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Living to 100 and Beyond

Timothy Harris, FSA, MAAA

Introduction

- Timothy Harris F.S.A., M.A.A.A.
  - Member of S.O.A. and A.A.A.
  - Consulting Actuary with Milliman, Inc.
  - Author of Book on Living to 100 and Beyond
  - Chair of Triennial International Symposium on Living to 100 and Beyond
  - Chaired Last Three Symposia, most recently in Orlando in January, 2014

2014 Living to 100 Symposium January 8-10 2014, Orlando

- The 5th International Symposium on Longevity
- Representatives from 15 countries attended
- Papers presented by Medical Doctors, Demographers, Actuaries, and Researchers

James Vaupel, Ph.D., of Max Planck Institute for Demographic Research in Germany

- Discussed the trend of how 2.5 years of life expectancy at birth are gained per decade, which will lead to a larger number of today's younger generations reaching 100 years of age

Tom Bakos, FSA, MAAA, of Genecast Predictive Systems LLC

- Noted the connections between genetics, disease and longevity.
- Discussed advancements with genetic markers, and how intervention and therapeutic strategies can mitigate the life-threatening nature of certain diseases.
- These developments help address the aging process to increase longevity.

Jonathan B. Forman, J.D., of the University of Oklahoma

- Discussed working longer and annuitizing retirement savings, to provide incomes for the oldest of the old.
- While social insurance programs are already in place, there are critical questions that need to be resolved to help the oldest of the old.
- How much will the government require the oldest old to save earlier in their lives?
- How much will the government redistribute to benefit the oldest old?”

Aubrey de Grey, Ph.D., of SENS Research Foundation

- Discussed ways to undo aging.
- Compared the work done rebuilding cars that stand the test of time to the possible future enhancements to help humans live longer.
- Over time, people aged 70 may be able to add 30 plus years to their timeline.
- He emphasized the need to change how and why research is conducted on aging instead of the pathology of aging

Gerontologist Sandra Timmerman, Ed.D

- Discussed the need for incorporating a fifth life stage, “the encore years,” focusing on the time period between adulthood and retirement (1. childhood, 2. adolescence, 3. adulthood and 5. retirement).
- To address when individuals work during retirement in some part, including when they take on a new career path.
- Retirement is well known as a transitional stage and is no longer a cliff.

Anna Rappaport, FSA, MAAA, Chair of SOA's Committee on Post-Retirement Needs and Risks

- Made call for action from the presenters and attendees to think about how to address the many risks and challenges from living longer.
- The symposium itself is a rare moment when such a mix of academics, physicians and researchers from various professions come together to contemplate and share not only the challenges but also the solutions needed for the impending future.

Longevity Topics

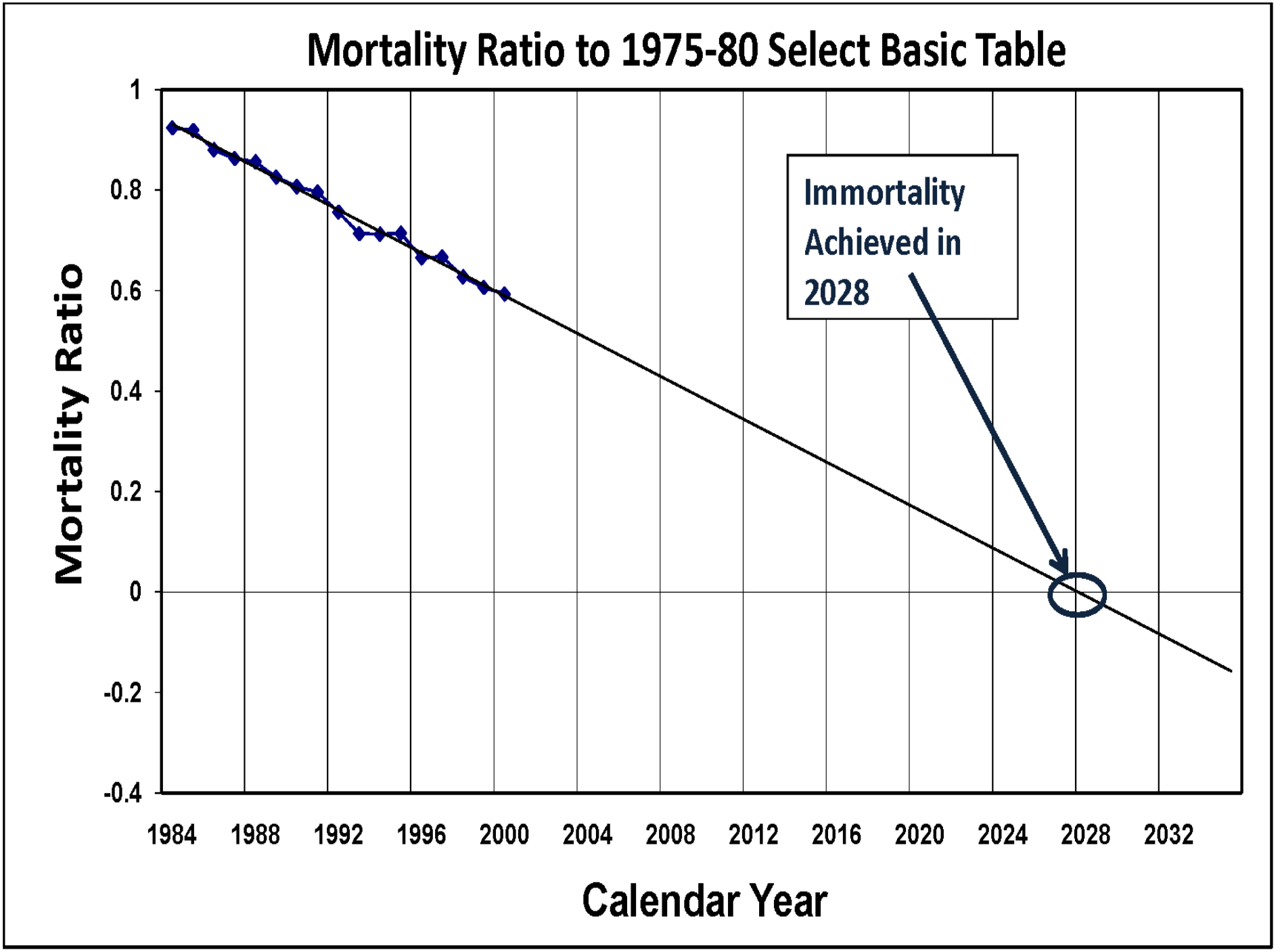
- Increasing Life Expectancy
- Is there an End in Sight?
- Projecting Longevity
- Country Specific Topics
- Extreme Longevity Claims
- Observations on Individual Case Studies
- Proper Lifestyles for Longer Lives

Longevity Topics (Cont'd)

- Genetics/Heredity
- Can We Afford to Live Longer?
- What Will Life be Like at Higher Ages?
- Implications for Social Insurance Systems
- Implications for Healthcare Delivery Systems
- Implications/Opportunities for Businesses

Increasing Life Expectancies

- Life expectancies have been increasing in recent history.
  - What are the reasons?
  - Will they continue to increase?


