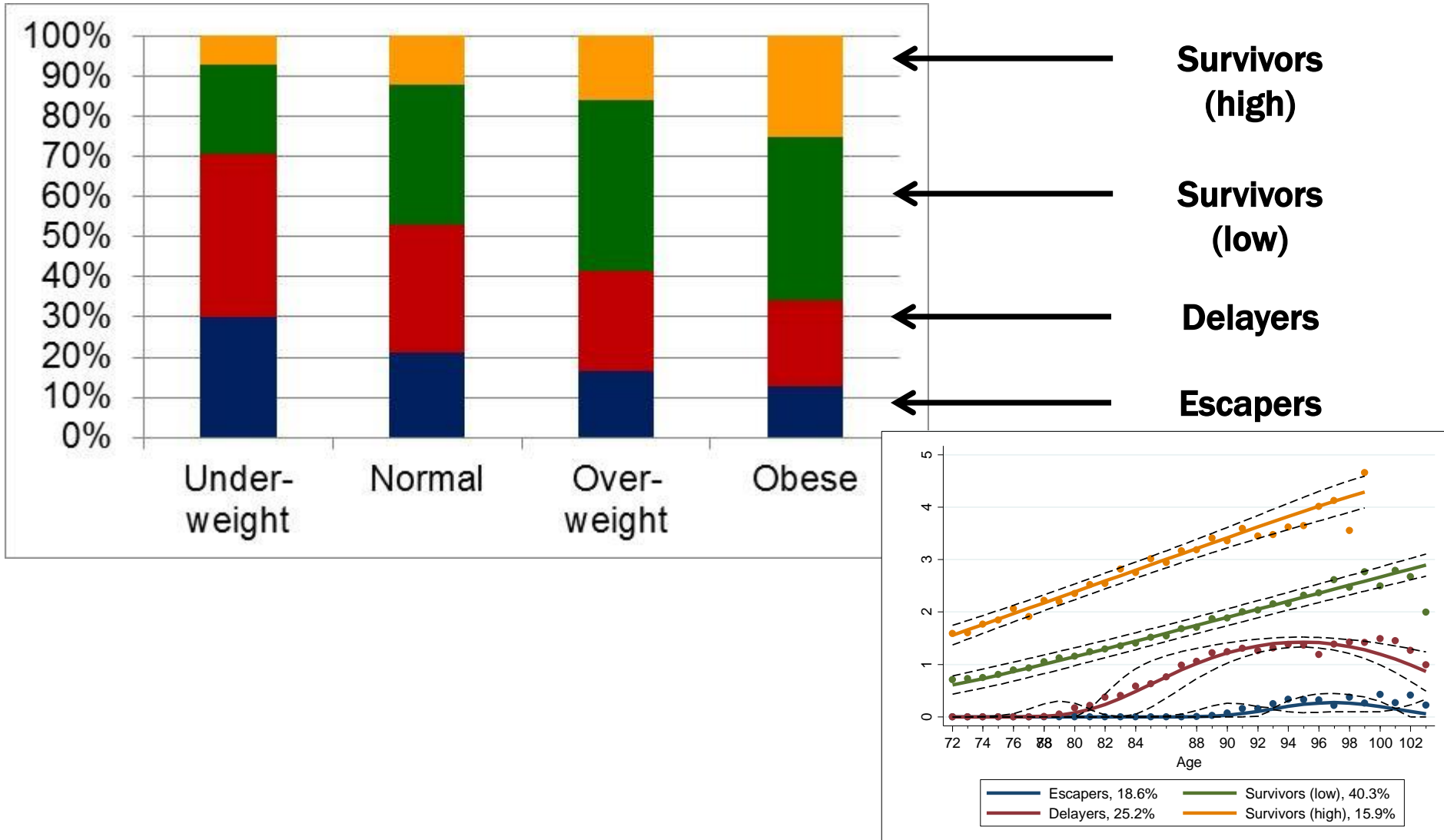


# Baseline Smoking Status

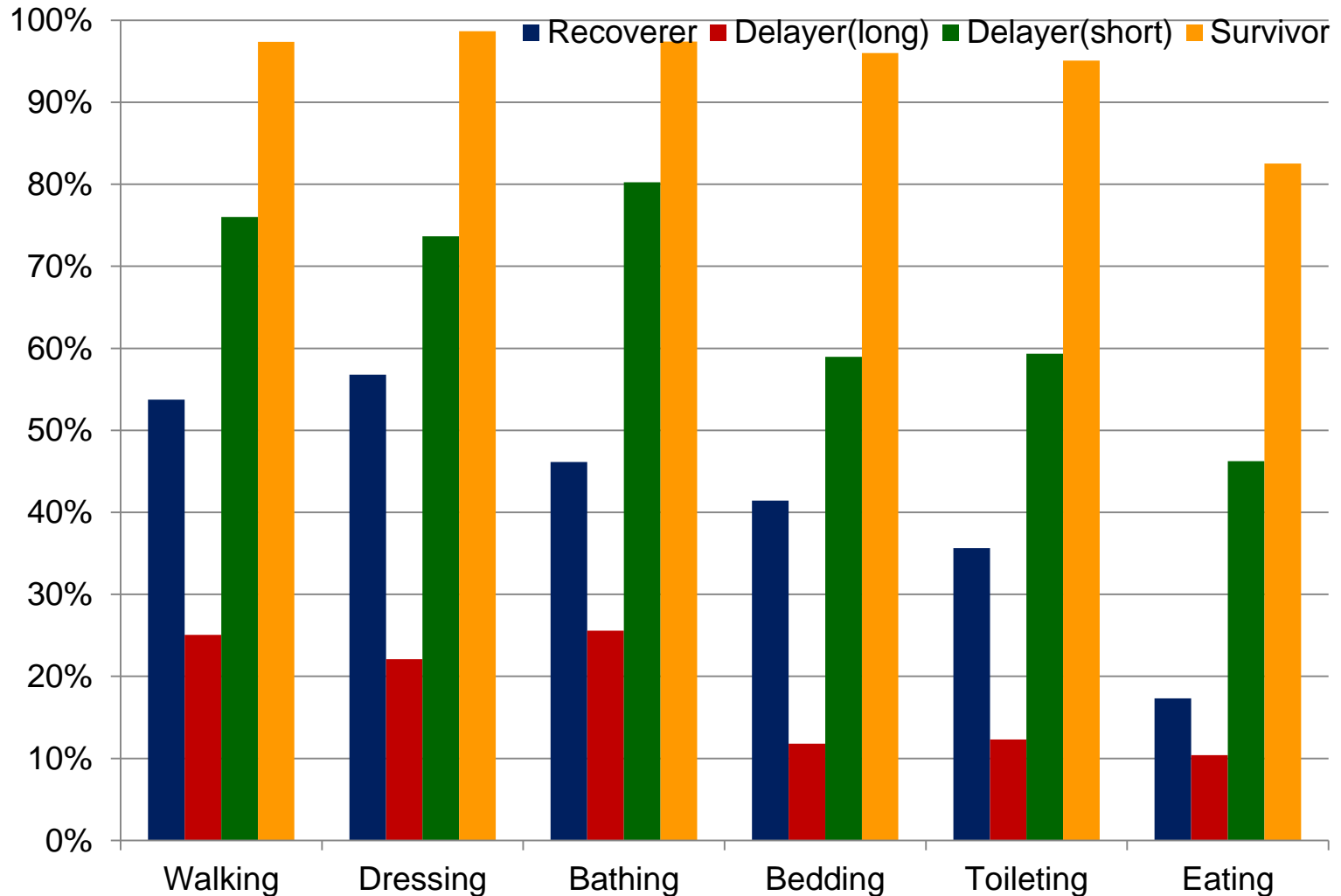


