Session 196: Evolving Baseline and Long-term Mortality Improvement Assumptions for Pension Plans and PRT Insurers

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Session 196 – Evolving Baseline Mortality and Mortality Improvement Assumptions for Pension Plans and PRT Insurers

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Baseline and improvements

Defining our language

Longevity assumption =

Baseline assumption

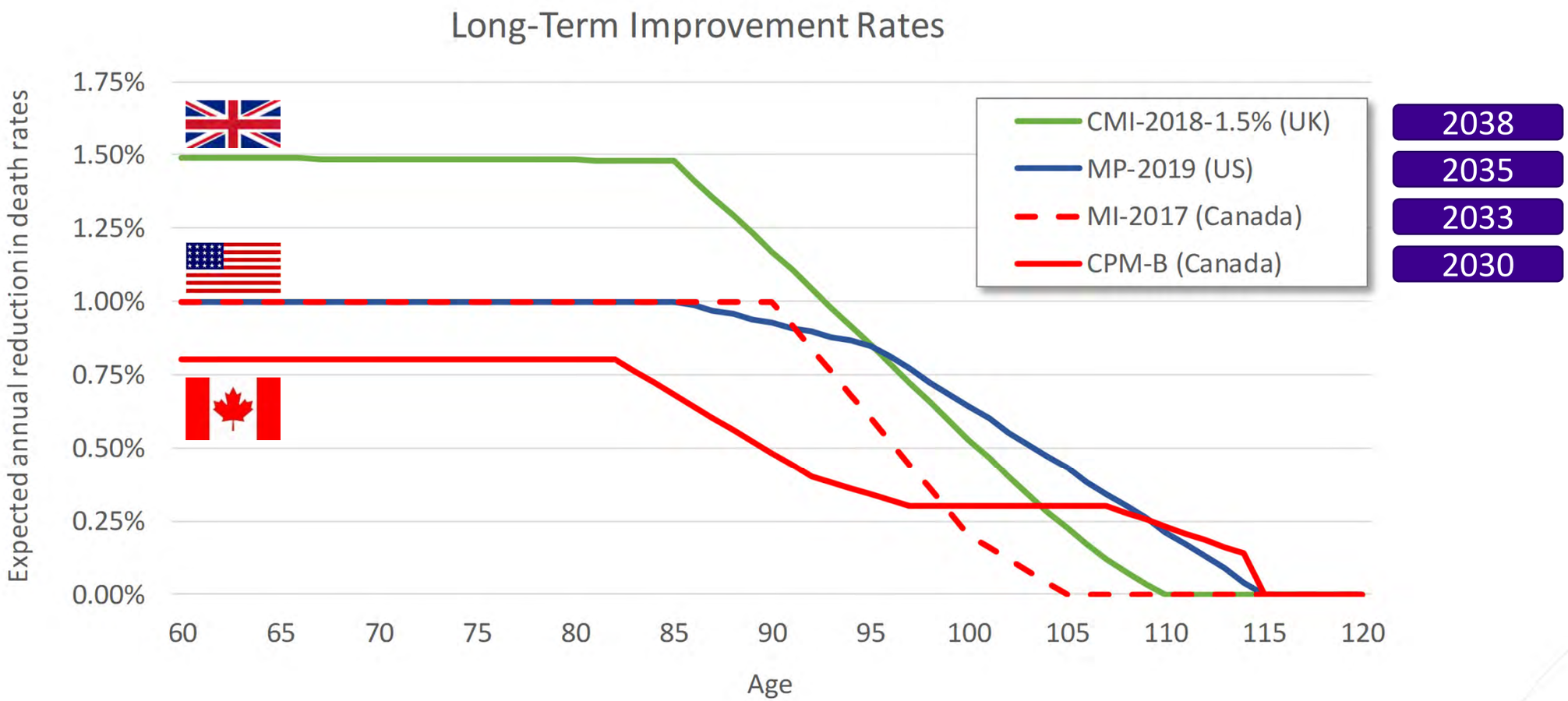
- How long people are **currently living** for.
- Can be measured **objectively** by looking at historical death rates.

+

Future improvements

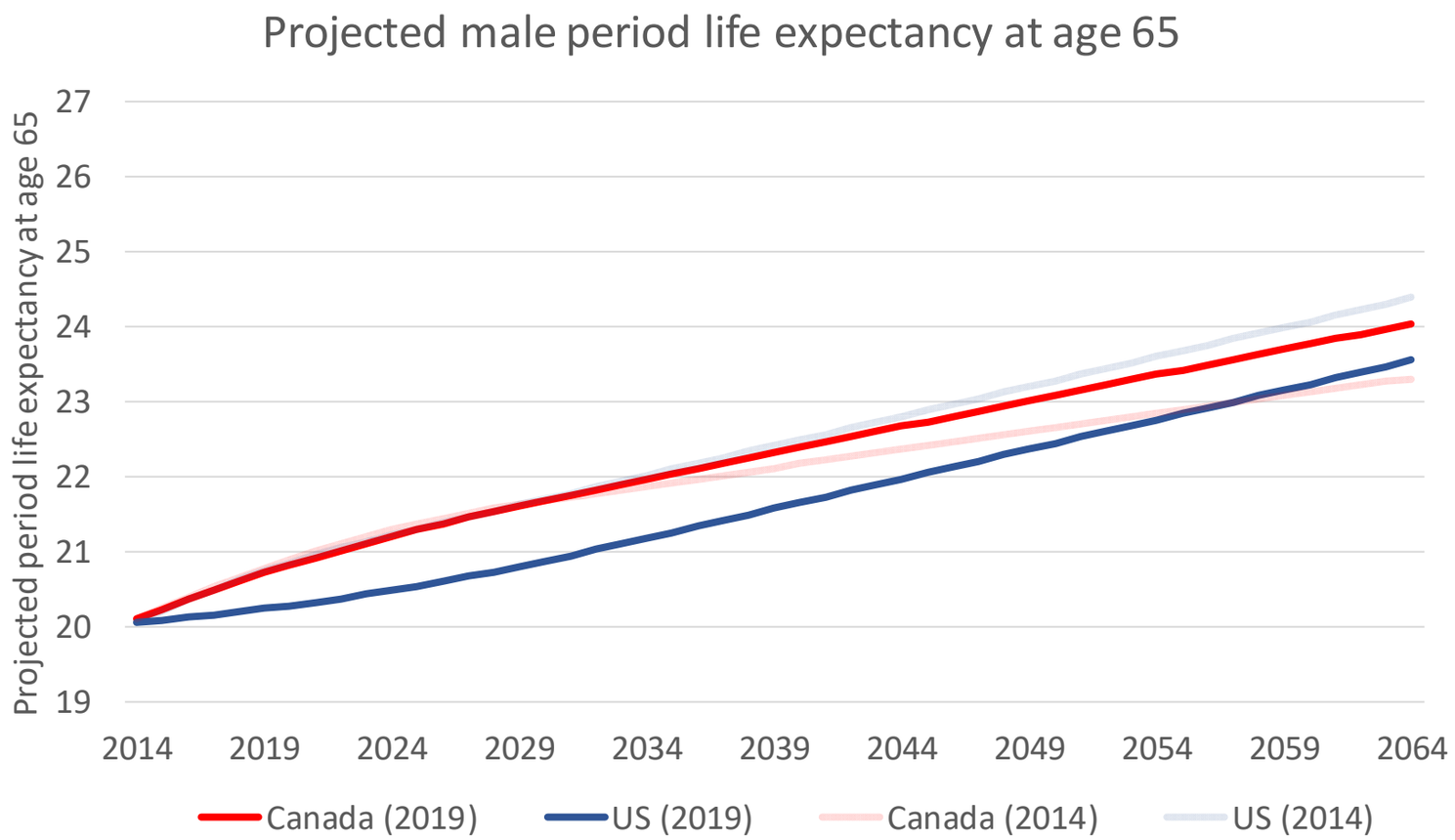
- How **longevity will change** in the future.
- Typically would expect mortality rates to decrease in the future and life expectancy to go up.
- Informed by views on future medical advances and generational differences in lifestyle, etc.
- Recent longevity trends will influence the assumptions you set, but it is important to understand the reasons behind recent experience before relying on it to adjust assumptions.
- This is a **subjective** assumption, and uncertainty will remain.

Different geographies… …different assumptions



Source: Club Vita compilation of common Canadian, US and UK pension plan mortality improvement assumptions.

But do the differences make sense?



2014 assumptions: CPM Private with CPM-B improvement scale; RP-2014 Healthy Annuitant with MP-2014 improvement scale
2019 assumptions: CPM Private with MI-2017 improvement scale; RP-2014 Healthy Annuitant with MP-2019 improvement scale

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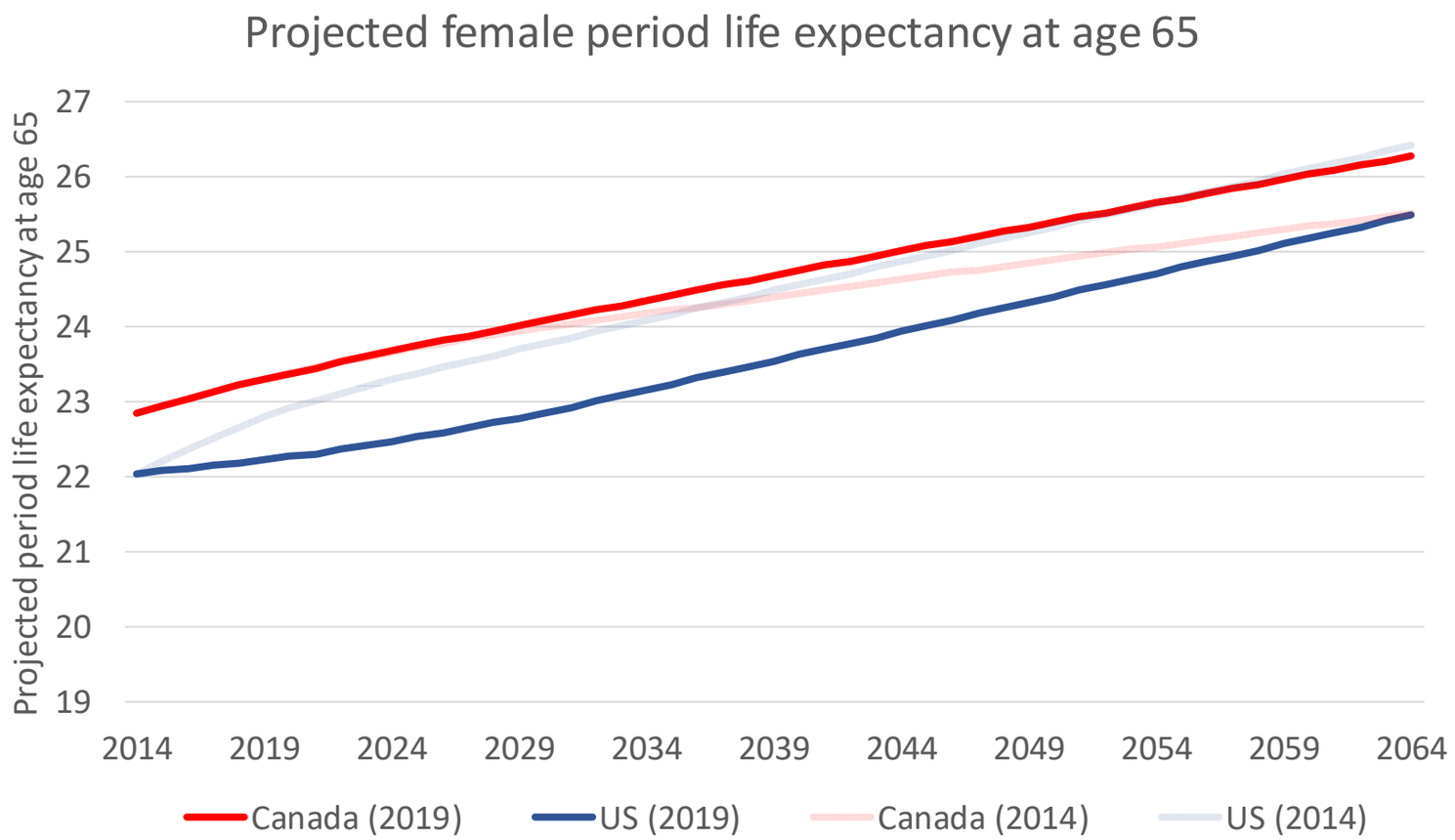
But do the differences make sense?