Mortality Ratio to 1975-80 Select Basic Table
Mortality Ratio
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
1984
1988
1992
1996
2000
2004
2008
2012
2016
2020
2024
2028
2032
Calendar Year
Immortality Achieved in 2028

Increasing Life Expectancies (Cont'd)

- Life spans have followed a pattern of almost continual increase since the existence of man (except for the Middle Ages) and the recent past is no exception. These increases in life span have at times followed changes in societies' hygiene and more recently have been the result of improvements in medical treatments, sanitation and modification of lifestyles.

Increasing Life Expectancies (Cont'd)

- Life Expectancy is a statistical calculation of how long an individual at a given age can expect to live.

$$e_x = \sum_{t=1}^{\infty} {}_t p_x$$

- Some individuals will live longer and some will not.

Life Expectancies by Age for selected Mortality Tables

Age	1793 UK Northampton	US 1941 CSO Insured Lives	Japan 1965-69	US 1979-81 Population	New Zealand 1990-92 Female Non-Maori
0	24.7	65.0	71.5	73.4	78.7
30	27.8	39.2	44.0	45.6	49.9
65	10.4	11.7	13.9	16.0	18.1
80	4.3	4.9	5.6	7.5	8.0

Life Expectancies by Gender and Tobacco Usage based on 2001 CSO

Age	Male Non-Smoker	Male Smoker	Female Non-Smoker	Female Smoker
0	76.8	71.7	80.6	75.1
30	47.9	43.1	51.3	45.9
65	16.6	14.0	19.6	16.1
80	7.0	6.0	9.1	7.5

Male vs. Female Life Expectancy

Age	Ratio of Male to Female Mortality
In the womb	1.43
Age 1	1.23
Age 2	1.24
Age 12	1.50
Age 22	3.17
Age 50	1.75
Age 112	1.00

Life Expectancy by Gender from Early Times to the Present - Expected Additional Years of Life Measured From Age 20

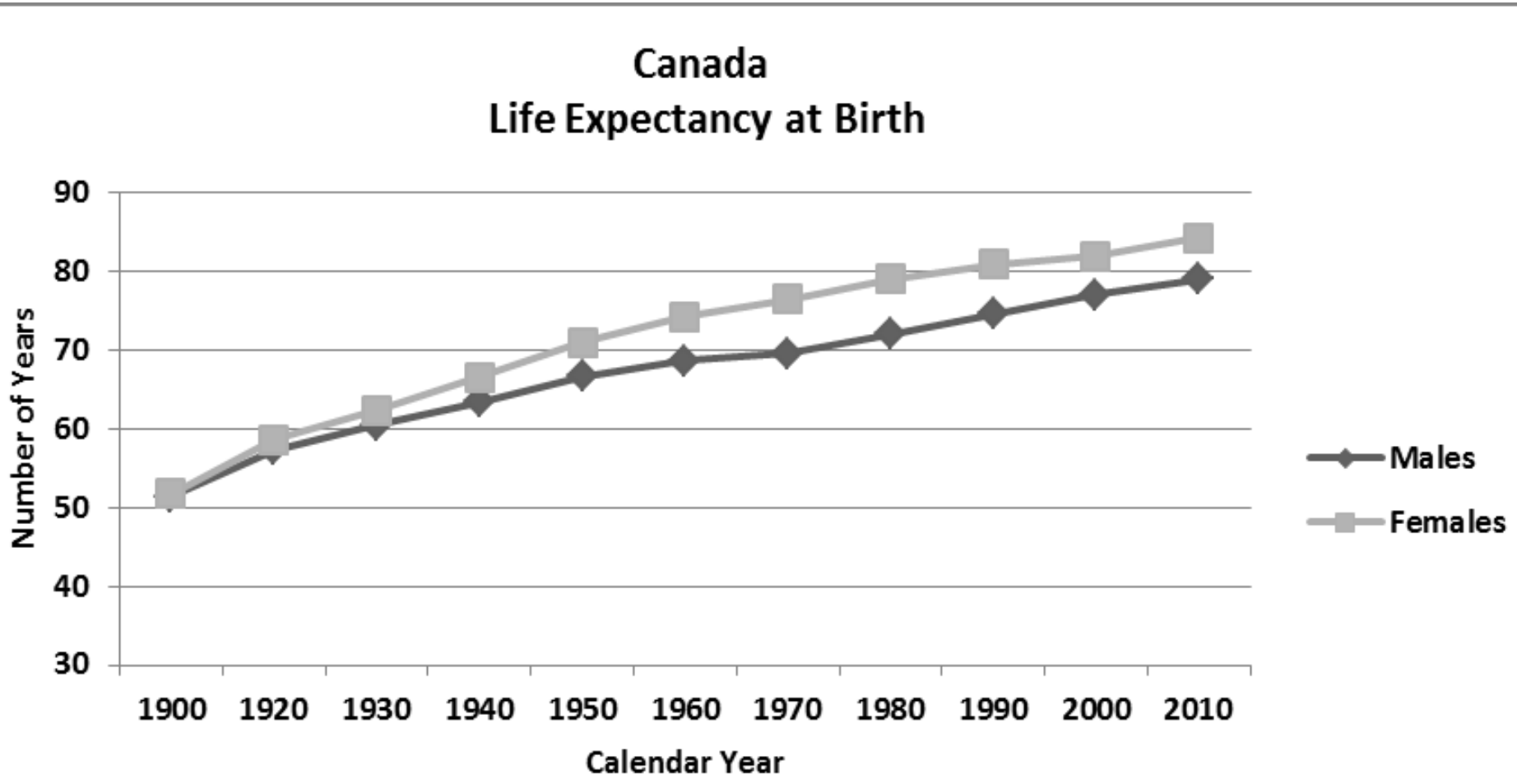
Era	Male	Female	Source
Neolithic Period (4000 BC)	21.0	14.0	Acsadi
Roman Empire	20.6	14.5	Hishinuma
Medieval (1200)	29.8	25.4	Hishinuma
1700s	28.0	28.4	Deprez
Current (2003)	55.8	60.8	US CDC/NHI

