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International Alliance of Dietary/  
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16 MAY | SEOUL

The Value of Supplementation: Mapping the Nutritional Landscape  
The role of Nutrition in Healthy Ageing

Andrew Shao

# From molecular to chronic disease

## Defining 'healthy ageing'



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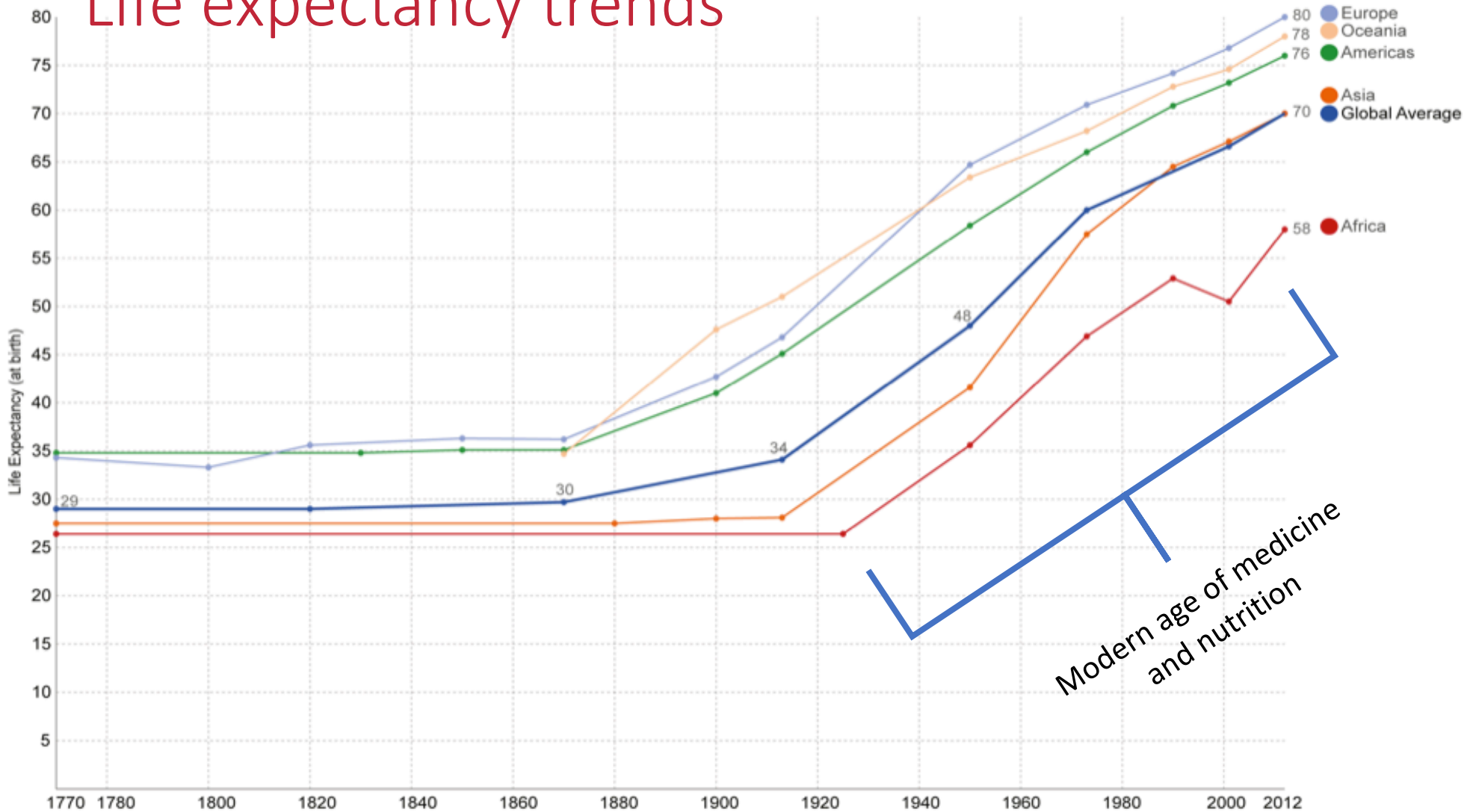
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# Outline

- Ageing trends
- Definitions of ageing
- What is 'healthy ageing'?
- Closing thoughts



# Life expectancy trends



Data sources: 1770-2001 from James C. Riley (2005) – Estimates of Regional and Global Life Expectancy, Population and Development Review; 2012 from WHO.

The interactive data visualisation is available at [OurWorldinData.org](https://ourworldindata.org). There you find the raw data and more visualisations on this topic.

Licensed under CC-BY-SA by the author Max Roser.