2014 assumptions: CPM Private with CPM-B improvement scale; RP-2014 Healthy Annuitant with MP-2014 improvement scale

2019 assumptions: CPM Private with MI-2017 improvement scale; RP-2014 Healthy Annuitant with MP-2019 improvement scale

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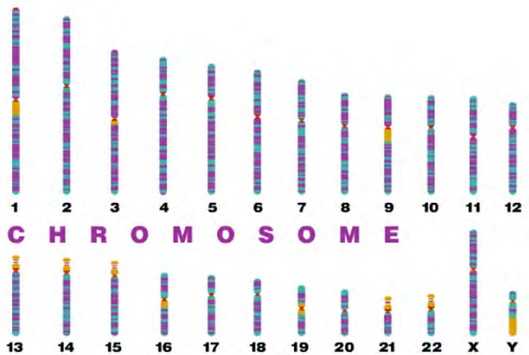
The impact of socio-economics
Baseline mortality

Nature or nurture?

Nature

Do genetics determine how long we live?



Nurture

Or is it our environment and life choices?

Evidence that only about 20% of lifespan variations explained by genetics

Study	Genetics	Everything else	
Herskind et al., 1996	26%	74%	Danish twins
Ljungquist et al., 1998	33%	67%	Swedish twins
Gavrilova et al., 1998	18%	82%	Royal families
Mitchell et al., 2001	25%	75%	Amish
Skytthe et al, 2003	25%	75%	Danish twins
Joshi et al (in prep)	16%	84%	Scottish nuclear families

The importance of healthy habits ….

54% of the fall in deaths from heart disease attributable to decline in smoking[1].

Eradicating prolonged sedentary behaviour might avoid ~10% of UK deaths[2].

The harmful use of alcohol is a causal factor in more than 200 disease and injury conditions[3].

1: over 1981-2000, source: Unal et al, 2005

2: 69,276 deaths avoided in 2016, Heron L, et al. J Epidemiology Community Health 2019;73:625–629. doi:10.1136/jech-2018-211758

3: Alcohol – Key Facts, WHO, Sept 2018

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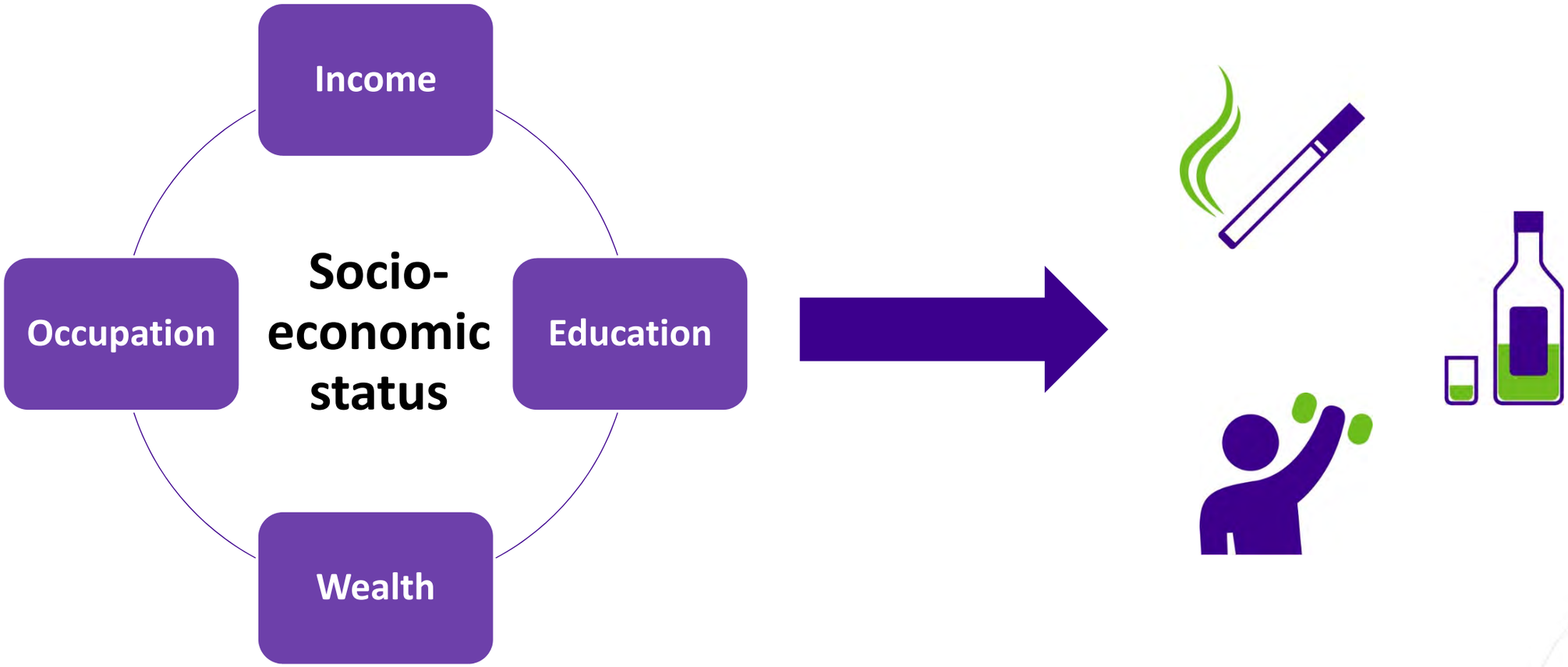
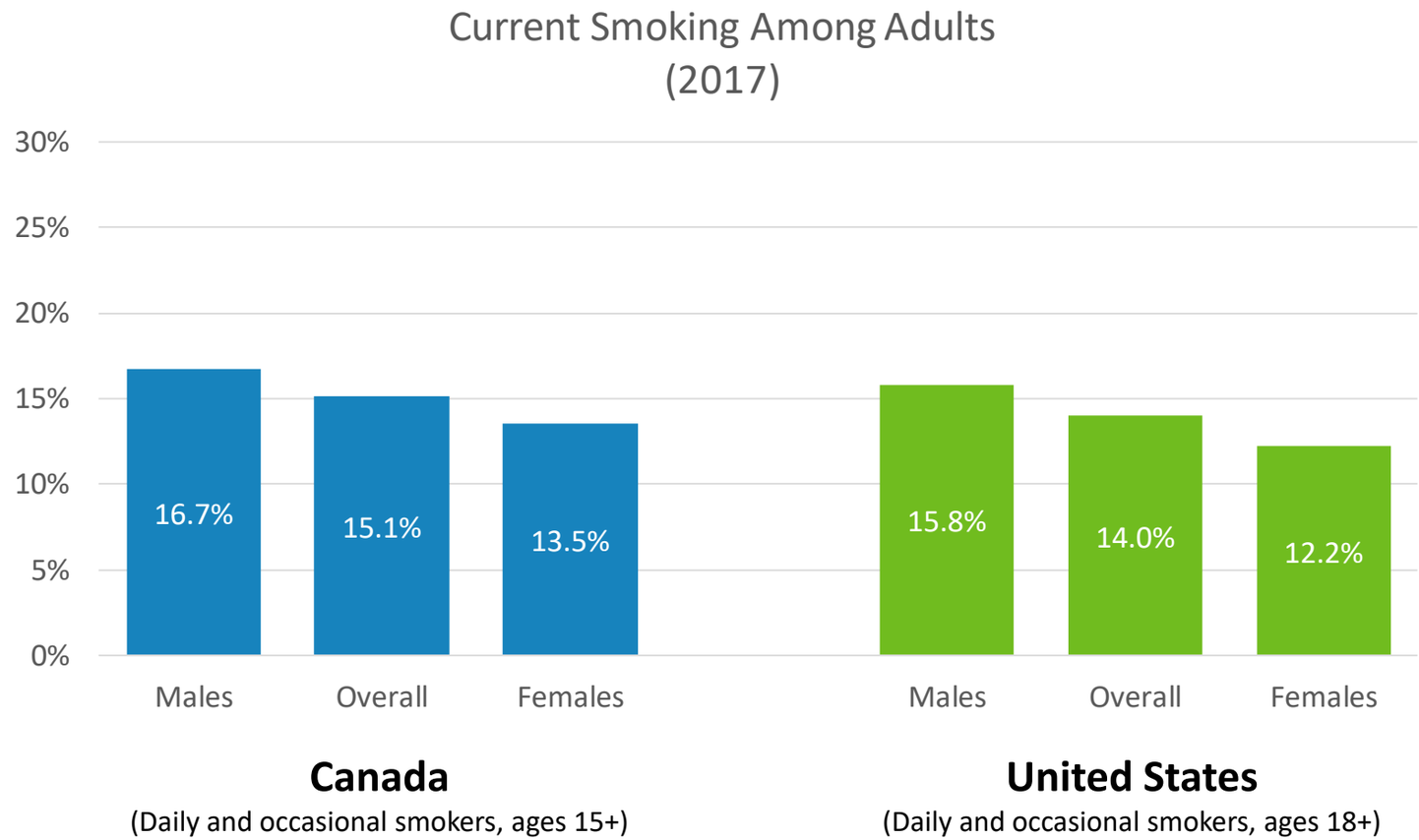
What is the relationship between socio-economic status and key health factors?



Current smoking prevalence



Current levels of smoking among adults similar for Canada and the US, and are among the lowest levels in 50 years.

Sources: University of Waterloo, Tobacco Use in Canada: Patterns and Trends (2019 Edition)
Centers for Disease Control and Prevention, Current Cigarette Smoking Among Adults in the United States