Male vs. Female Life Expectancy

- “Sex differences in mortality are well established facts. In the human population of developed countries where infectious diseases are not significant causes of death, the penalty for maleness is that almost every important disease has a higher mortality rate in males than in females” (Hayflick 1982)

U.S. Remaining Life Expectancy at Ages 0, 65 and 75

Age and year	All	Male	Female	Female Advantage
At birth				
1900	47.3	46.3	48.3	2.0
2005	77.9	75.2	80.4	5.2
At 65 years				
1950	13.9	12.8	15.0	2.2
2005	18.7	17.2	20.0	2.8
At 75 years				
1980	10.4	8.8	11.5	2.7
2005	11.9	10.8	12.8	2.0



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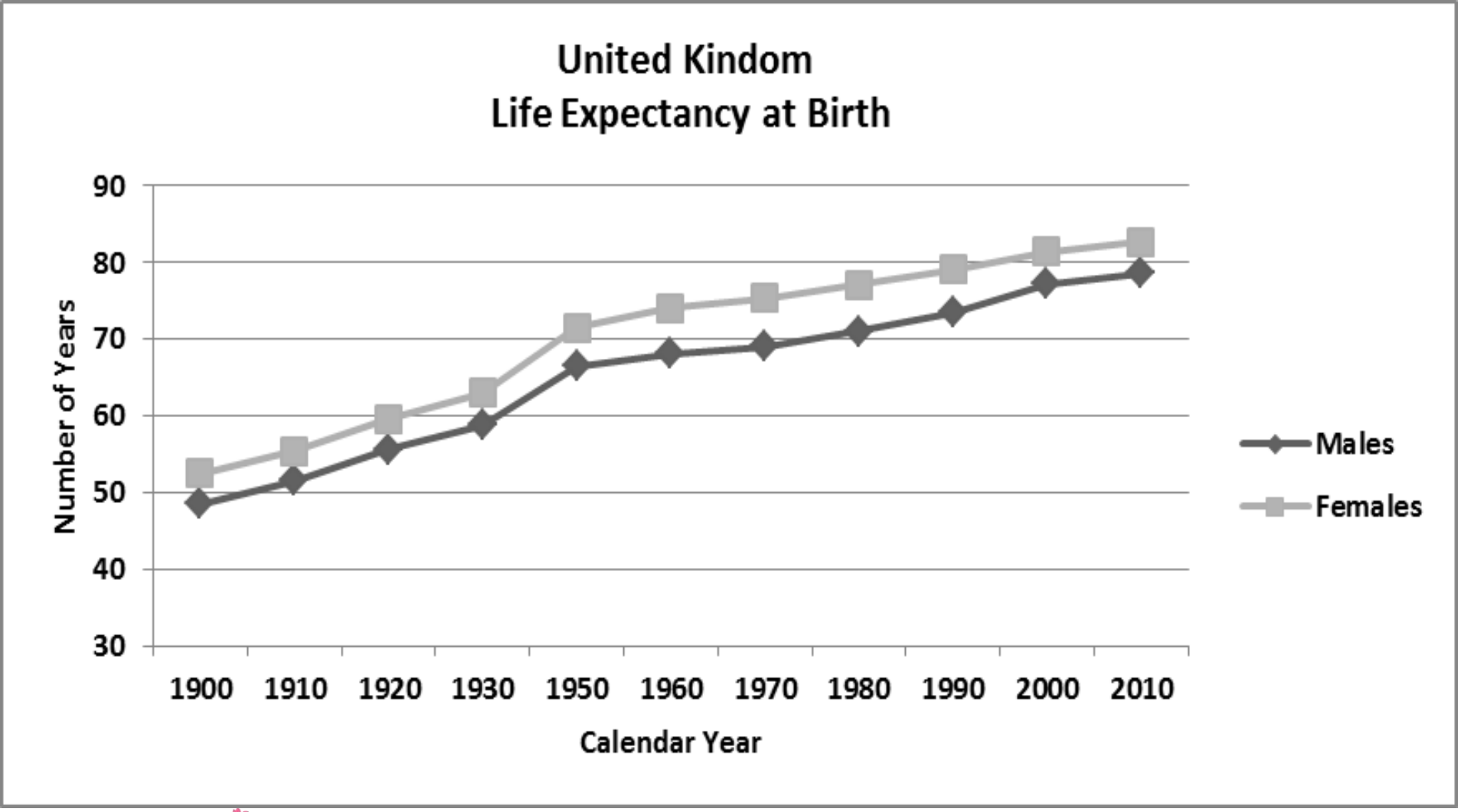