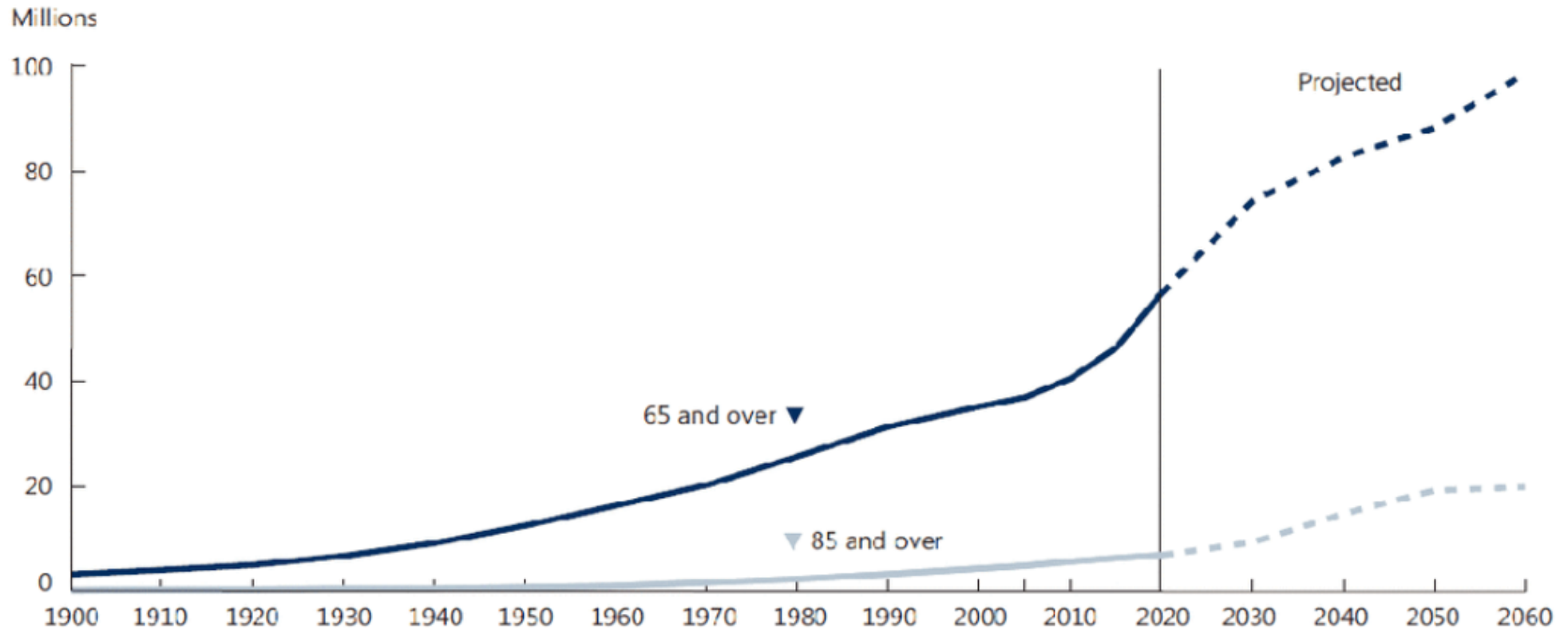


## Mapping the Nutritional Landscape: The role of Nutrition in Healthy Ageing

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# Population of older adults predicted in the US



*Nutrition Across the Lifespan for Healthy Aging.* National Academy of Sciences, December 2016.



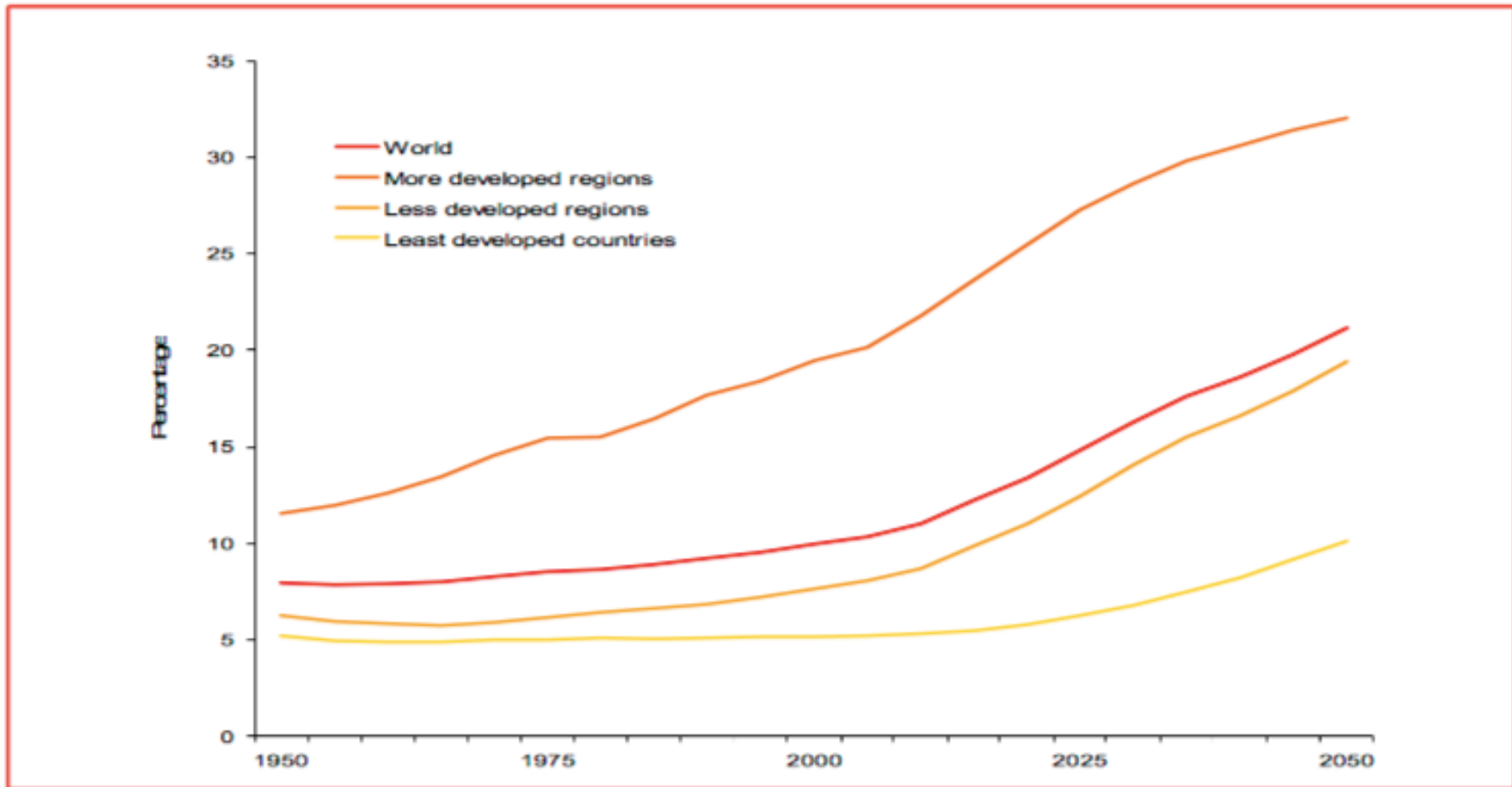
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# The world is rapidly ageing