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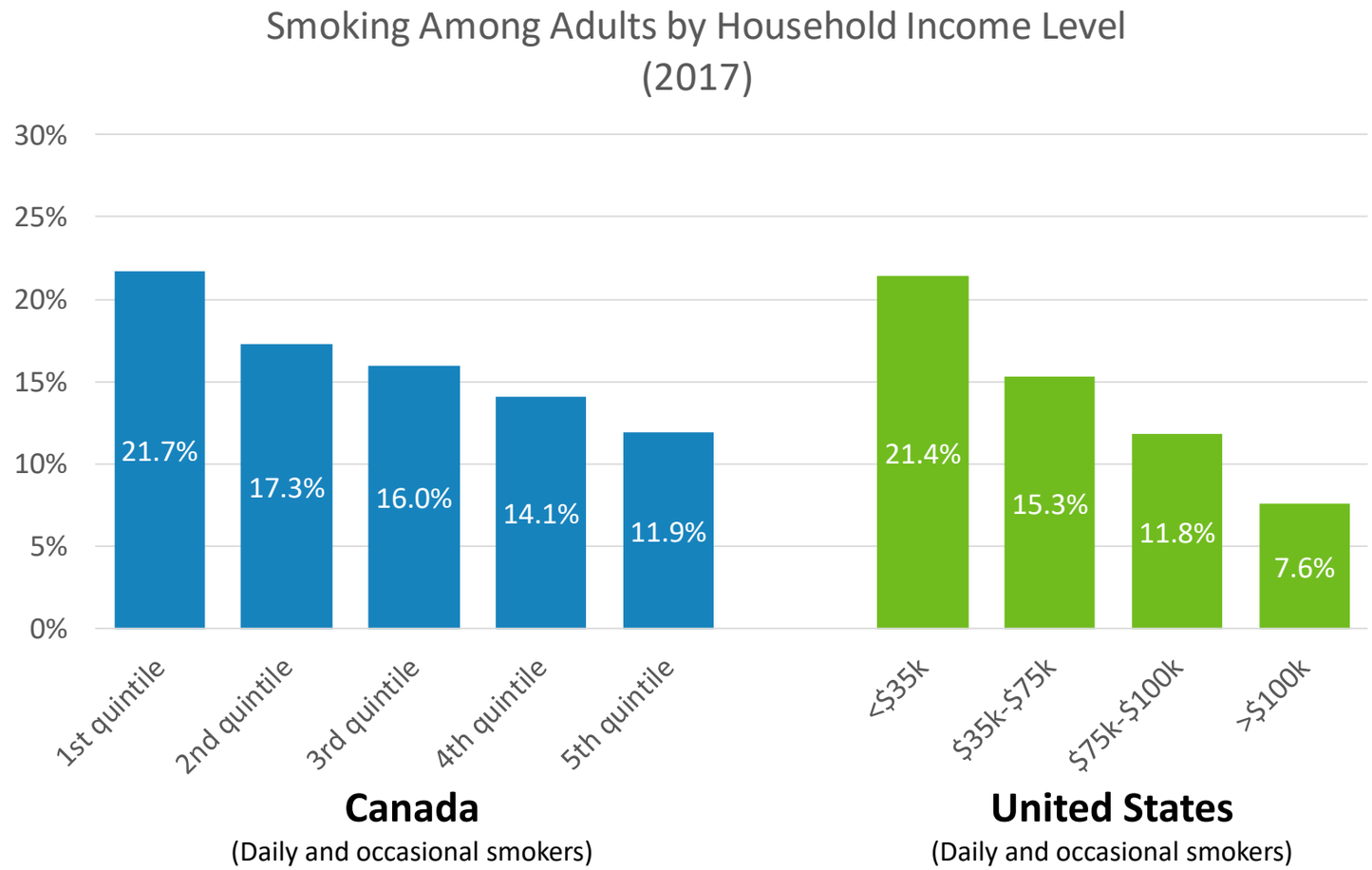
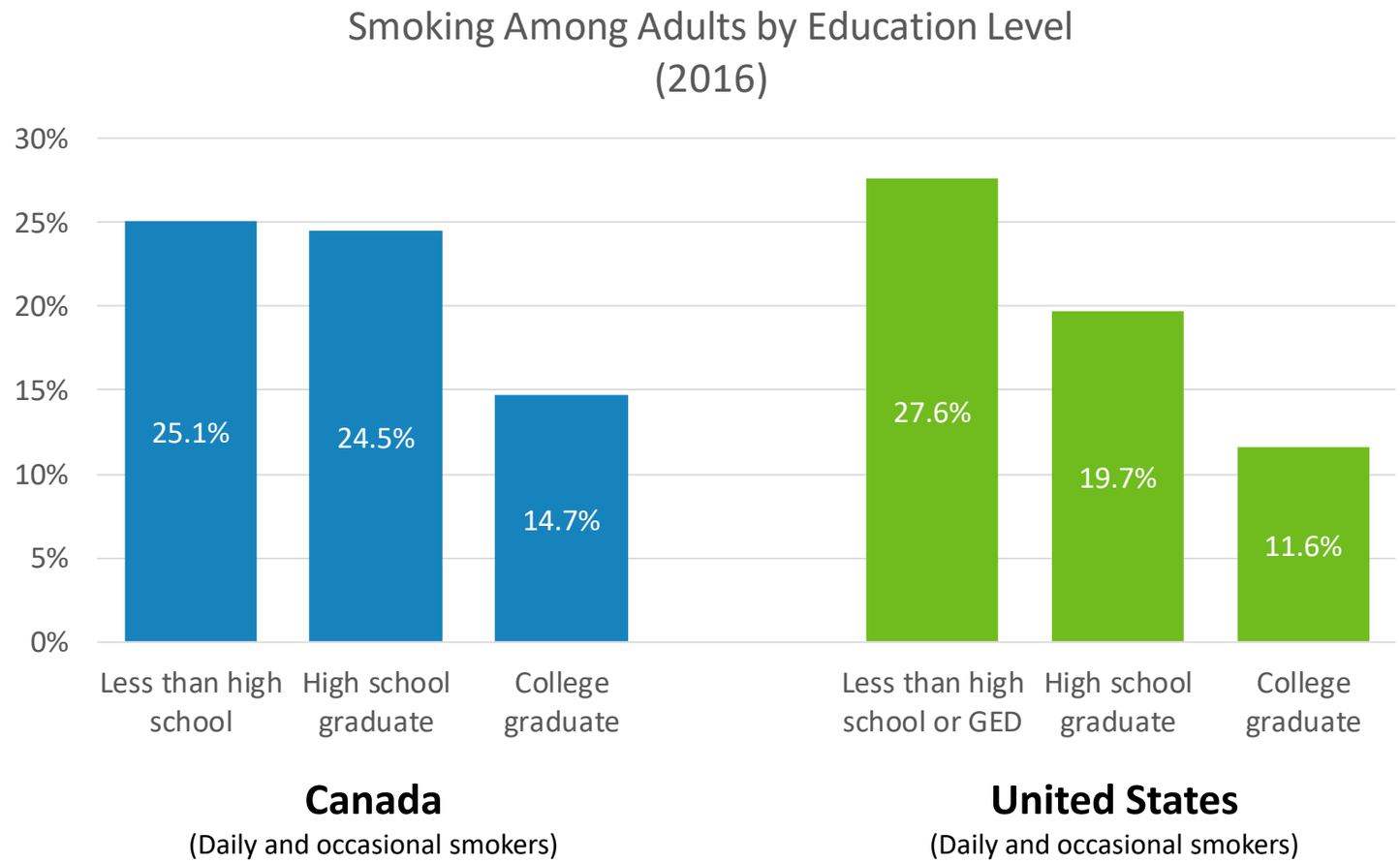
Smoking prevalence by income level



Large declines in smoking prevalence as income increases

Sources: Statistics Canada. Table 13-10-0097-01 Health characteristics, annual estimates, by household income quintile and highest level of education
Centers for Disease Control and Prevention, Current Cigarette Smoking Among Adults in the United States

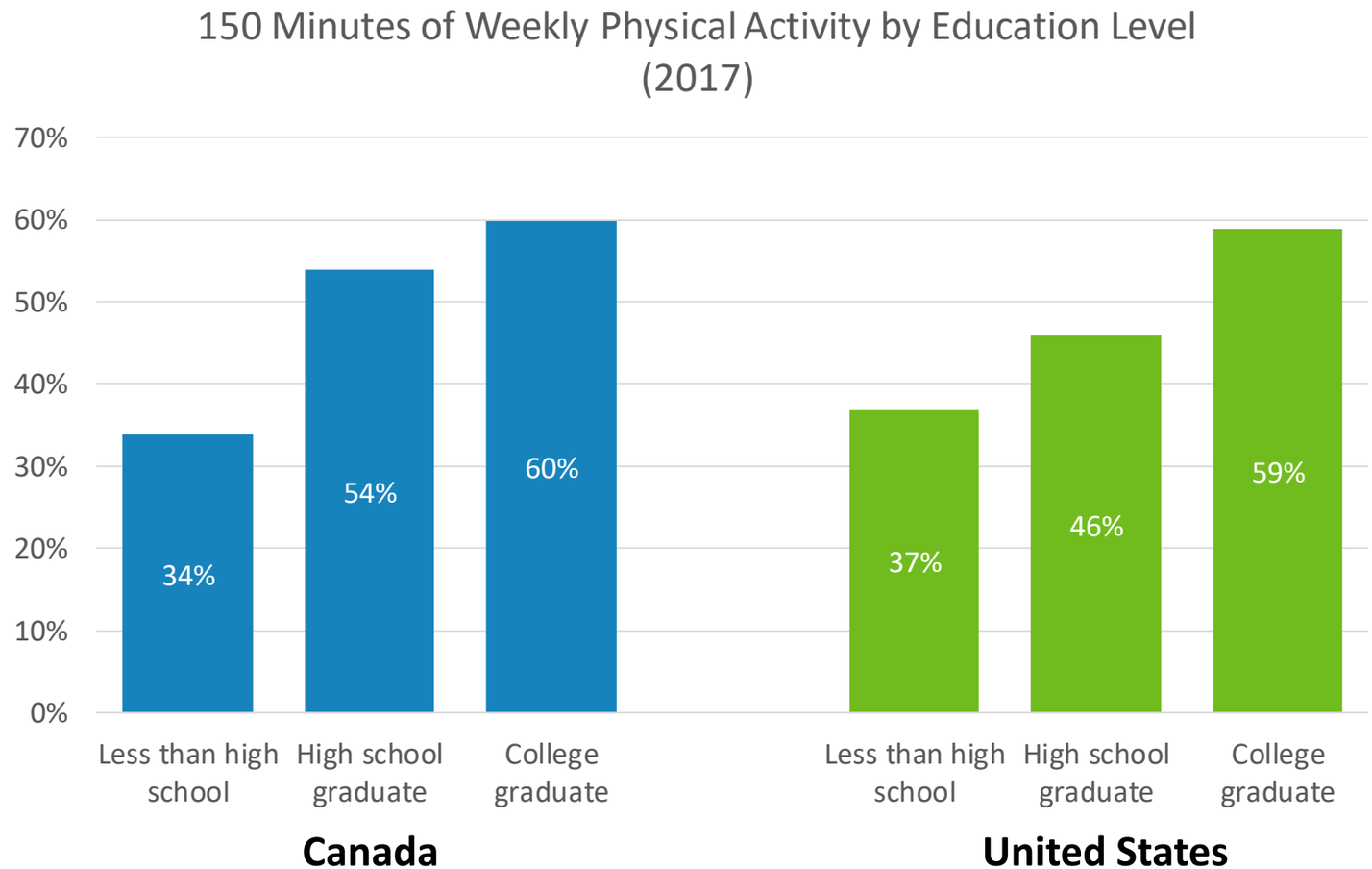
Smoking prevalence by education level



Smoking prevalence decreases significantly with post-secondary education

Sources: Statistics Canada. Table 13-10-0097-01 Health characteristics, annual estimates, by household income quintile and highest level of education
Centers for Disease Control and Prevention, Current Cigarette Smoking Among Adults — United States, 2016

Physical activity by education level



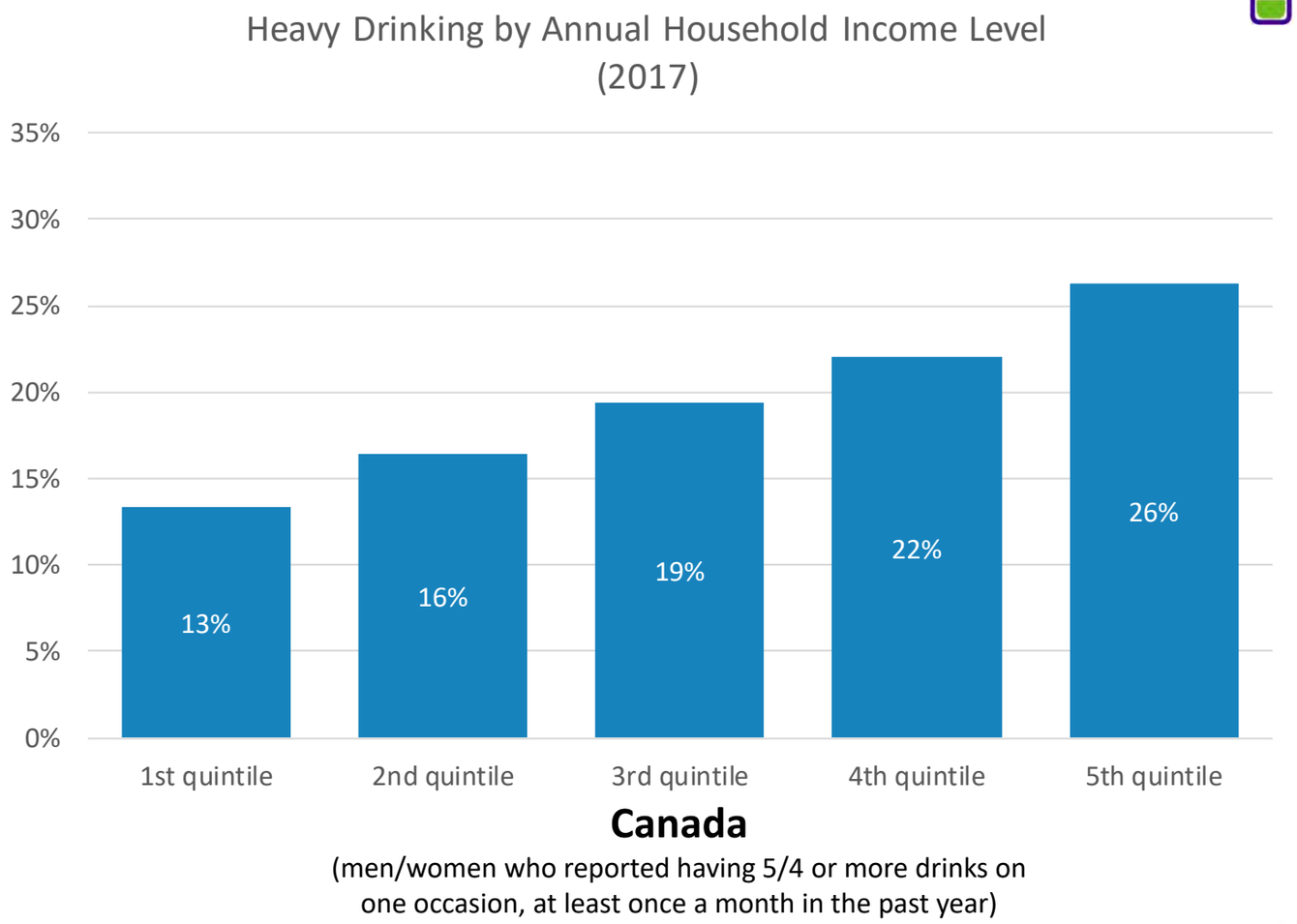
Regular physical activity levels increase substantially with education level

Sources: Statistics Canada. Table 13-10-0097-01 Health characteristics, annual estimates, by household income quintile and highest level of education
Centers for Disease Control and Prevention, Nutrition, Physical Activity, and Obesity: Data, Trends and Maps

Heavy drinking

Drinking tends to increase with socio-economic status, however alcohol-related mortality has been found to be much higher among lower socio-economic groups[1]

[1] Alcohol-related mortality as a function of socio-economic status, Mäkelä P. (1999).