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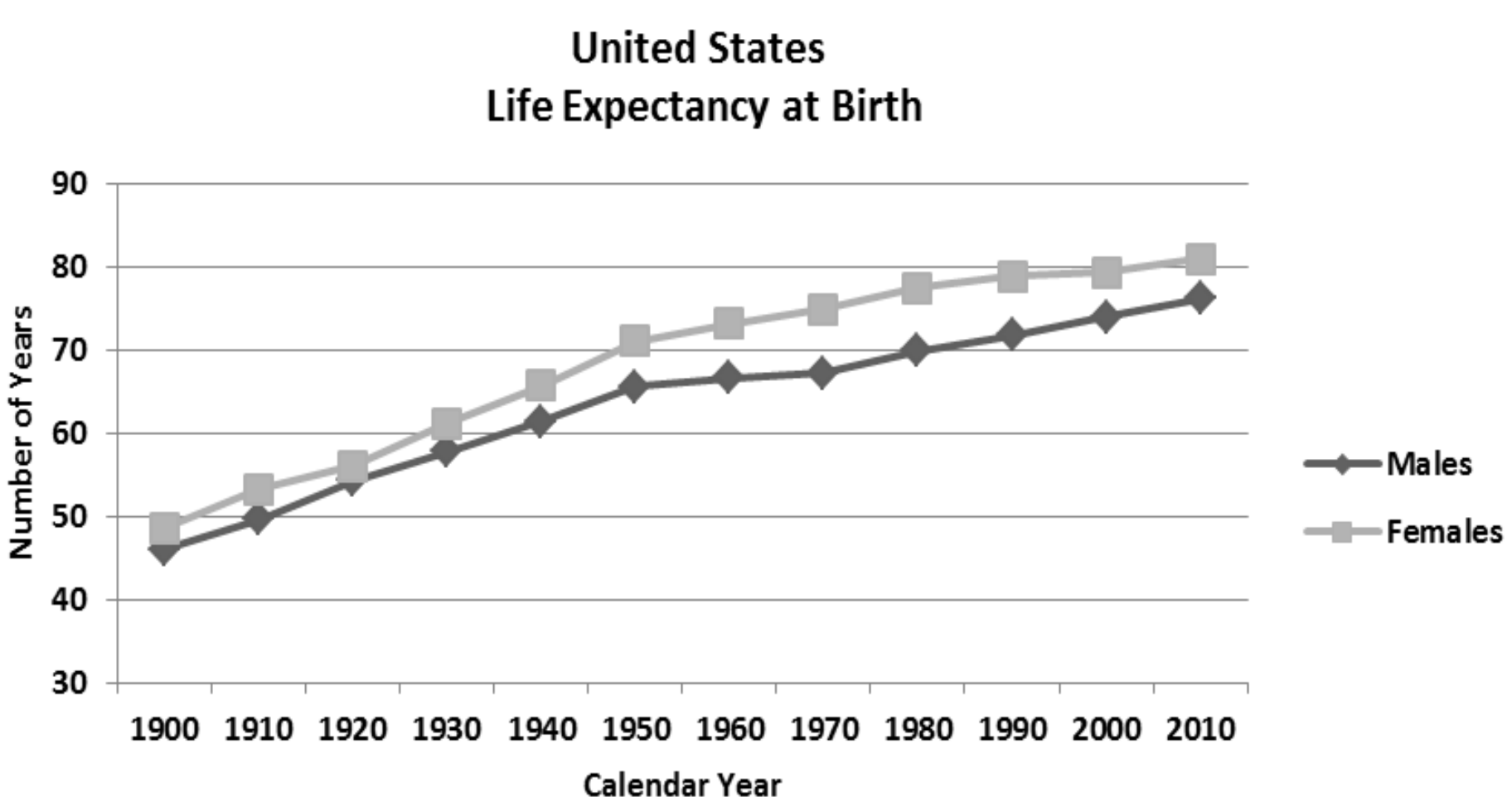

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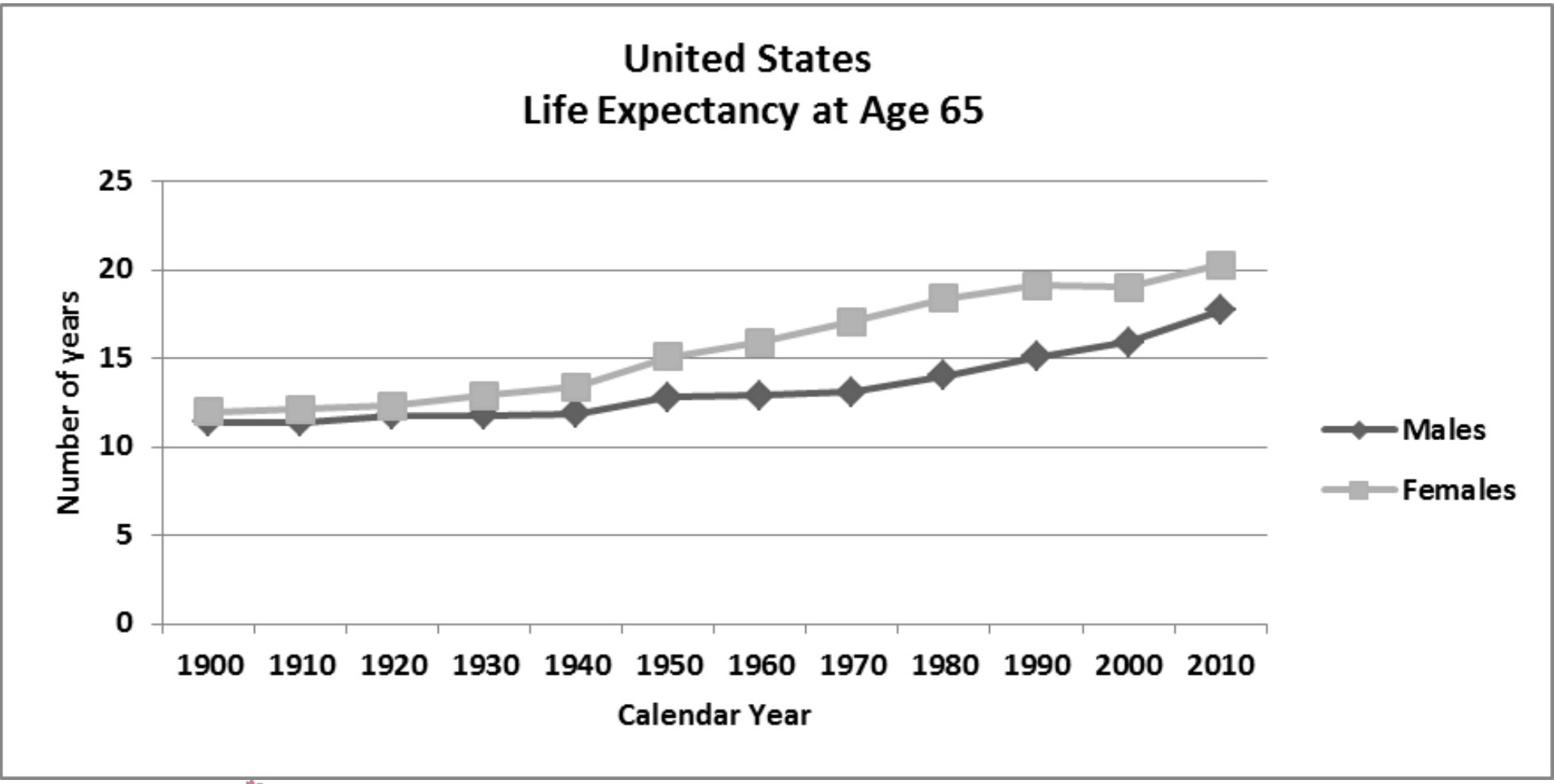

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Limits on Human Life Expectancy

- Debate: Are there limits on increases in human longevity?
  - Life Expectancy vs. Life Span
  - Are there fixed limits on life span regardless of biotechnology and health care?
  - Can medication or genetic modification eliminate the limits on life span?