- Current smokers more likely to escape or delay

# Baseline Weight Status

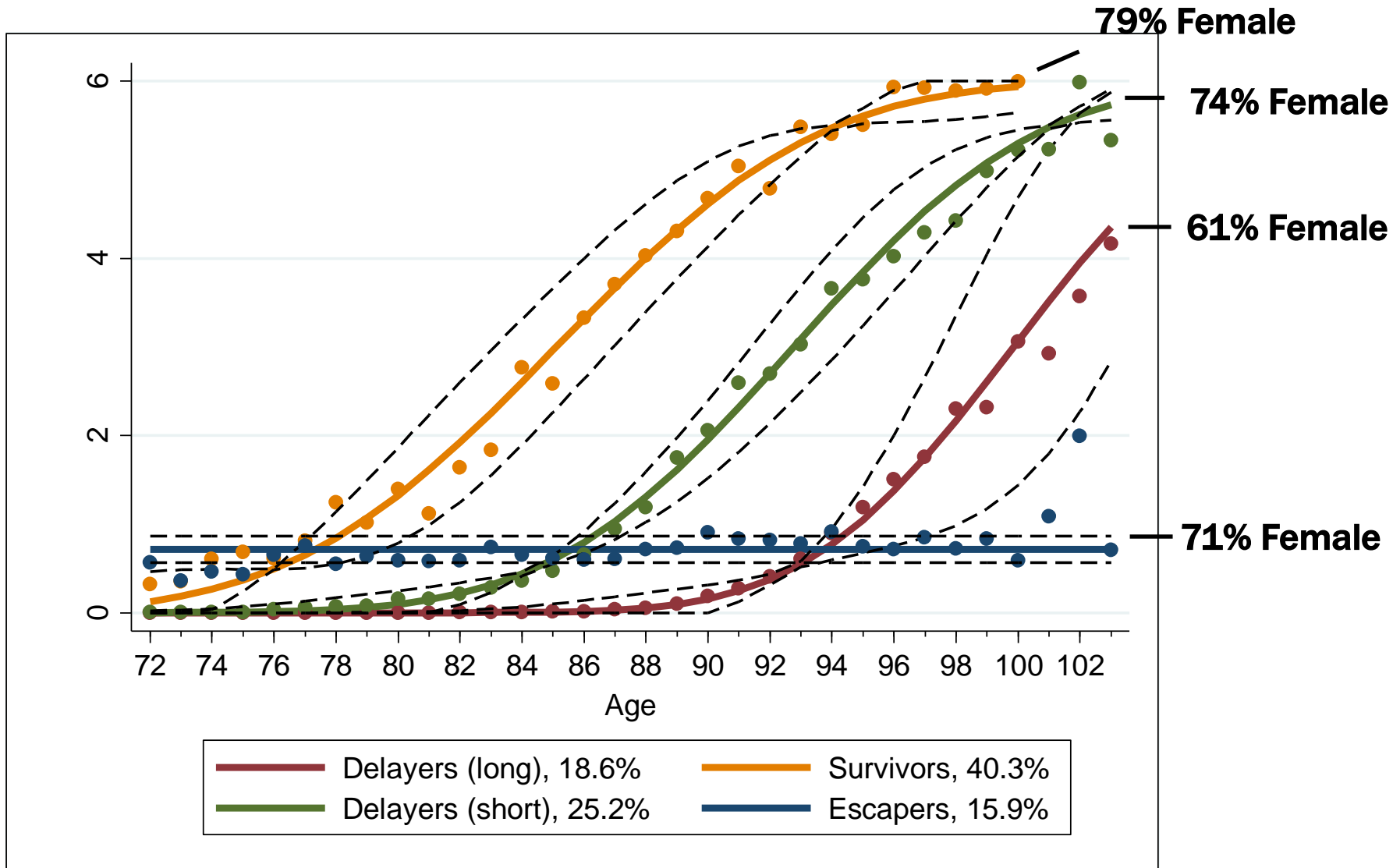