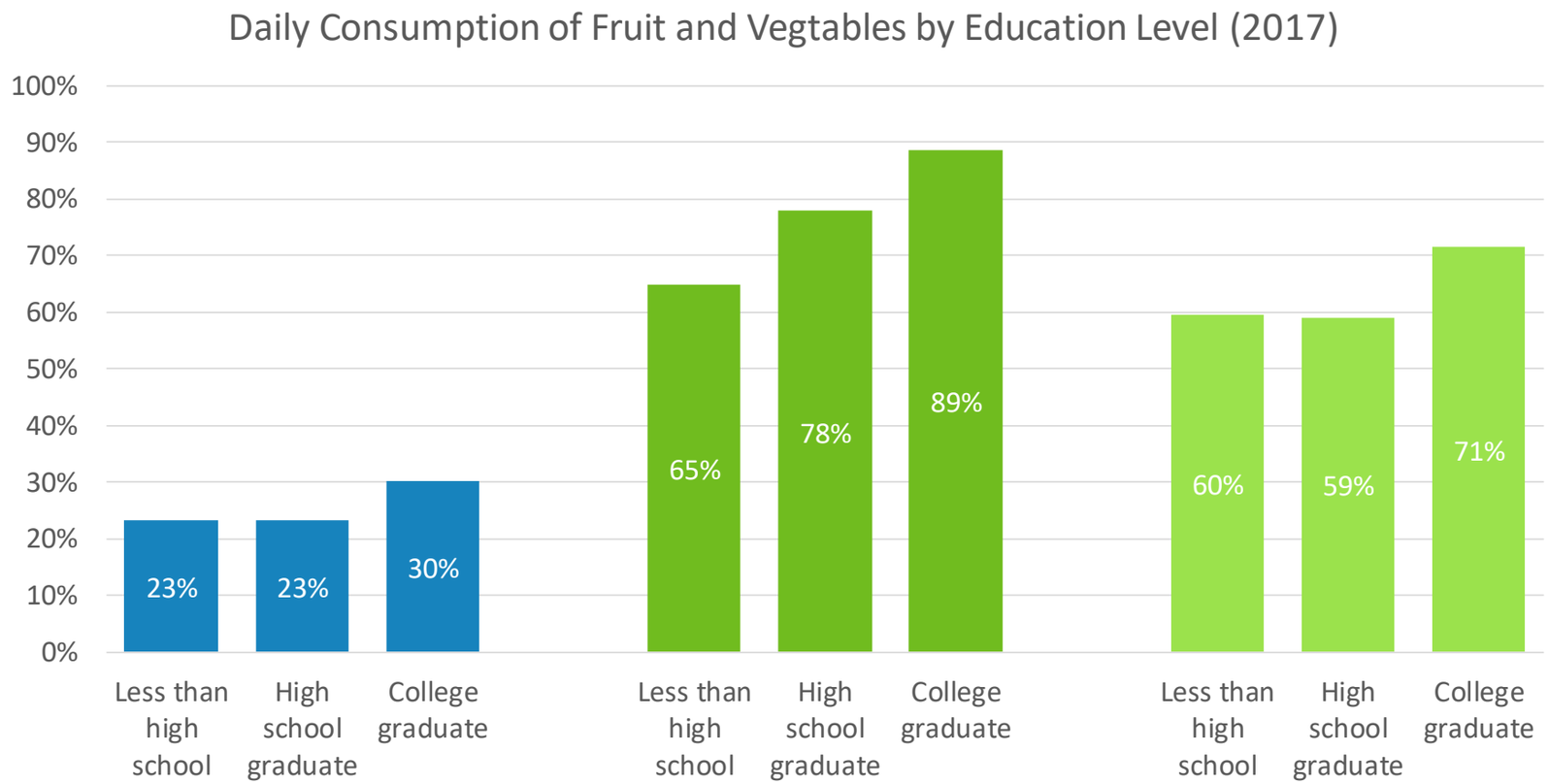


Canada

(men/women who reported having 5/4 or more drinks on one occasion, at least once a month in the past year)

Source: Statistics Canada. Table 13-10-0097-01 Health characteristics, annual estimates, by household income quintile and highest level of education

Daily fruit and vegetables by education level



Canada
(Fruit and vegetables consumed 5 times or more per day)

United States
(Vegetables consumed >=1 time daily)

United States
(Fruit consumed >=1 time daily)

Sources: Statistics Canada. Table 13-10-0097-01 Health characteristics, annual estimates, by household income quintile and highest level of education
Centers for Disease Control and Prevention, Nutrition, Physical Activity, and Obesity: Data, Trends and Maps

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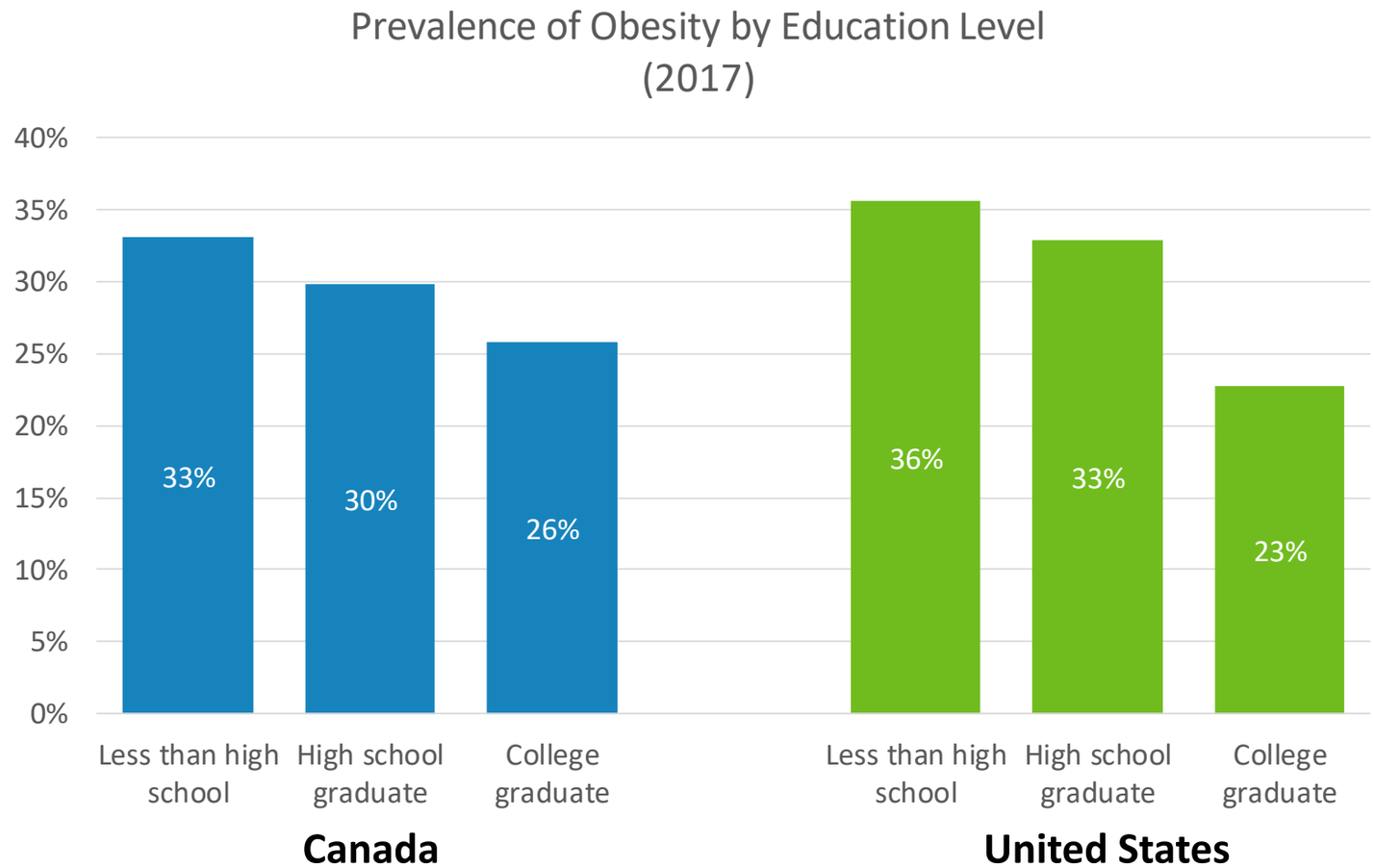
Obesity by education level



Prevalence of obesity among adults by education level consistent with physical activity and diet patterns

Sources: Statistics Canada. Table 13-10-0097-01 Health characteristics, annual estimates, by household income quintile and highest level of education
Centers for Disease Control and Prevention, Nutrition, Physical Activity, and Obesity: Data, Trends and Maps

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The impact of socio-economics
Pension plan *baseline mortality*

Factors available in pension plan records

Age

Gender

Health at Retirement

Retiree vs. Survivor

Pension or Salary

Job Type/ Industry

Marital Status

Postal Code/ Zip Code

Using socio-economics with pension plans

SOA analysis for retiree mortality

Pub-2010

Multivariate analysis identified the relevance of multiple variables…

"..benefit quartile was generally the most significant explanatory variable among the region, job category, quartile and year indicators."

"Regressions by gender for each job category (e.g., male Safety) continued to show benefit amount quartile as a statistically significant variable, with a more pronounced effect for males than for females."

..and the care needed in constructing multivariate tables…

"As with benefit quartile, interaction terms among age and job category indicated the differences were not simple factor relationships but actually different curve shapes."

Stratified tables by gender, retiree type and job category

Source: SOA paper "Pub-2010 Public Retirement Plans Mortality Tables Report"

Pri-2012

Multivariate analysis identified the relevance of multiple variables…

"…after controlling for the age, gender and collar type covariates, the income quartile was still a significant predictor of Retiree mortality, with mortality decreasing with increasing retirement benefit amount."

..and the care needed in constructing multivariate tables…

"A regression model including not only collar type and income quartile but additional interaction terms with age / collar type and age / income quartile, demonstrated the statistical significance of interaction effects. This indicated to the committee that separate tables, as opposed to simple loading factors, are desirable…"

Stratified tables by gender, retiree type and either collar or benefit amount

Source: SOA paper "Pri-2012 Private Retirement Plans Mortality Tables Exposure Draft Report"

Using socio-economics with pension plans

Taking a multivariate approach

Fitting a wide range of internally consistent tables **simultaneously** across a range of variables

1 Split the data

Gender

Retiree

Disability

2 Fit the data across lots of variables

ZIP+4

Annuity

Collar

Makes maximum use of the available data, improving confidence in the resulting tables while creating a model that captures the diversity of the underlying population.

Building a model for longevity

Using pension plan data

An independent data utility collecting and analyzing pension plan longevity data for the benefit of pension pans, advisors, insurers and asset managers.