**Figure 1.8**

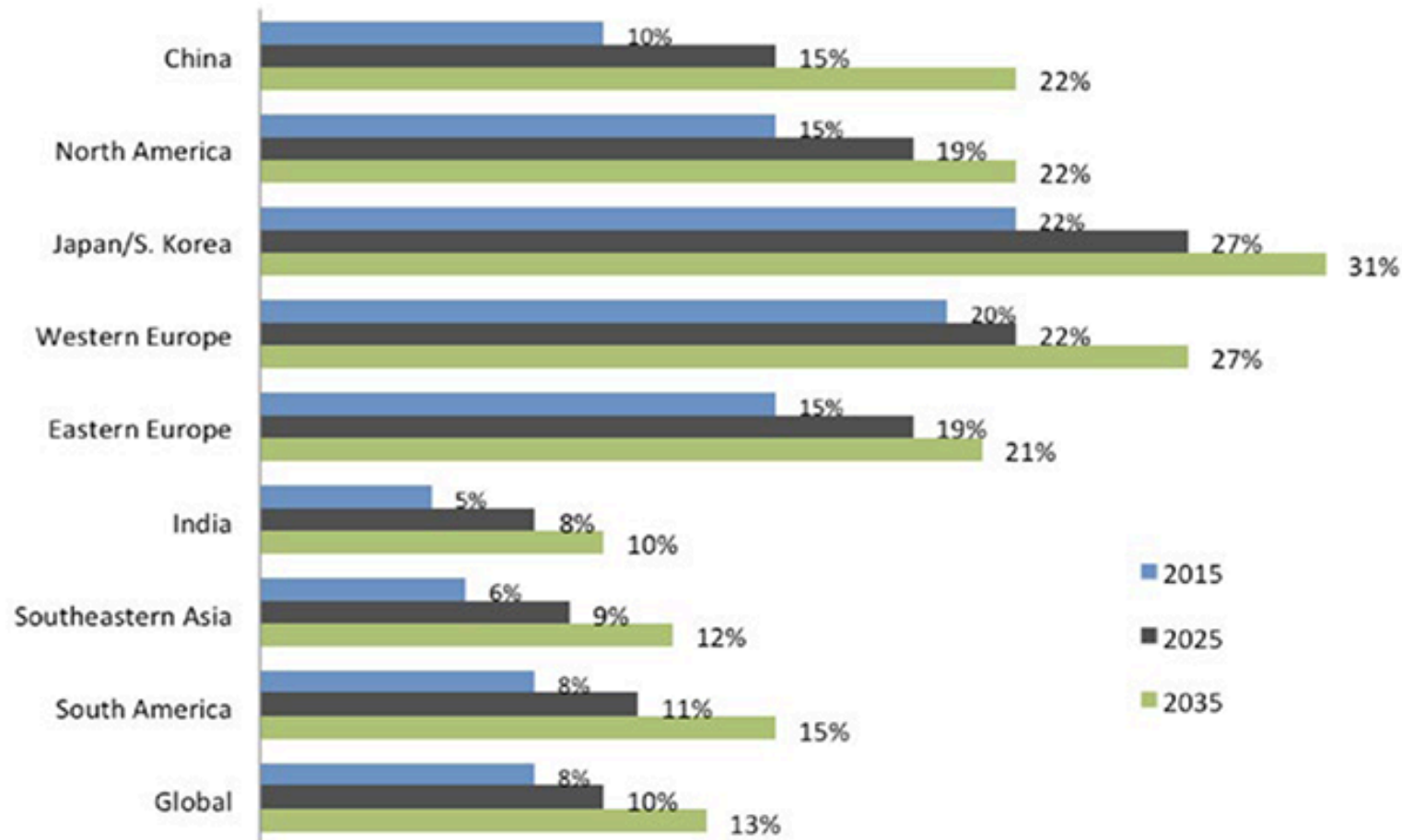
**Proportion of the population aged 60 years or over: world and development regions 1950-2050**



Source: World Population Ageing 2013 report, United Nations



Figure 2. 65-and-Older Population as % of Total Population: 2015, 2025E and 2035E



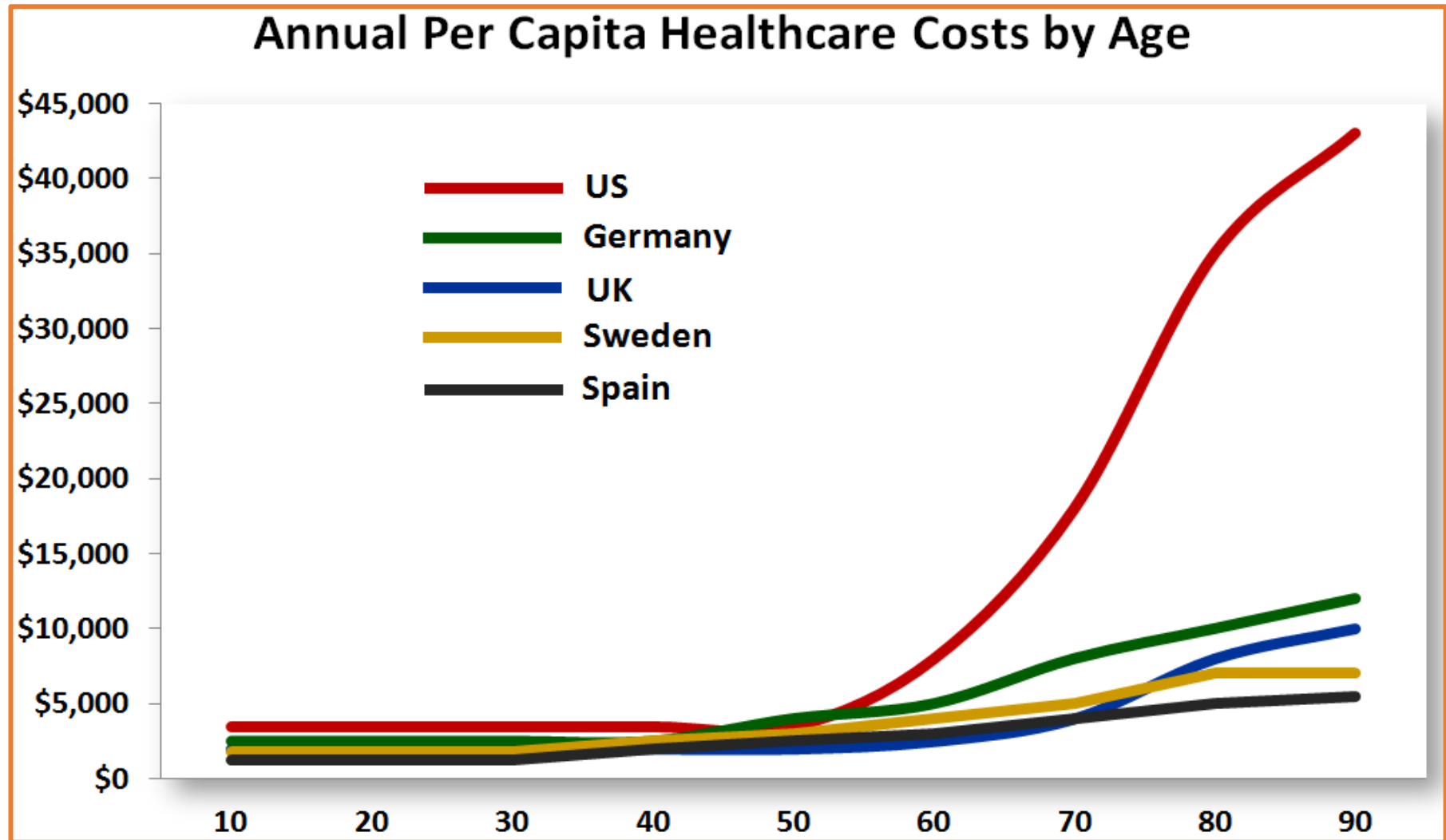
Source: UN, Department of Economic and Social Affairs, Population Division/Fung Global Retail & Technology

*The Silver Wave: Understanding the Aging Consumer.* The Fung Group, 2016.