# Lifetime ADL Prevalence by Disability Pathway

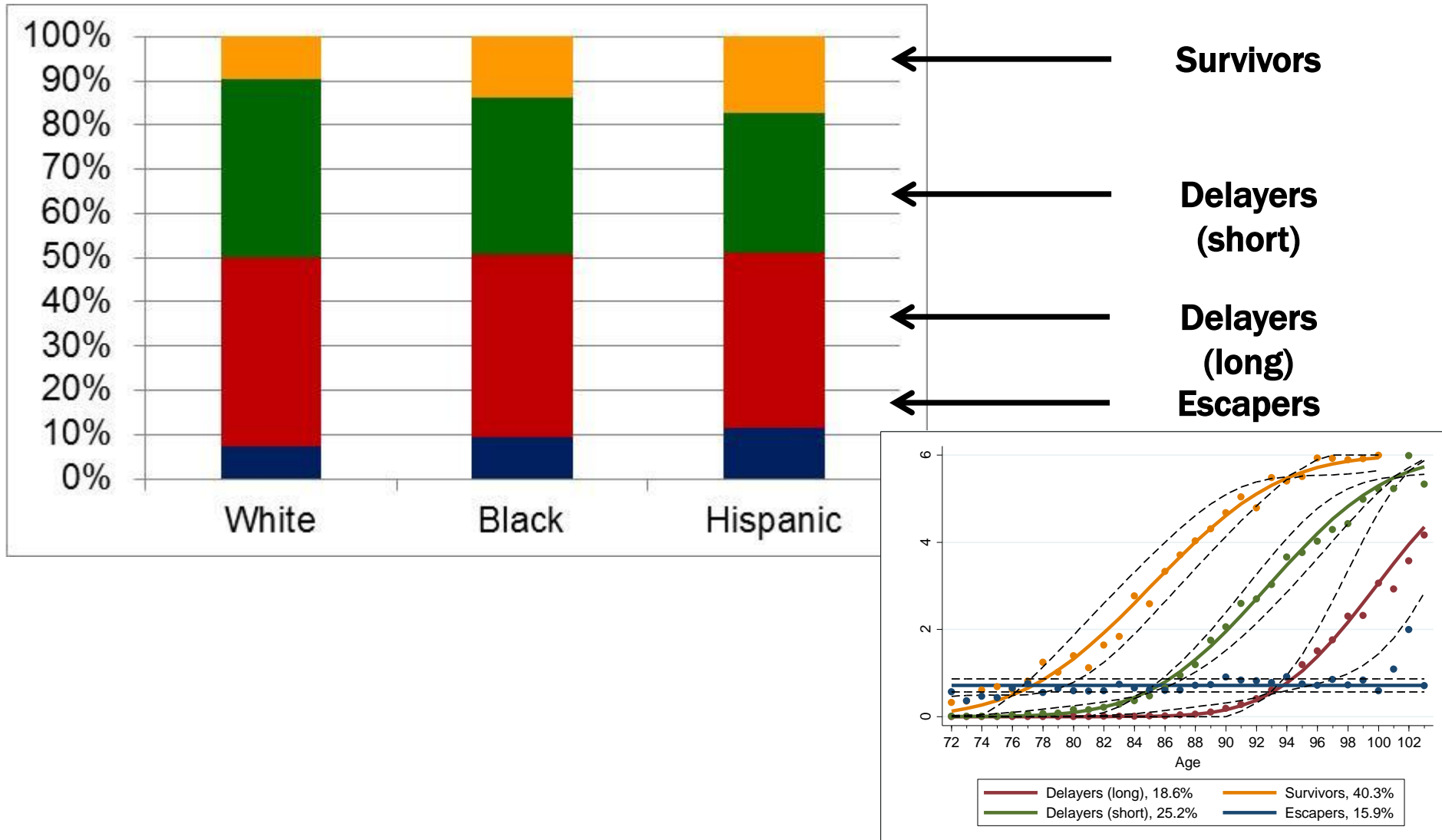