Aging Theories

- Vitalism – Ancient Theory
- Cellular Mutation – Conflicting results using radiation.
- Reproduction Related Obsolescence – eg. Salmon and Squid
- Programmed Obsolescence
- Human Machine Theory – Reliability Theory

Aging Theories

- Burnout Theory – The body is a furnace with a limited number of calories.
- Accumulation of Cellular Waste Theory
- Free Radical Theory – DNA mutation

Human Life Span

120

Extending Life Span

- Caloric Restriction
- Resveratrol
- Genetic Manipulation

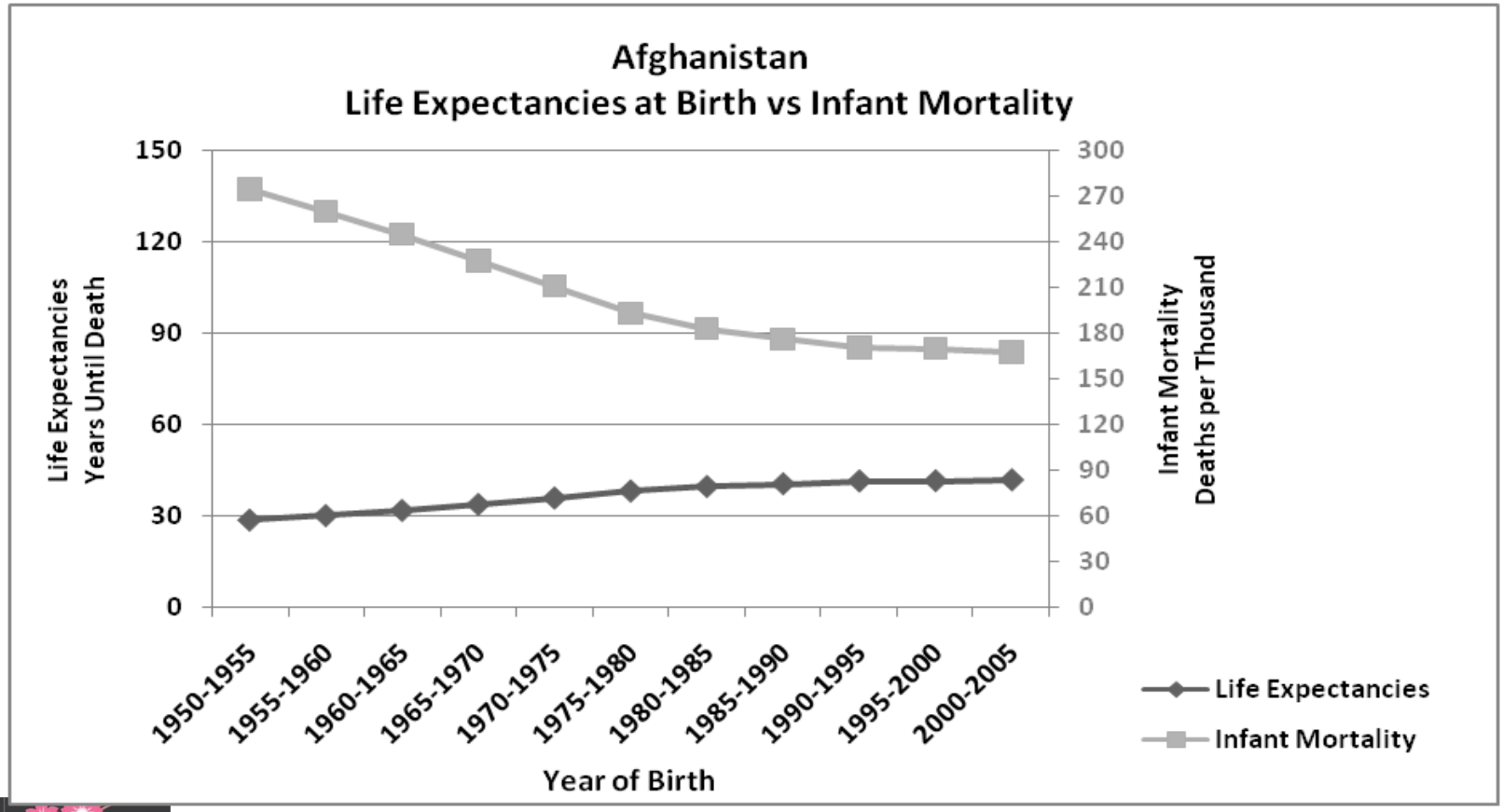
Theories on Projecting Longevity

- Actuarial formulae used to project mortality
  - de- Moivre – Straight Line
  - Gompertz – Exponential
  - Makeham – Gompertz with an added constant
  - Reliability Theory – Logarithmic used for machines
  - Lee and Carter – Statistical Time Series – discontinuity at higher ages
- Predictability of mortality at higher ages still a work in progress

Longevity by Country

- Differences in life spans by country
  - Largely a function of infant mortality
- Projected future changes in population.