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# Age-related changes in healthcare costs

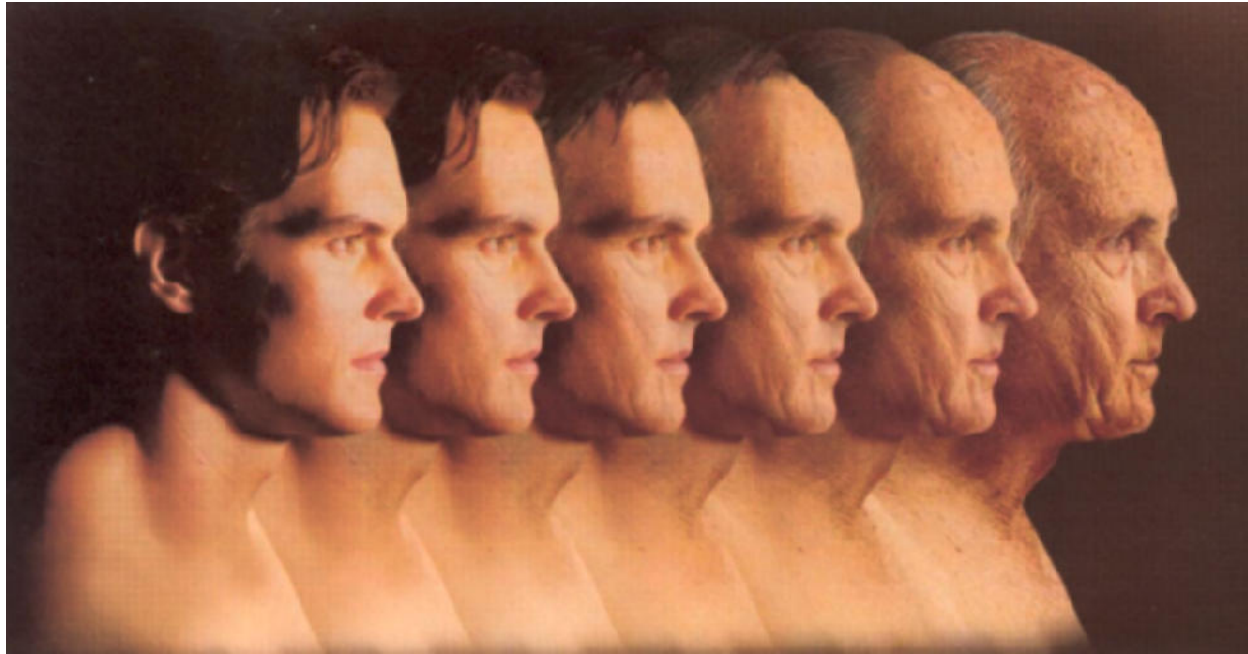


Organisation for Economic Co-operation and Development. OECD.org



# What is ageing?

*the act or process of becoming old or older.* Learner's Dictionary



*“...a decline or loss (a “de-tuning”) of adaptation with increasing age, caused by a time-progressive decline of Hamilton’s forces of natural selection...”* Rose MR, et al. *Frontiers in Genetics* 2012(3);134



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# Ageing is multifaceted

## Molecular

- Telomere length, DNA instability, epigenetic alterations

## Cellular

- Deregulated signaling, mitochondrial dysfunction, senescence

## Physiologic

- Inflammation, insulin sensitivity

## Functional

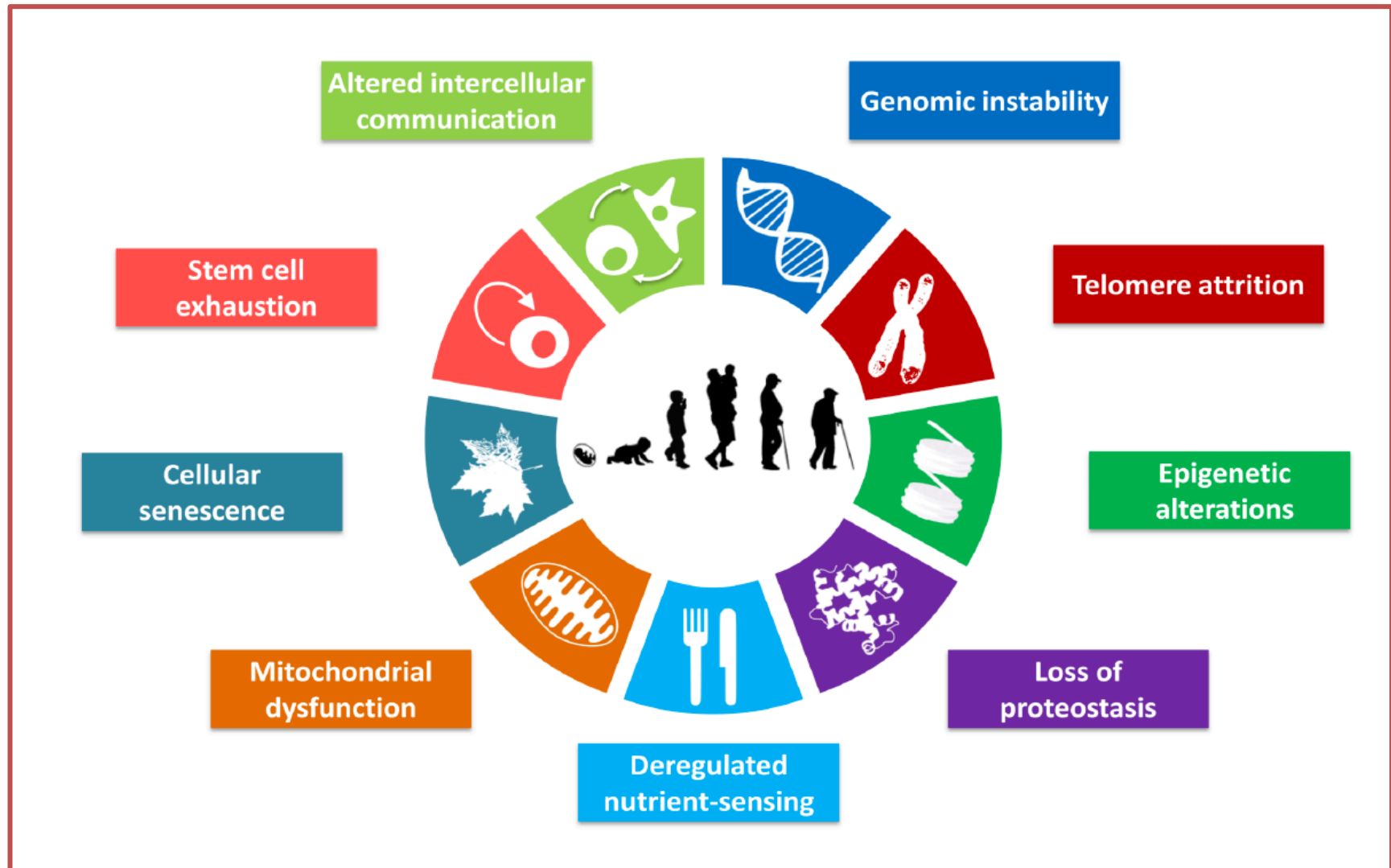
- Sensory, balance, strength, cognitive, cardiovascular