			
Founded	2008	2015	2019
Key stats	**2.9m** UK pensioners **1 in 4** DB pension plan participants Over **230 pension plans** **1.4m** deaths Stretching back **25+ years**	**0.75m** Canadian pensioners **1 in 4** DB pension plan participants Over **60 pension plans** **200k** deaths Stretching back **20 years**	**0.8m** in payment participants Over **100 pension plans** **150k** deaths Stretching back **9 years**

A geographical and industry diverse dataset in each country

Building a model for longevity

Beyond factor based to full multivariate modelling

The predictors j are the longevity group (A to G as determined by ZIP+4), annuity amount and collar type

Main effect for each predictor: Additions depending on the value taken by each predictor j (can be negative)

Controls for mortality rate variations between calendar years, and is 0 for central year

$$logit(q_x|values\ of\ predictors, j) = \sum_i a_i x^i + \sum_j b_j + \sum_{i,j} c_{ij} x^{-i} + \text{YOE}$$

$$logit(q) = \ln\left(\frac{q}{1-q}\right)$$

Main age function: A polynomial in age, x, with a small number of terms (typically 3 or 4) where i takes values in range $[-4, -3, \ldots, 3, 4]$

"Interaction" terms, whereby there is a small number of terms of the polynomial in age, x, which depend on the value taken by the predictor

Parsimony principle: A simpler model with few rather than many parameters is favored over comparatively complex ones, provided they fit the data about equally well.

Source: Club Vita, for more information see Modelling Technical Paper.

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Turning ZIP codes into a longevity rating factor

Marketing principles:

1. People living in similar neighborhoods have similar characteristics *(large diversity within ZIP codes mean ZIP+4 is necessary)*

2. Neighborhoods can be characterized by types of people living there

3. Neighborhoods with same characterization appear all over the country

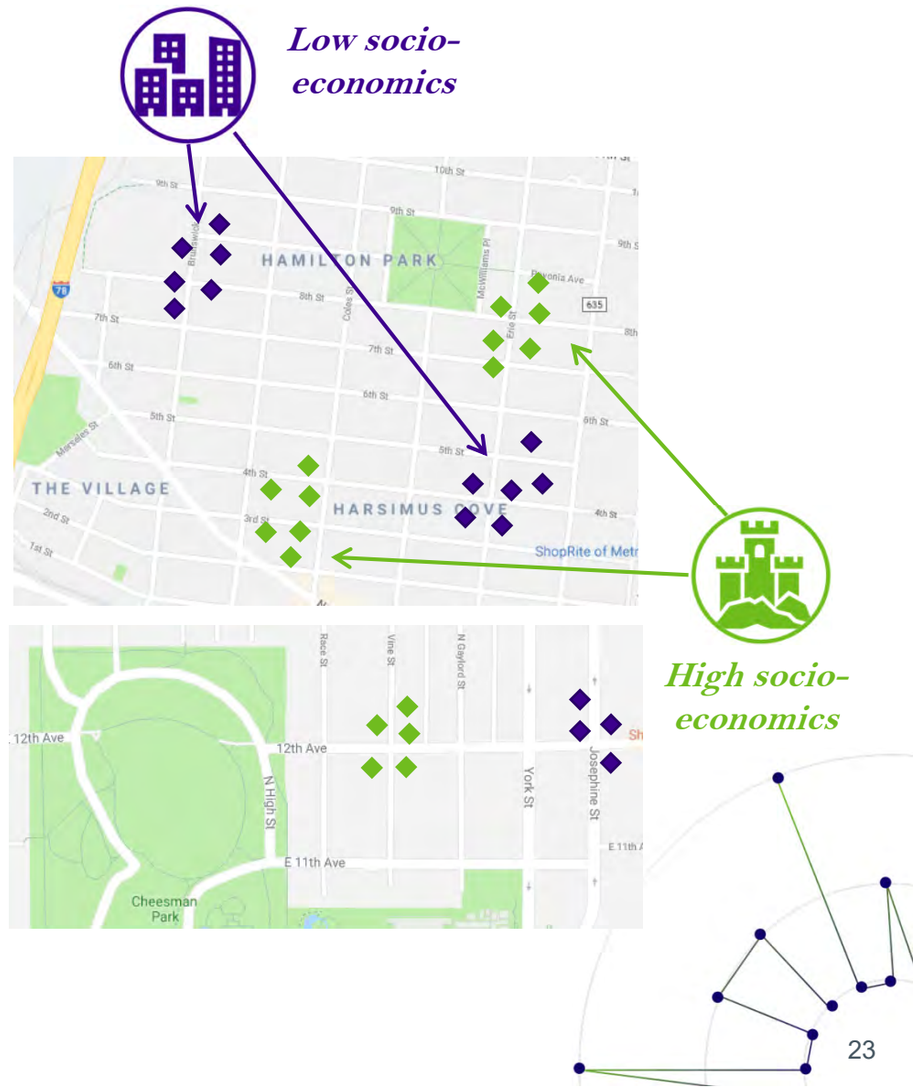
46 million + US ZIP+4 codes => 58 marketing groups

Longevity modelling principle:

4. People with similar characteristics have similar longevity

58 marketing groups => 7 longevity groups men (6 for women)

*Neighborhood characteristics for illustration only



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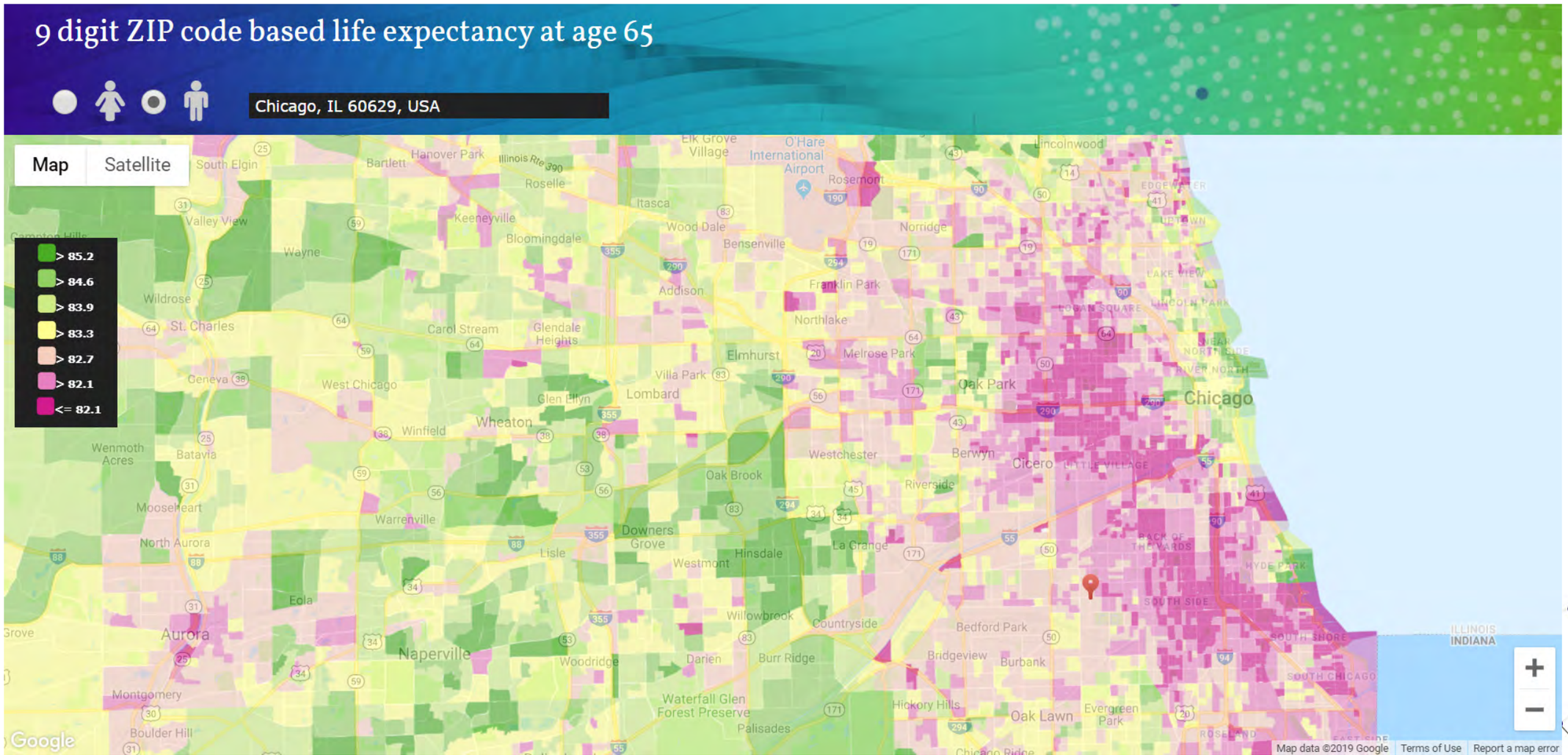
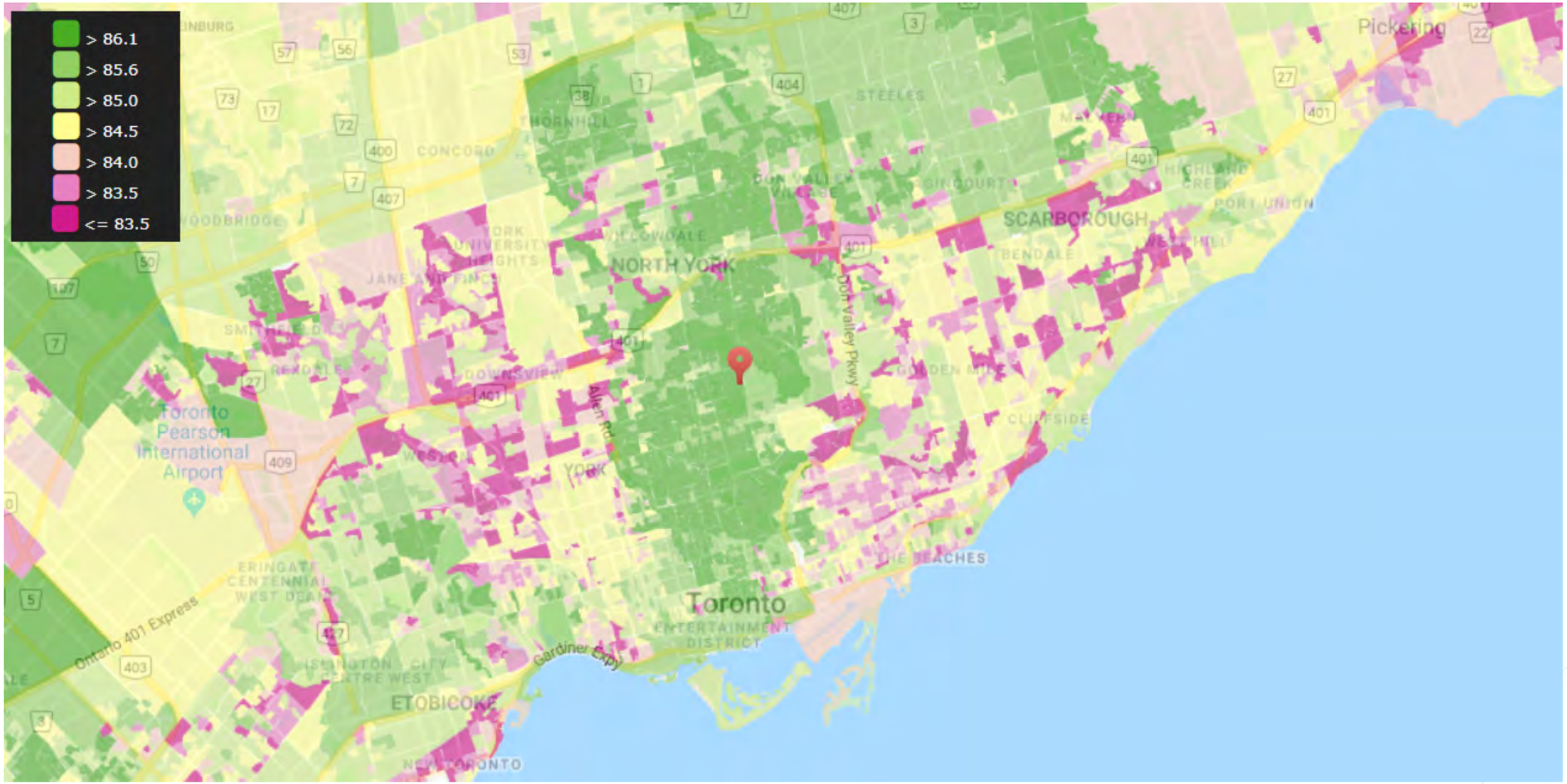
Zooming in on ZIP+4 – Chicago males



CLUB VITA https://maps.clubvita.us/

Perusing postal codes – Toronto males



Spread in baseline from socio-economics

VITACURVES™						
Total spread	12 years		10 years		9½ years[a]	
Gender specific spread	10½	8½	7	7½	8½	6½
Retirement health	2½	3	½	2	1	1
"Normal health" spread	8	5½	6½	6	7½	6
Lifestyle	4¼	4½	2¾	3½	3¼[a]	3½[a]
Affluence	3½	½	2	2½	3¼	1½
Occupation	¼	½	1¼	<¼	1¼	1

Technical note: Effects shown are the impact of changing one rating factor in isolation. Precise impacts depend on order of changing variables and so above reflects broad quantum and therefore relative importance of each variable. Sums may not add due to rounding. UK and Canada calibrated to data from both public and private sectors, which show no material difference when salary and postcode are known (the first generation US calibration only used private sector data). (a) Anticipating a wider US spectrum in 2020 release as salaries are introduced as measure of affluence.