Afghanistan



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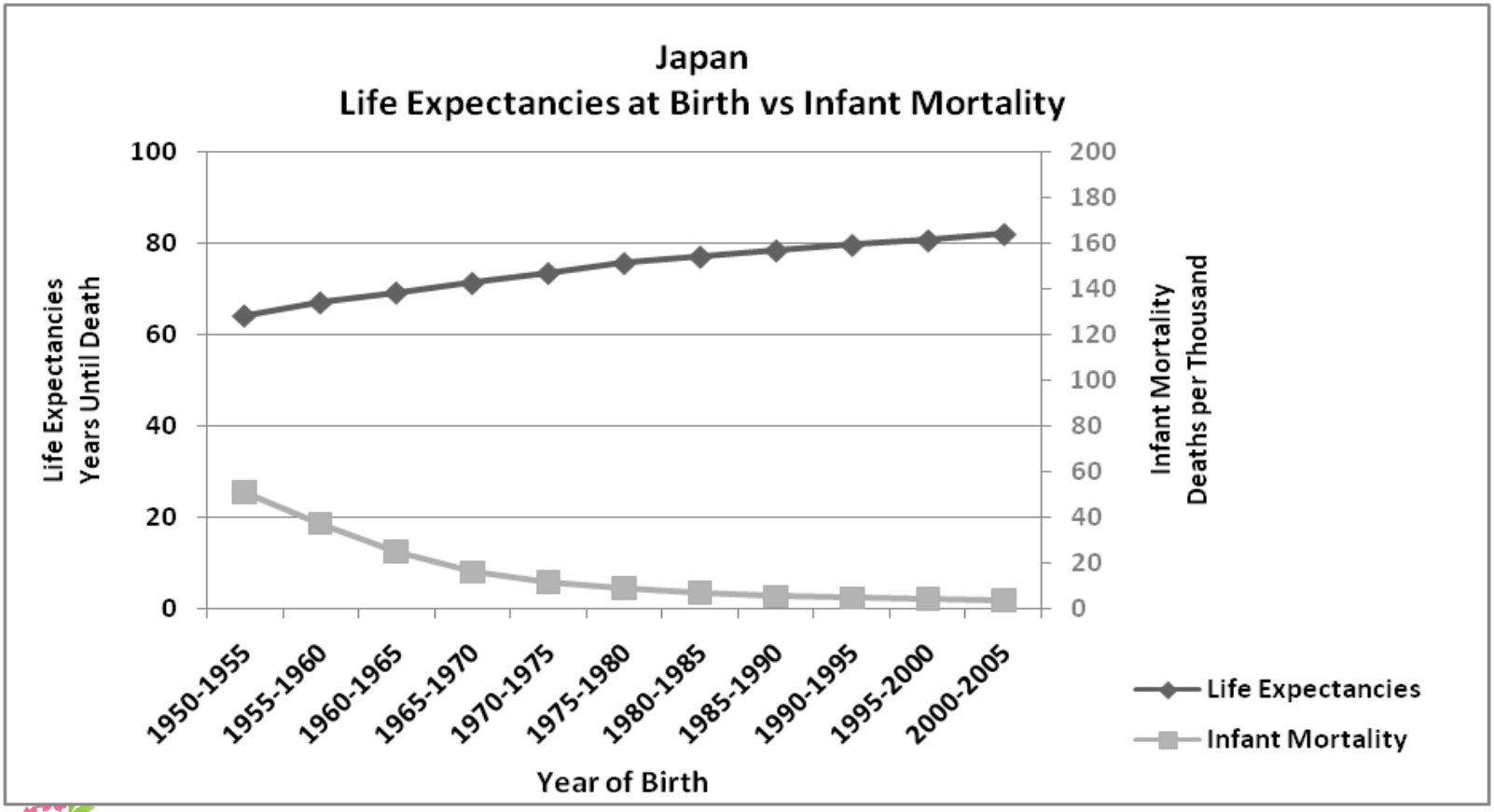
Japan



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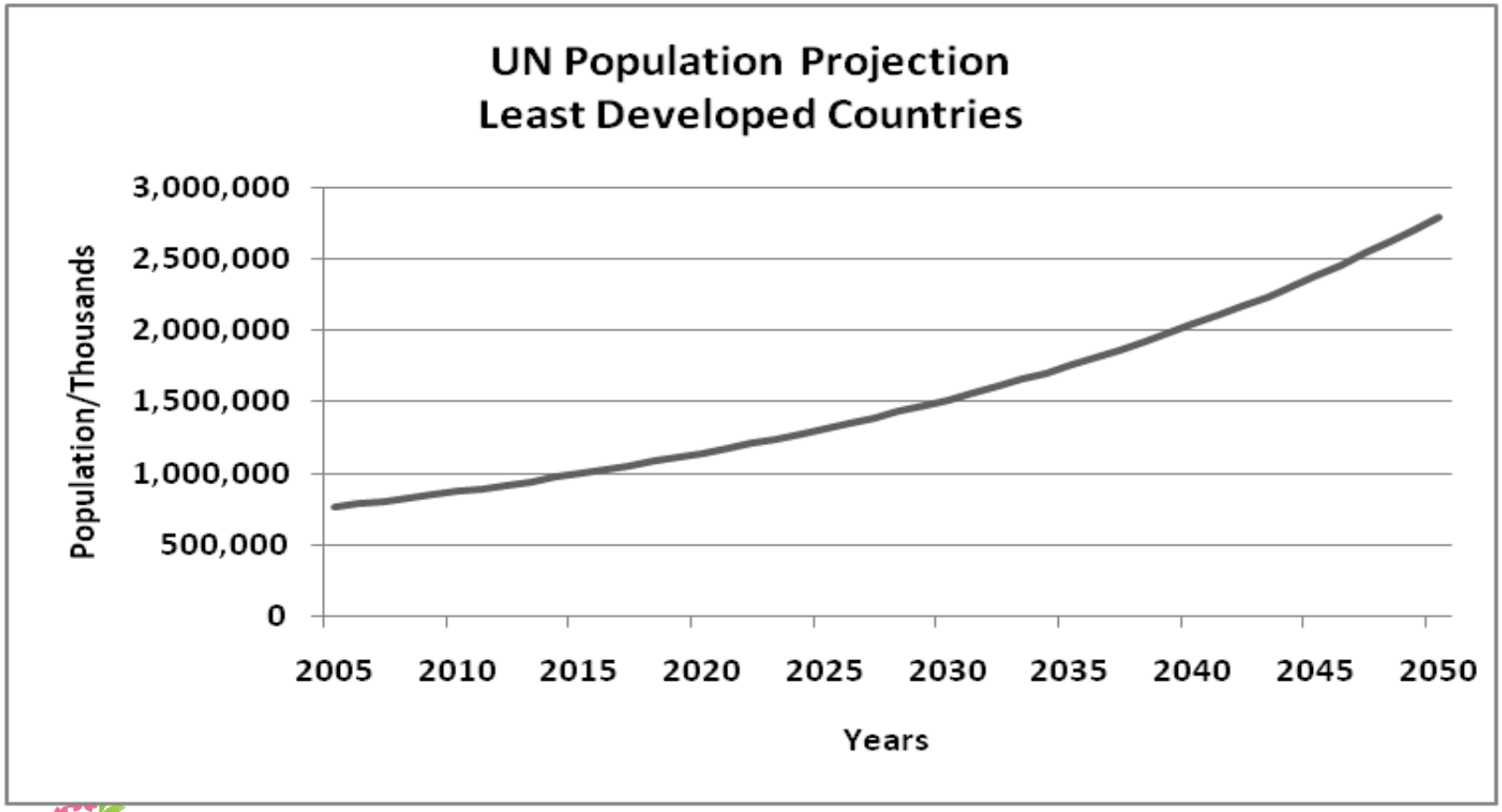
Projected Populations