## Chronic disease

- Heart disease, Alzheimer's, diabetes, cancer, osteoporosis



# Molecular & cellular aspects of ageing



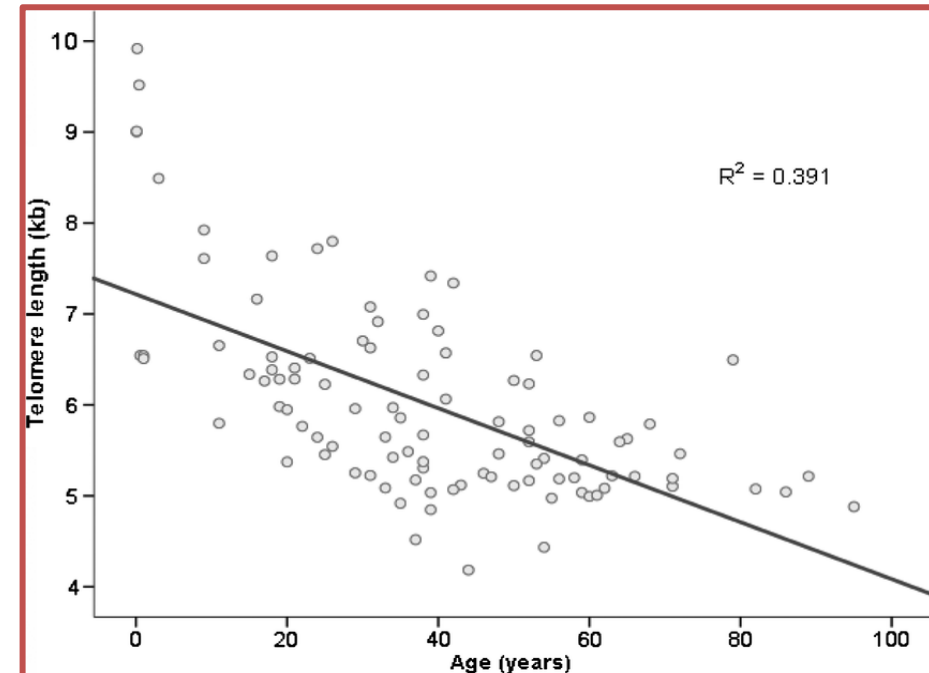
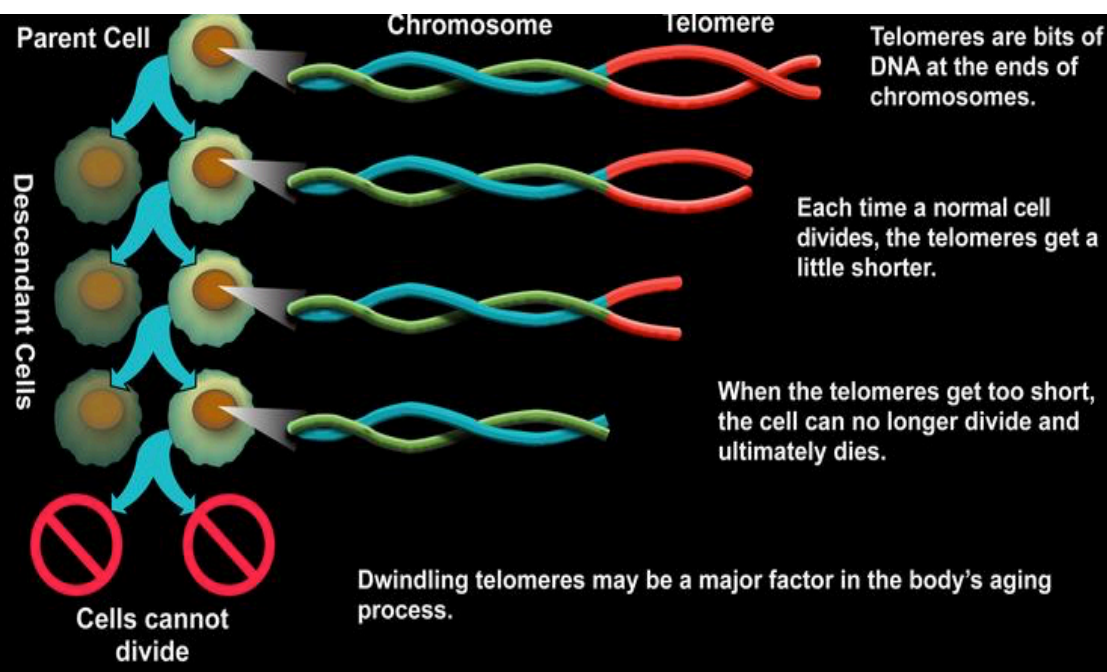
Lopez-Otin C, et al. *Cell*. 2013 June 6; 153(6): 1194–1217.