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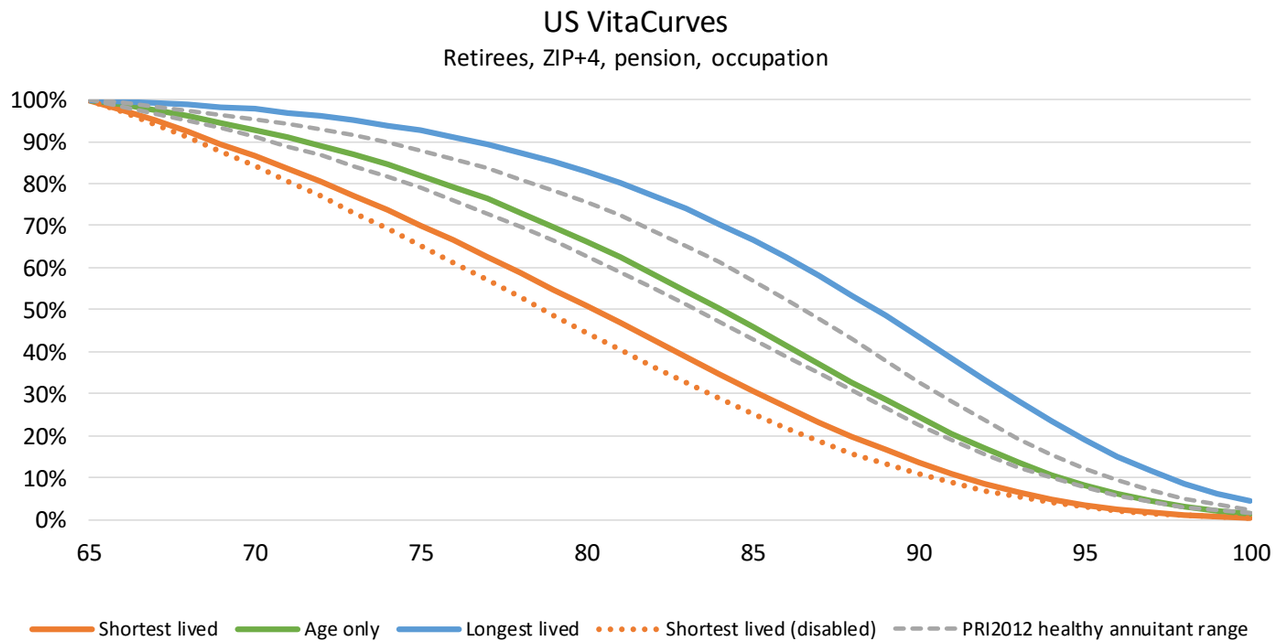
Comparison with draft Pri-2012 tables

(with MP18 improvements 2012-2015)



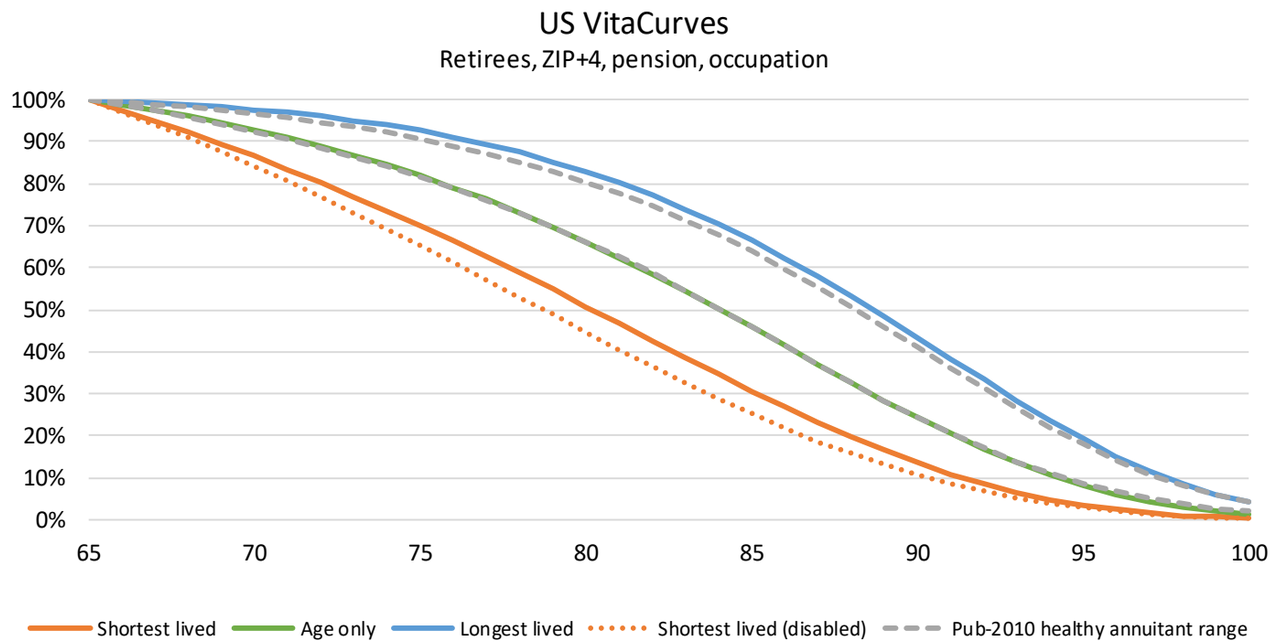
Life expectancy for age 65:

		"Healthy" Annuitant		
	Disabled	Bottom	Age only	Top
9 digit ZIP VitaCurves	14.1	15.2	18.5	22.8
Draft PRI-2012 *(with MP18 roll up from 2012 to 2015)*	14.5	17.9	19.3	20.6

MP18 improvements used to roll forward draft Pri-2012to 2015 (the effective year of VitaCurves, No allowance made in the above for any improvements after 2015. Note that age-only healthy annuitant and disabled tables are amount weighted for Pri-2012 and lives weighted for VitaCurves. Pri-2012 bottom table is lower quartile income; top table white collar.

Comparison with Pub-2010 tables

(with MP18 improvements 2010-2015)



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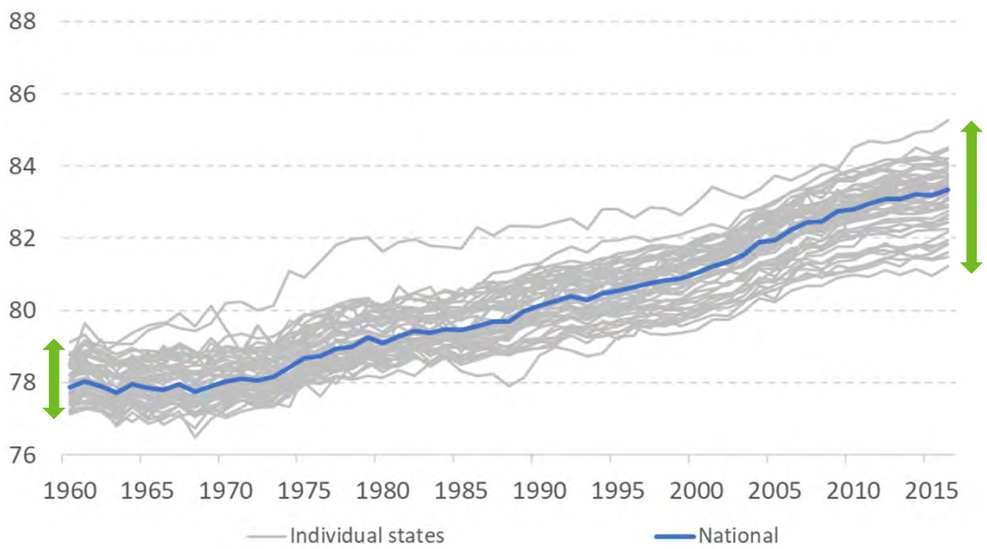
The impact of socio-economics
Mortality improvements