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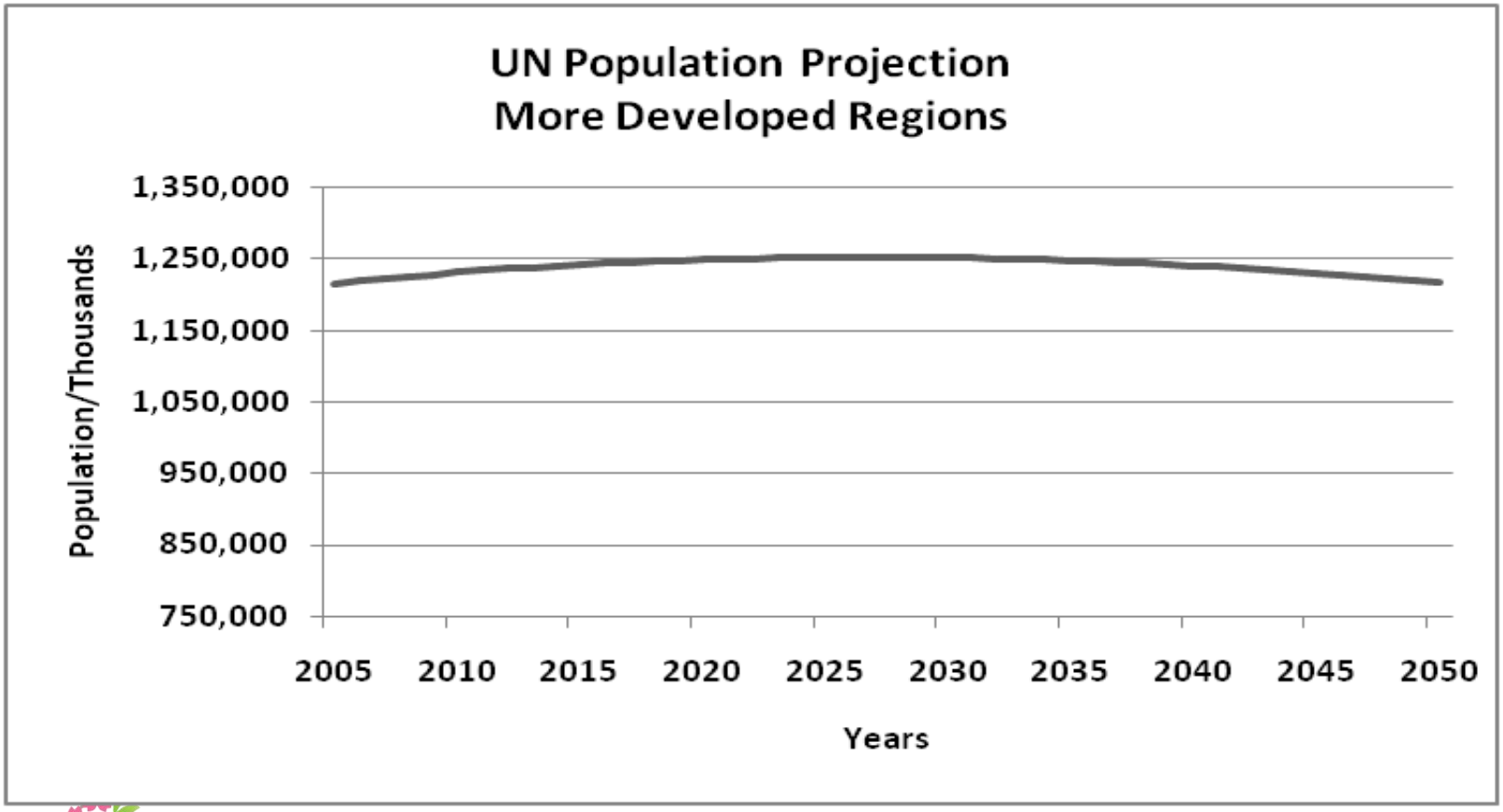
Projected Populations



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Longevity Claims – Fact or Fiction

- Greek – Hyperboreans
- Romans – similar fable
- Chinese – Eight Immortals on Mount Penglai
- Biblical
- Fountain of Youth

Longevity Claims – Fact or Fiction(Cont'd)

- Soviet Georgia (Stalin/Zhores Medvedev)
- Hunza Valley – Pakistan
- Vilcabamba – Ecuador
- Sardinia Italy
- Okinawa

Individual Case Studies

- Individuals who have lived unusually long lives
  - Heredity
  - Lifestyle choices
  - Financial status
  - Quality of life

Individual Case Studies (Cont'd)

- Individuals who have lived unusually long lives
  - Preponderance of Farm Backgrounds including hard work, farm diets, and reduced exposure to epidemics.
  - Some drinkers, some non-drinkers
  - Non-smokers except for Jean Calment
  - No large city dwellers

Analysis of Longest Living Individuals by Country

Country	Number Longest Living Ever	Number Longest Living Currently (2008)	Population in Millions (2008)	Longest Living Ever per Million	Longest Living Currently per Million
United States	53	35	301.1	0.18	0.12
Japan	16	24	127.4	0.13	0.19
United Kingdom	8	3	60.8	0.13	0.05
France	7	3	60.9	0.11	0.05
Canada	4	1	33.3	0.12	0.03

Proper Lifestyles for a Longer Life

- Research on the impact of lifestyle on longevity
  - Cambridge Study
  - Baltimore Longitudinal Study
  - Seventh Day Adventists Studies
  - Gavrilov/Gavrilova Research
  - Dutch Study on Smoking and Obesity
  - HALE – European Longitudinal Study

Proper Lifestyles for a Longer Life (Cont'd)

- Don't smoke.
- Wear your seat belts.
- Stay married or get married.
- Practice safe sex and one researcher suggests practicing often .
- Drink alcohol in moderation and learn to enjoy red wine.