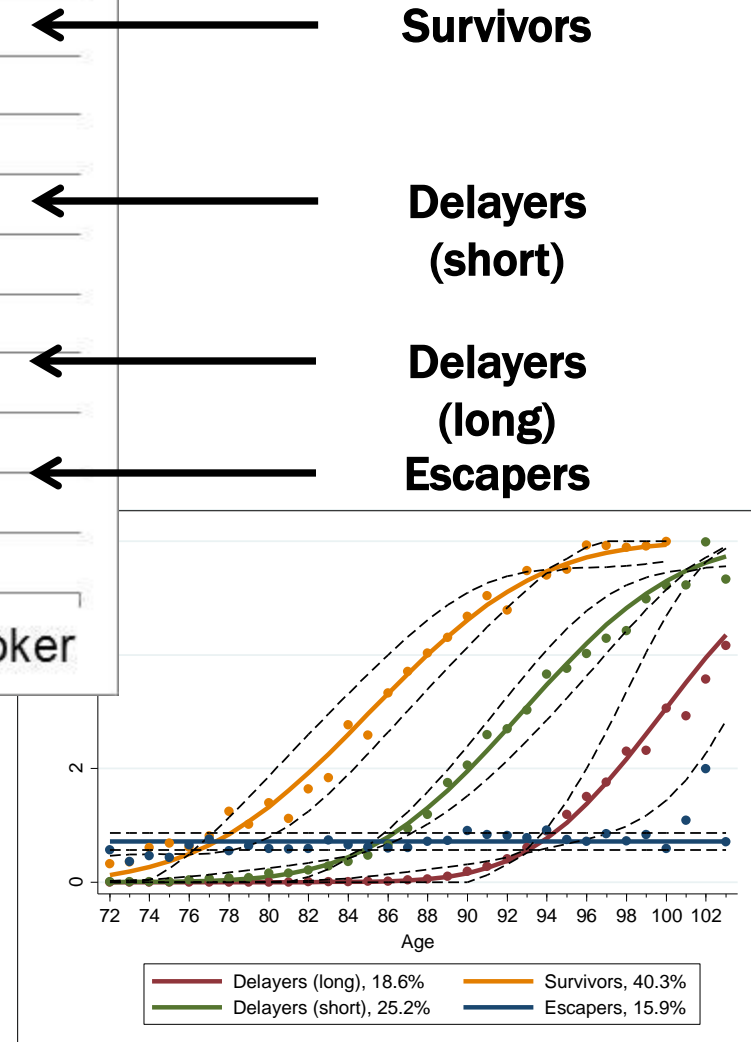
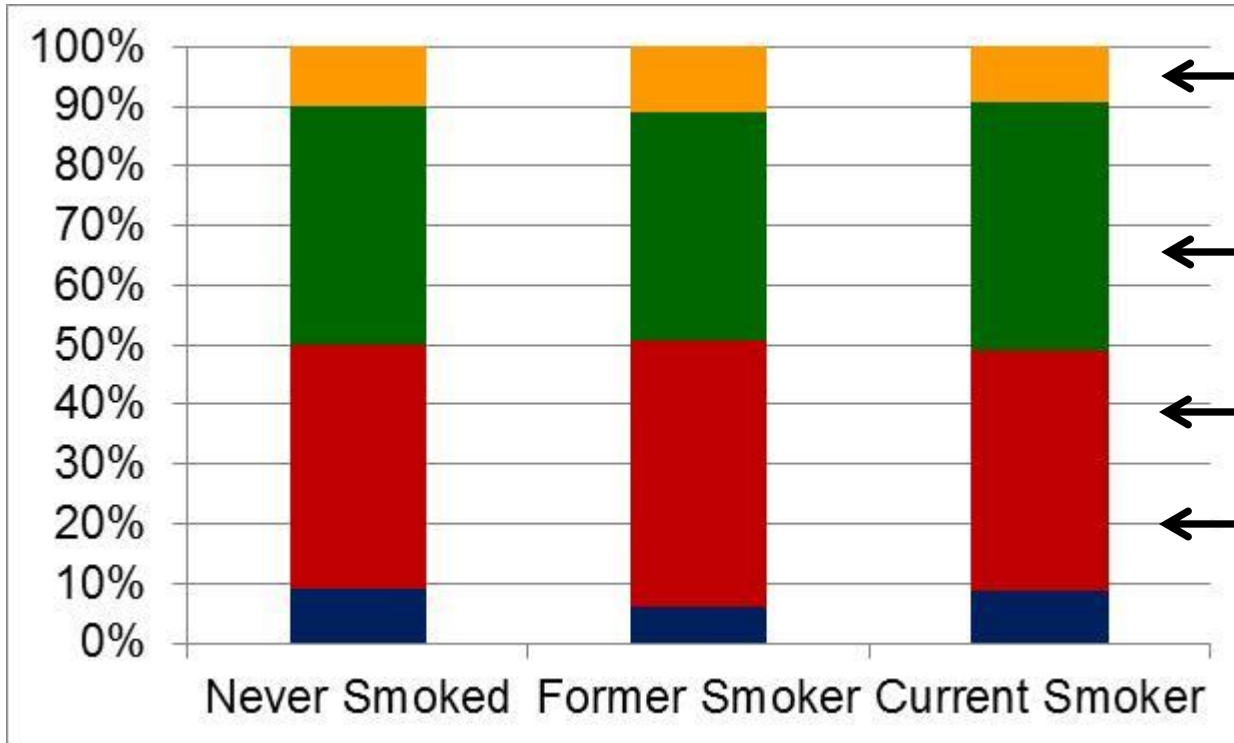
# Gender Differences in Trajectories



# Race/Ethnic Composition



# Baseline Smoking Status



# Baseline Weight Status