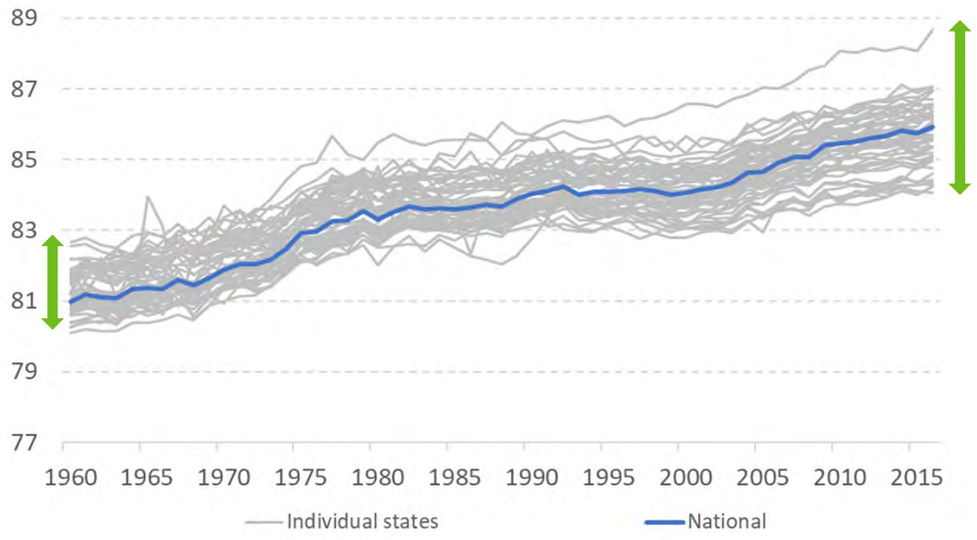
Longer lifespans, but widening gaps

Life expectancy from 65



2 year gap → 4 year gap

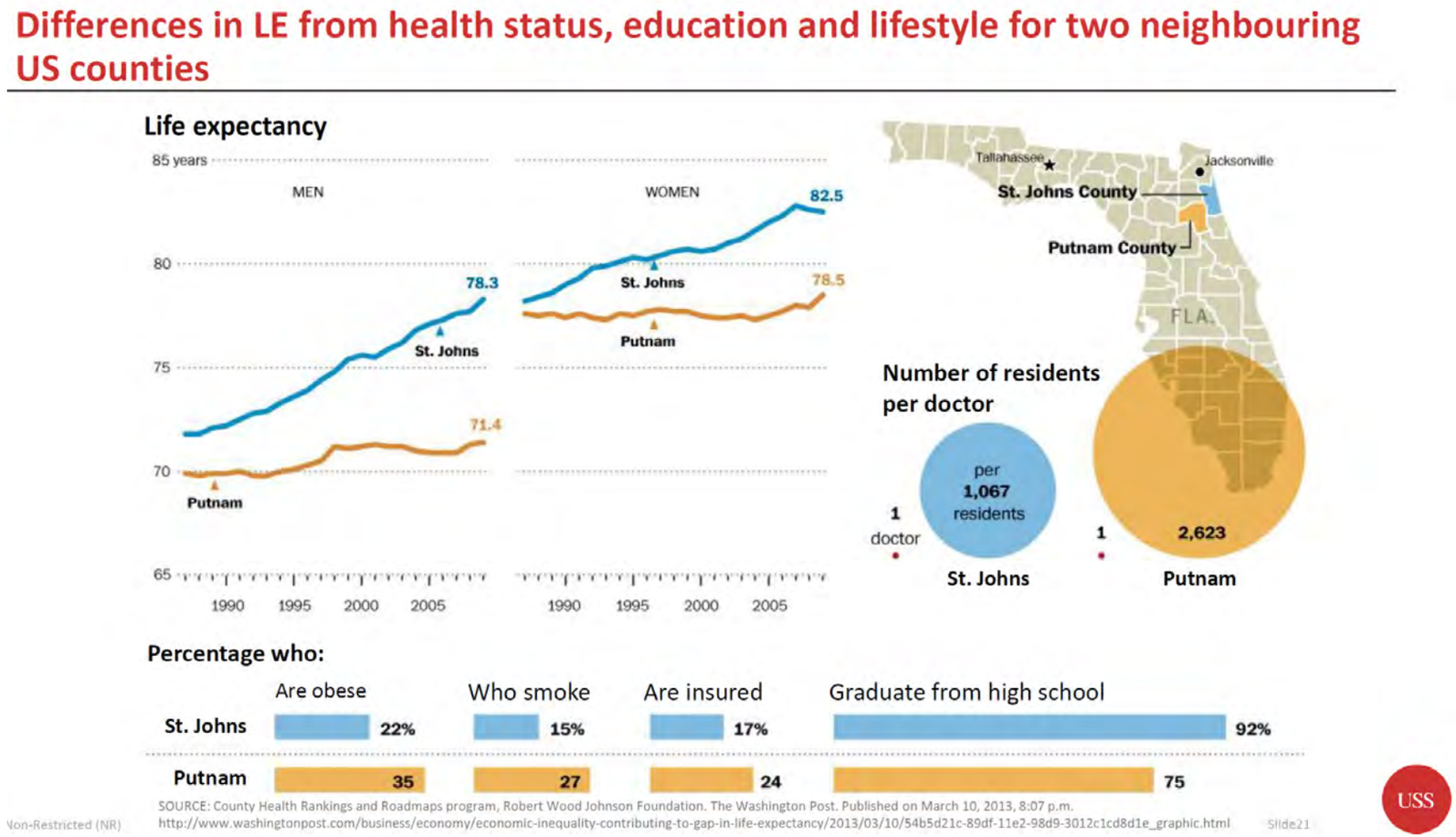
Life expectancy from 65



2.5 year gap → 4.6 year gap

What is driving this diversity and how can we describe it?

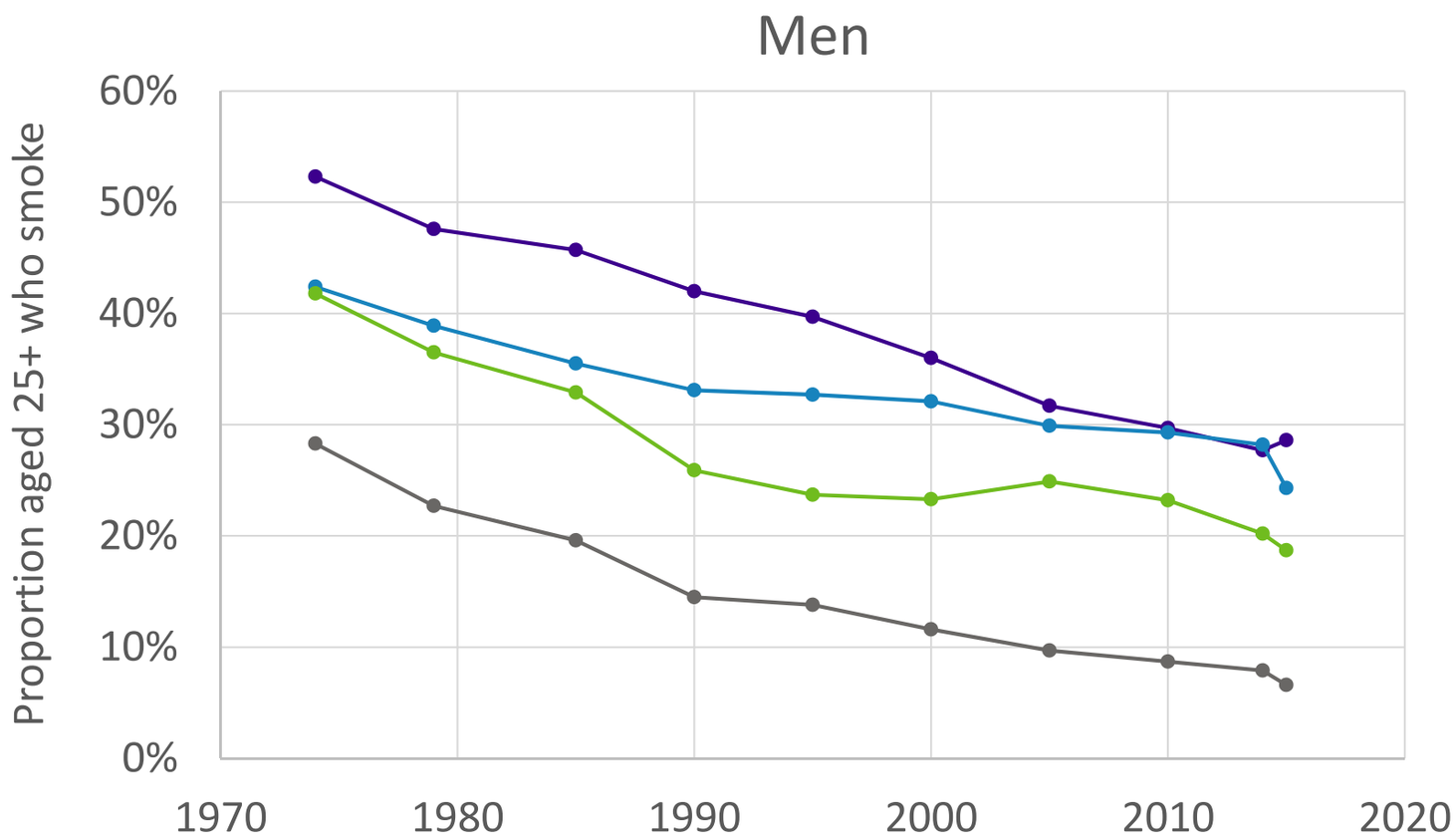
A tale of two counties...



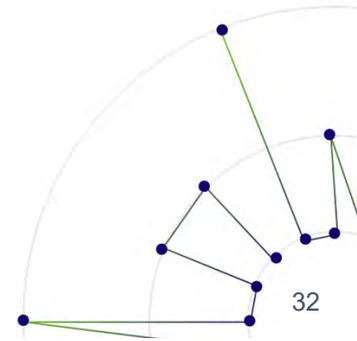
Source: Presentation by Guy Coughlan of USS to Longevity 13, 2017.

Trends in smoking prevalence by education

Males

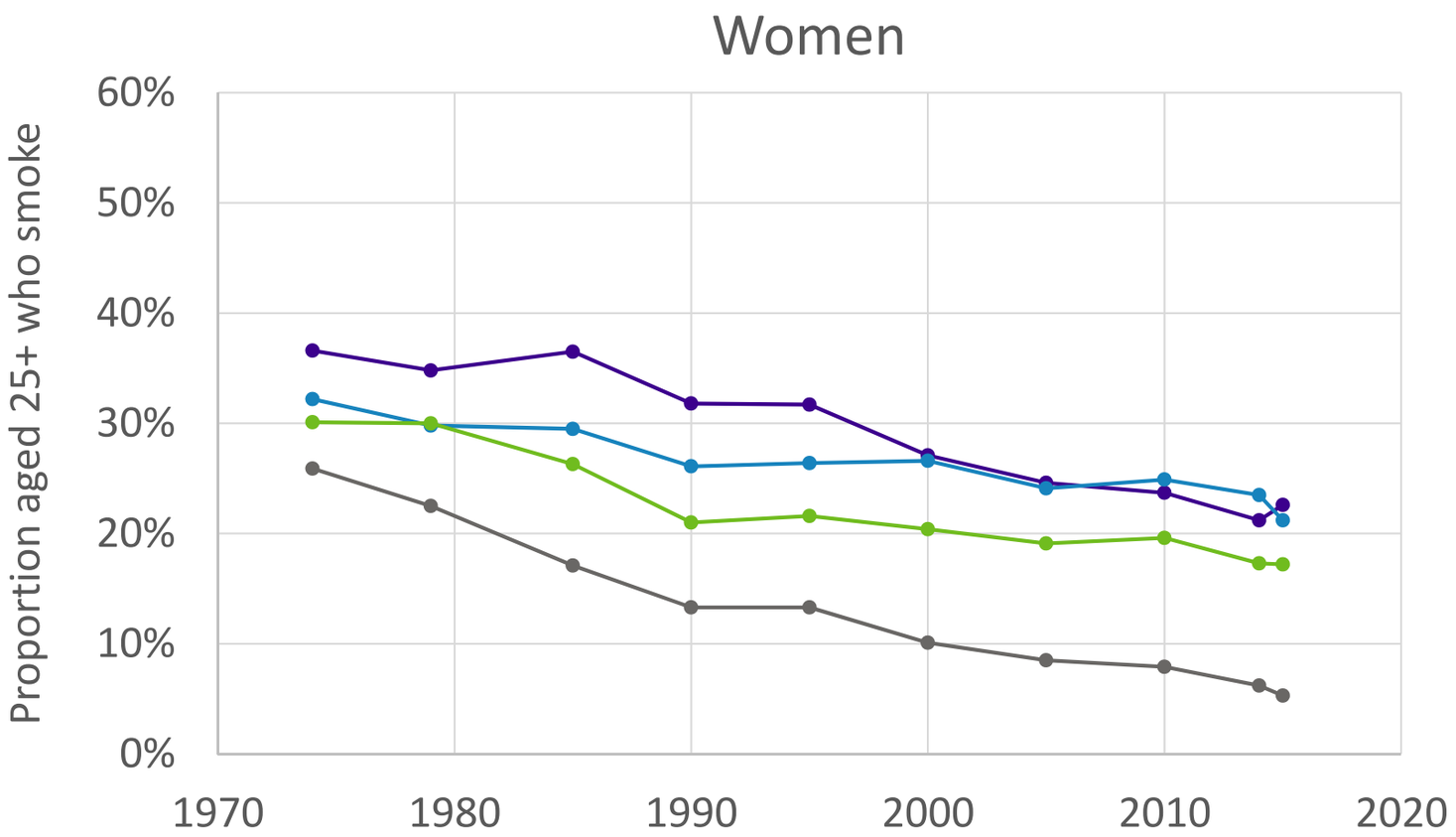


Source: Age-adjusted prevalence of current cigarette smoking among adults aged 25 and over, by sex, race, and education level: United States, selected years 1974–2015 (CDC)



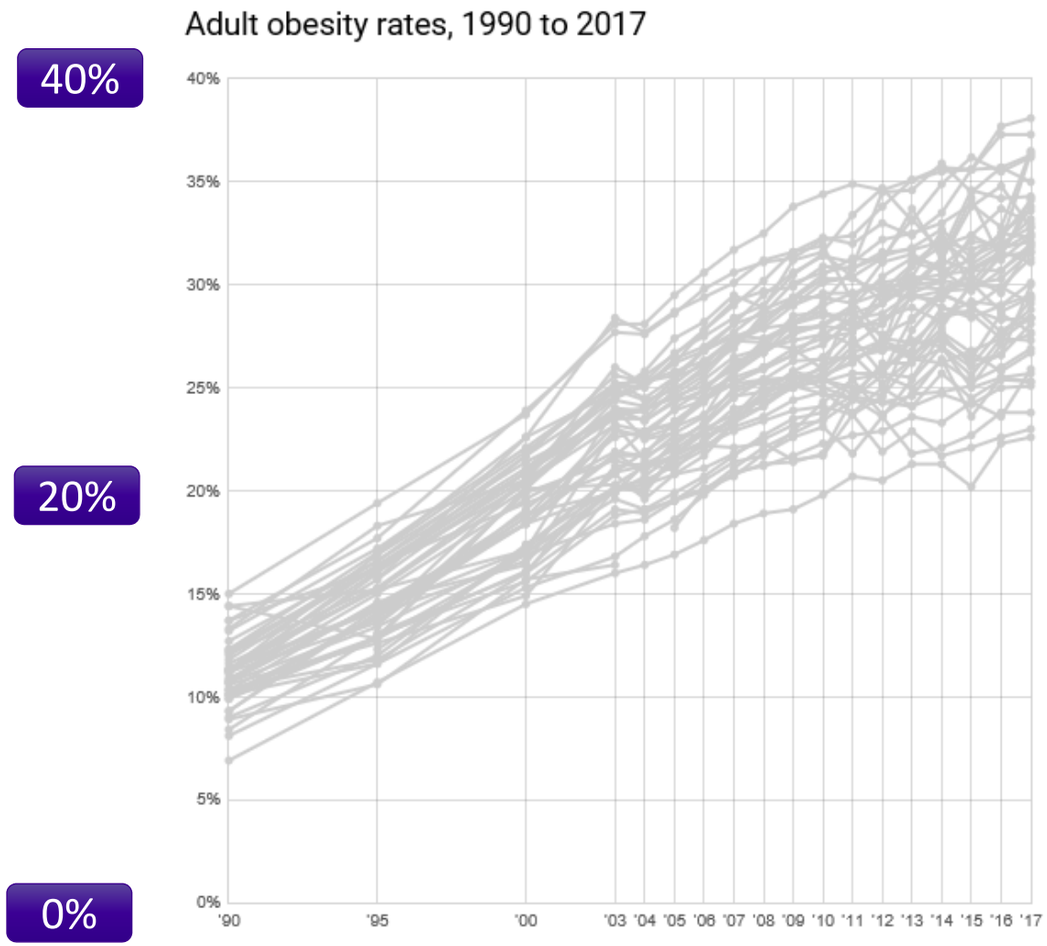
Trends in smoking prevalence by education