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# Molecular ageing: Telomeres

- Telomeres determine lifespan of cells
- Telomere length inversely related to age



Source: <http://www.antiagingforme.org>

Srettabunjong S, et al. *Am J Forensic Med Pathol* 2014; 35(2): 148-153.



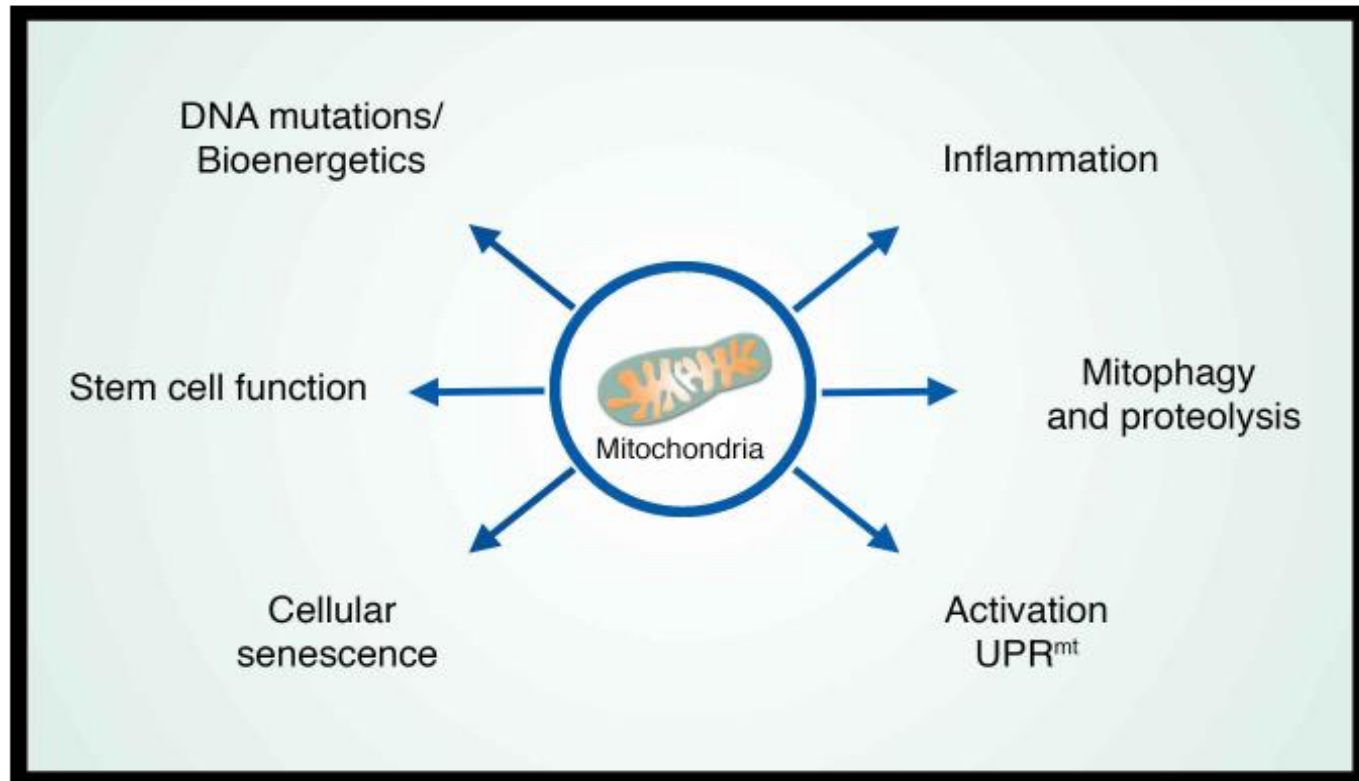
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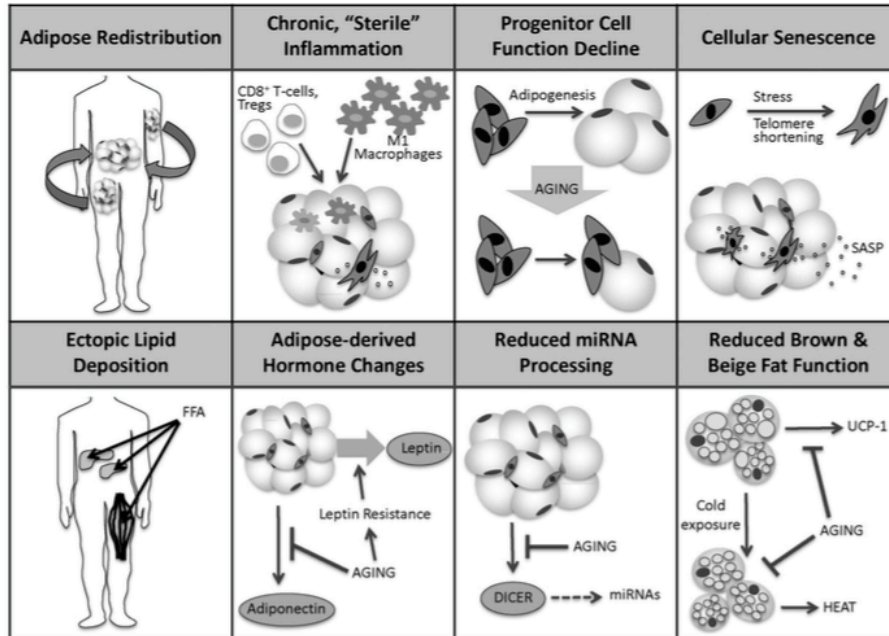
# Cellular ageing:

A decline in mitochondria function contributes to aspects of the aging process, including cellular senescence, chronic inflammation and the age-dependent decline in stem cell activity.