Proper Lifestyles for a Longer Life (Cont'd)

- Stay trim. Limit your caloric intake to the recommended level or less.
- Follow a healthy diet including recommended levels of fruit and vegetables. A vegetarian diet has a marginal additional benefit, as does a diet comparable to that consumed in the Mediterranean or Japan.

Proper Lifestyles for a Longer Life (Cont'd)

- Stay active. Moderate activity was in one study defined as 30 minutes of physical activity per day.
- Continue to learn. Keep the mind active as well as the body.
- Enjoy your life as you age and respect the elderly.
- Don't worry; be happy as some of the super centenarians were.

Proper Lifestyles for a Longer Life (Cont'd)

- Use vitamins to supplement what you may be missing in your diet but do not anticipate any additional benefit from them.
- Should you move to a farm? Possibly.
- Maintain one or more active interest, such as your religion, your grandchildren, your gardening.

Years Lost due to Adverse Lifestyle Choices (120 less?)

Choice	Loss in Years
Smoking	7
Obesity	4 to 8
Inactivity	4
Eating meat	2
Unmarried	10
Lack of education	3

Gaming the System

- Caloric Restriction (Caloric Restriction Society)
- Resveratrol
- Other drugs?

Relationship of Caloric Restriction in Mice to Longevity

Weekly Caloric Intake	Longevity in Months	Ratio to Unchanged	(Life Expectancy)^2 Multiplied by Kcal
Unchanged 113 Kcal	27.4	100%	84,836
25% Reduction 85 Kcal	32.7	119%	90,890
55% Reduction 50 Kcal	42.3	154%	89,464
65% Reduction 40 Kcal	45.1	165%	81,360

Resveratrol

- Anti-fungal defense chemical of wine
- Source of French Paradox
- Highest in Pinot Noir grapes
- Even Higher in Pinot Noir from colder damp regions
- Clinical trials at Sirtris (Dr. David Sinclair) show promise

Rapamycin/Sirolimus

- Another antifungal
- Increased life of mice by 38% in recent trials
- Equivalent to a 30 year increase applied to 60 year old humans

Genetics

- Research
  - Impact of heredity on the anticipated lifespan of an individual
  - Fruit Fly Studies
  - Siblings of Centenarians
  - Clustering of Centenarians within Families
- Still a Topic of Debate

Affordability

- Can you afford to live that long?
- Yes, if you are one of the few that has a paternal employer that provided a defined retirement benefit and post retirement health.
- Otherwise?

Affordability (Cont'd)

- Employee Benefit Research Institute (EBRI)
  - Need 10 x desired after tax income in 401(k)
  - 401(k)'s declined around 20% through for 55-64 age group as of 12/31/2008, recovered 5% of that though 6/30/2009.
  - Only 26% of workers 55+ have saved at least $250,000

Affordability (Cont'd)

- Fidelity Investments projects that a couple retiring at age 65 in 2008 will need $225,000 to fund Medicare Premiums and Out-of-Pocket expenses for healthcare (Excluding Nursing Home Costs)

Solutions

- Financial Planning
- Saving
- Consider spouse/partner
- Delayed Retirement (Converse is often the case)

Expectations

What will life be like at higher ages?

- "Compression" of mortality and morbidity
- Increasing percentages of obesity, diabetes, and hypertension (7-10% from 1994-2004)
- Lower percentage of smokers
- Frailty/Increased risk of falling
- More people functioning with disabilities
- Ageism

Health Expectancy

- How Long will we live functional lives
- Women lose their life expectancy advantage
- Research by Faye Albert F.S.A., M.A.A.A.

Expectancy for Elderly with No Health Issues

Male Expectancy	Age 75	Age 80	Age 85
Life Expectancy	14.84	11.47	8.32
Healthy Period	10.52	7.93	5.59
Assisted Living	2.72	2.11	1.45
Skilled Nursing	1.60	1.43	1.28
Female Expectancy			
Life Expectancy	16.24	12.61	9.12
Healthy Period	10.55	7.97	5.59
Assisted Living	2.80	2.24	1.66
Skilled Nursing	2.89	2.40	1.87

Implications for Social Insurance Systems

- Continued Stress on Social Security Systems
  - A number of possible solutions in the U.S.
  - Fixable
- Continued Stress on Healthcare Security Systems
  - Difficult choices will have to be made in the U.S.

Social Security as % of GDP (OECD)

Country	2000	2050
Canada	5.1	10.9
France	12.1	16.0
Italy	14.2	13.9
Sweden	11.1	12.3
UK	4.3	3.6
U. S.	4.6	6.5

Longevity Dividend

- Theory Supported by a Number of Longevity Researchers
- Increased Longevity means Increased Productivity means Increased Tax Revenue
- Assumes Delayed Retirement.

Healthcare Delivery Systems

- Implications of healthcare delivery systems
- Modeled U.S. Healthcare Services – Results are highly sensitive to assumptions.
  - Future hospital capacity of the U.S. – Sufficient due to reduced lengths of stay and use of outpatient facilities
  - Supply of healthcare professionals – Shortages especially in nursing and certain physician specialties including gerontologists.

Healthcare Delivery Systems (Cont'd)

- Outpatient Facilities – Shortage due to increased utilization and shifting to outpatient from inpatient
- Nursing Homes – Sufficient with possible increase in staff qualifications
  - Compression of morbidity
  - Increased functionality

Implications for Business

- Implications for increasing longevity for:
  - Insurance companies
  - Annuity companies
  - HMOs and other insurers of the senior population in the U.S.
  - Health-care related corporations
- Effect of changing demographics on other corporations
  - Delayed retirement/Phased in retirement
- Longevity Bonds/Indices
- Reverse Mortgages