Females



Source: Age-adjusted prevalence of current cigarette smoking among adults aged 25 and over, by sex, race, and education level: United States, selected years 1974–2015 (CDC)

Obesity trends by state

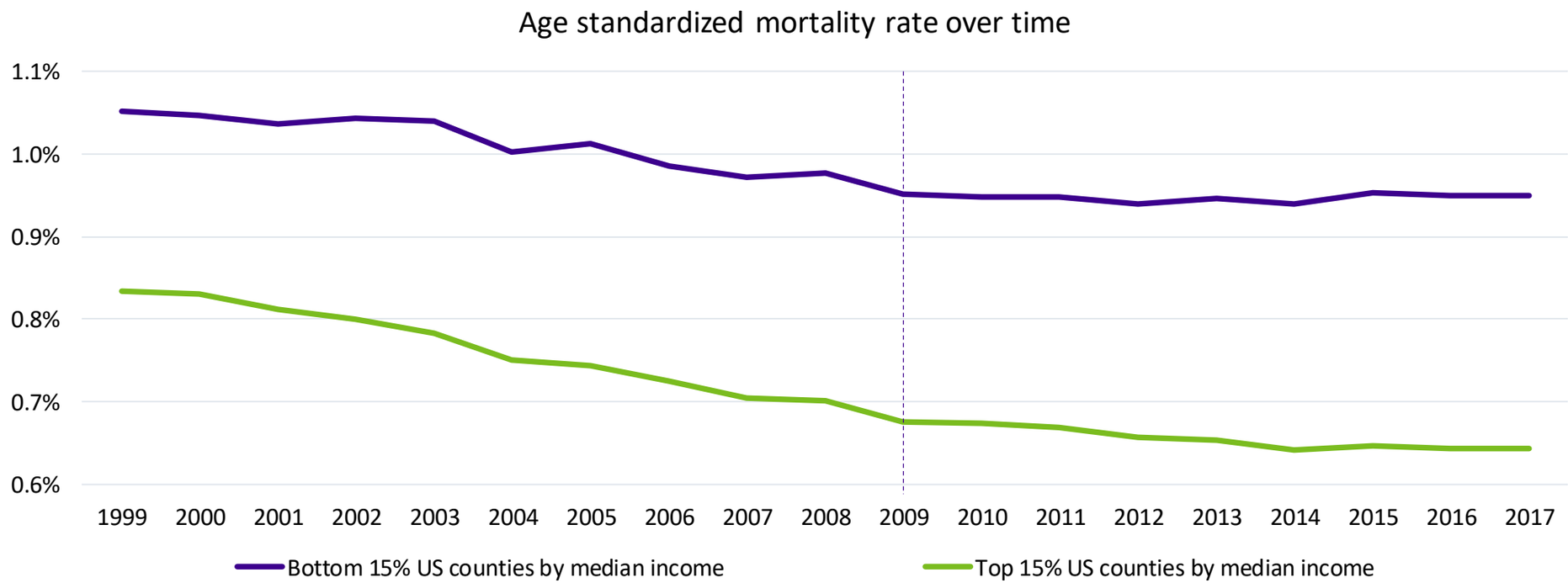


1990… **8% spread**

2017… **16% spread**

Adult obesity rates = percentage of adults with BMI of 30+. Based upon self-reported BMI.
Source: State of Childhood Obesity (https://stateofchildhoodobesity.org/adult-obesity/) analysis of the Behaviourial Risk Factor Surveillance System for adult obesity.

Mortality fallen fastest amongst highest incomes



Annualized mortality improvements	1999-2009	2009-2017
Bottom 15% of counties by income	1.0% p.a.	0.0% p.a.
Top 15% of counties by income	2.1% p.a.	0.6% p.a.

Source: Club Vita calculations based on Society of Actuaries U.S. Population Mortality Observations, 2019

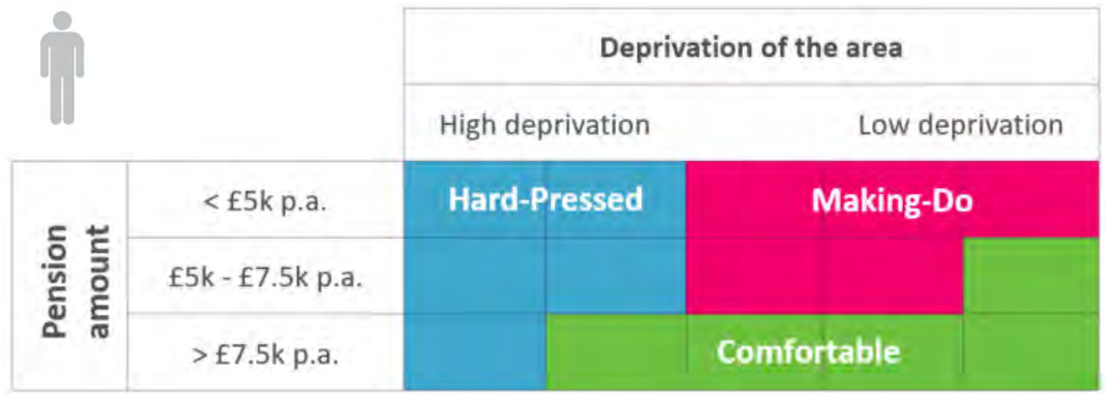
The impact of socio-economics
Pension plan *mortality improvements*

Identifying socio-economics in pension plans

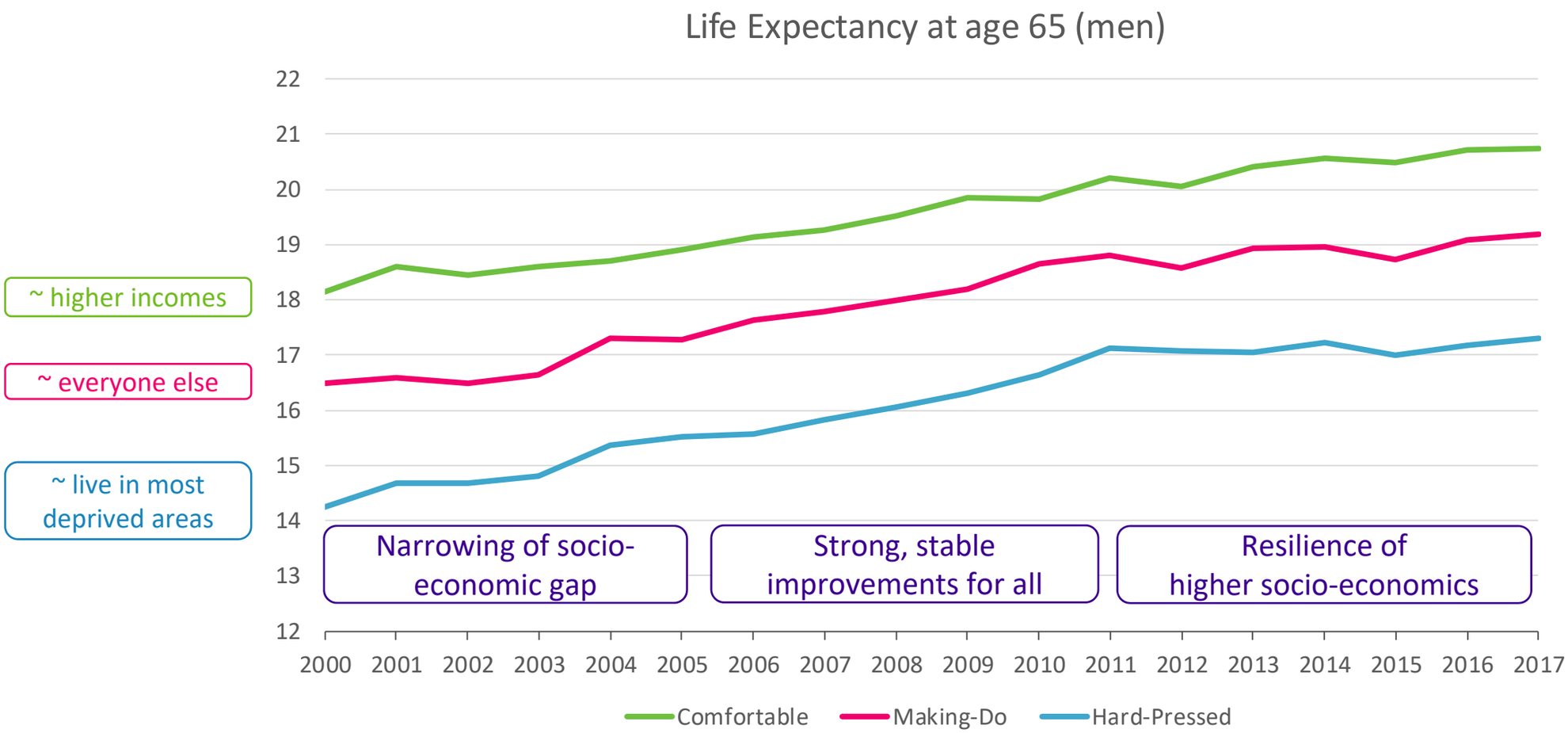
Socio-economic groups determined by clustering pension plan members subject to **4 key principles**:

1. Reliability *(min data volumes)*
2. “Likeness” *(similar characteristics)*
3. Different improvement rates
4. Different mortality rates

For more information see: NAPF Longevity Trends Report.



Mortality improvements in pension plans
UK



Source: Club Vita, Longevity Trends: Does one size fit all?
https://www.clubvita.co.uk/assets/images/general/170623_16_PLSA-Longevity-model.pdf

How to reflect socio-economics in improvements

Building into the RPEC framework

1 Current "run-rate" of improvements

3 Smooth transition

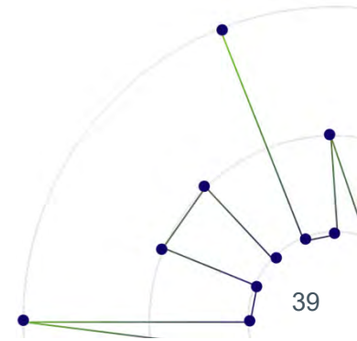
2 Long term rate of improvements

Allowance: Waves of convergence and divergence?

Allowance: Can socio-economic differences persist over longer term?

Time

Group	2011-2016 "run rate"
Comfortable	1.5% (±0.4%)
Making-Do	1.1% (±0.3%)
Hard-Pressed	0.7% (±0.3%)

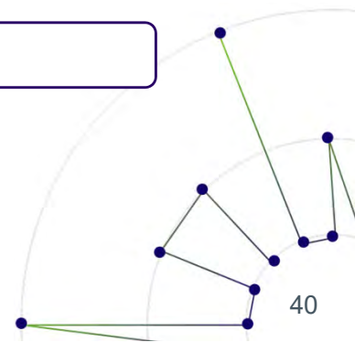


In summary
Evolving assumptions

Baseline	Improvements

• **Plan participant level assumption** now viable
• Automatically captures:
  • Generational variations
  • Different life expectancies amongst different sub-populations (e.g. "high" PBGC premium vs annuity participants)
	• Portfolio level SEG adjustments made to *population-based* improvements
	• Easy to capture current run-rate in existing modelling approaches
	• Care needed in subjective assumptions for the medium and long term improvements

Standard practice	Widely used
Increasingly used	*Emerging*
Early adopters	*Emerging*



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Questions?