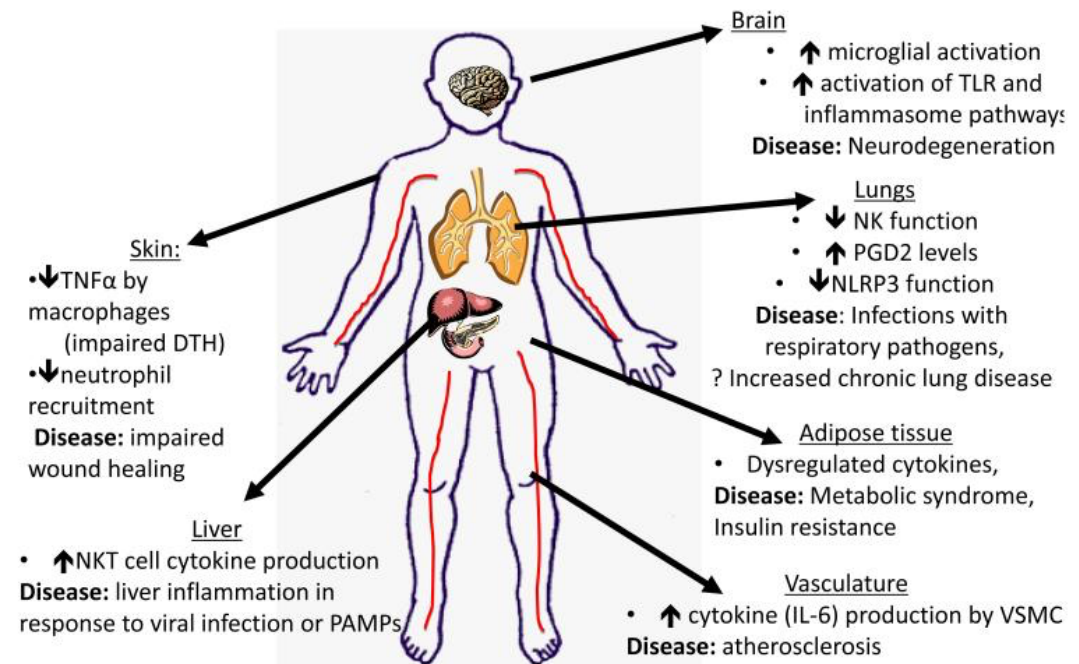
Sun N, et al. *Mol Cell*. 2016; 61(5): 654–666.

# Ageing & inflammation



Palmer AK, *Experimental Gerontology* 2016; 86: 97–105

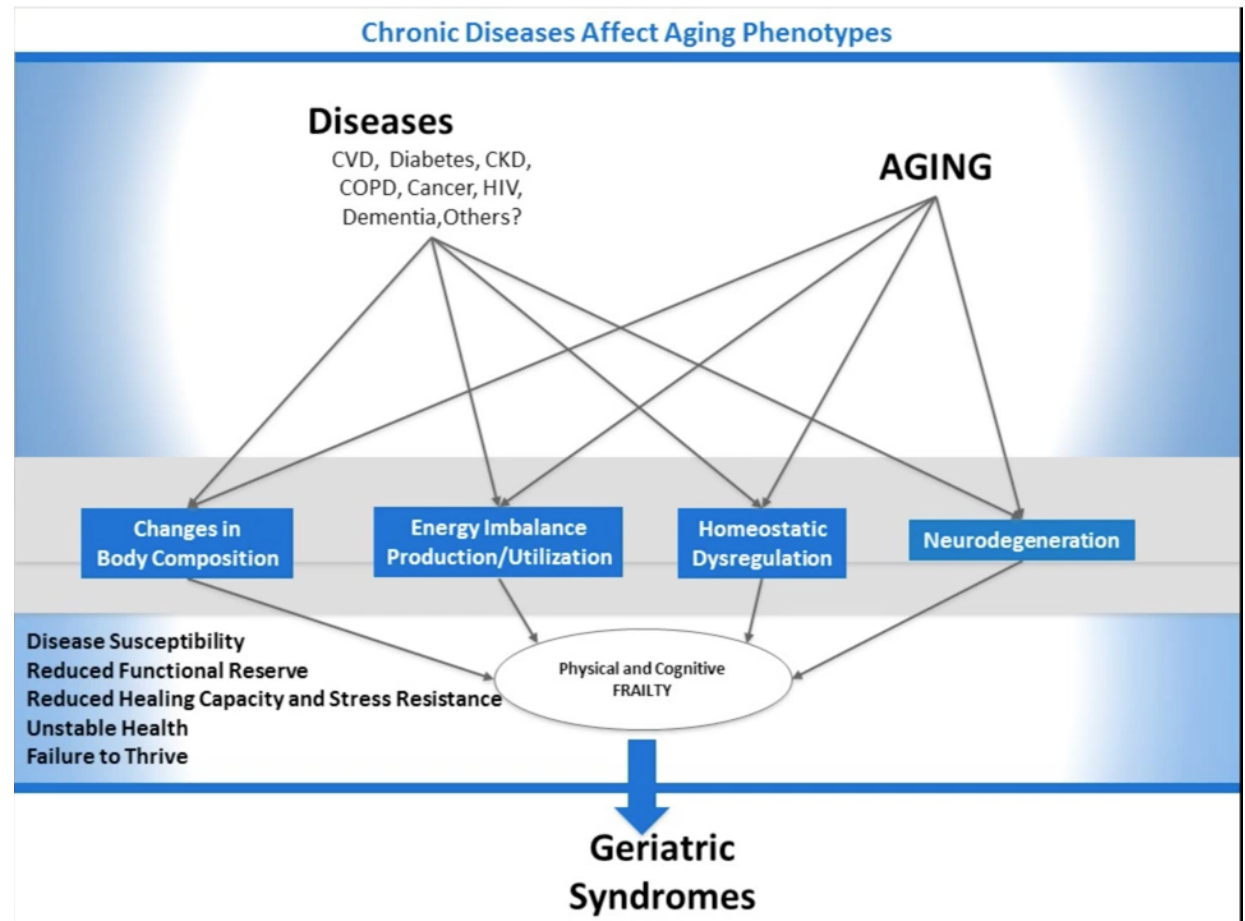
- Ageing is associated with chronic inflammation
- This adversely affects many cells and organ systems in the body
- Eventually, physiologic function is compromised



Shaw AC, et al. *Nat Rev Immunol.* 2013 Dec; 13(12): 875–887.

# “Pathological” ageing

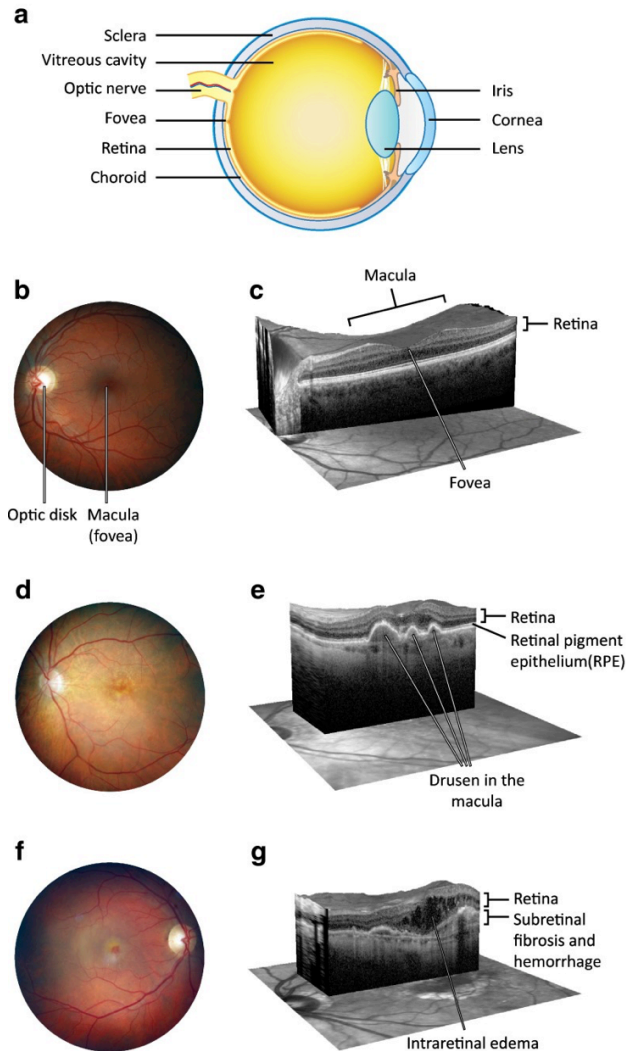
- Cellular aging and inflammation lead to adverse changes in four key domains:
  - Body composition
  - Energy metabolism
  - Homeostasis
  - Neuronal function
- These in turn lead to reduced function, unstable health and chronic disease



From Luigi Ferrucci, National Institute on Aging, National Institutes of Health ILSI North America and Gerontological Society of America Annual Meeting, Washington, DC, USA, November, 2014



# Ageing & sensory changes



Kauppinen A, et al. *Cell Mol Life Sci.* 2016;73(9):1765-86.

- Functional changes include sensory areas, sight, smell, taste
- These changes have longer-term consequences on aspects of health and quality of life

Wysokinski A, et al. *Age* (2015) 37: 81

**Table 1** Mechanisms of the anorexia of aging

Physiological	Pathological	Social
<p>Age-associated changes in taste and smell</p> <p>Diminished appetite:</p> <ul style="list-style-type: none"> <li>• Changes in appetite-regulating peptides</li> <li>• Changes in gastrointestinal hormones</li> </ul> <p>Delayed gastric emptying</p>	<p>Depression</p> <p>Dementia</p> <p>Anxiety</p> <p>Psychosis and delirium</p> <p>Behavioral disorders</p> <p>Comorbidities:</p> <ul style="list-style-type: none"> <li>• Gastrointestinal diseases</li> <li>• Malabsorption syndromes</li> <li>• Hypermetabolism (e.g., hyperthyroidism, acute and chronic infections)</li> <li>• Other diseases (cardiovascular, respiratory, kidney, cancer)</li> </ul> <p>Medications</p> <p>Poor dentition</p> <p>Ill-fitting dentures</p> <p>Swallowing problems</p> <p>Dietary interventions (low-fat, low-salt diets)</p>	<p>Low income and poverty</p> <p>Loneliness and social isolation, especially at mealtimes</p> <p>Physical and psychological abuse</p>



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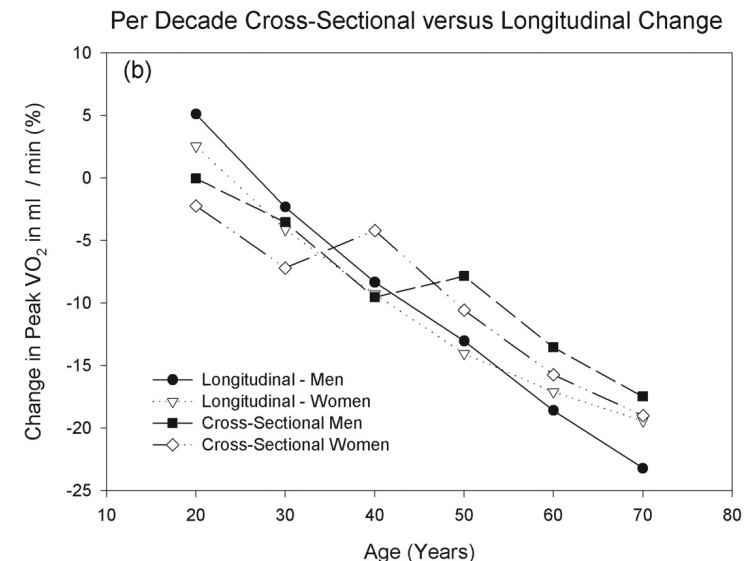
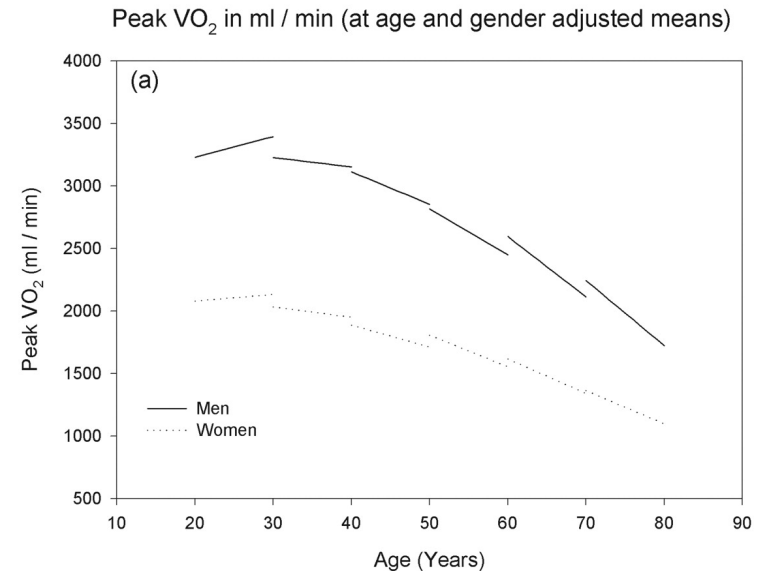
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# Ageing & physical decline

- Clear and demonstrable decline in physical function due to combination of loss of muscle mass and declining muscle quality
- Effort and energy need to perform given tasks increases drastically

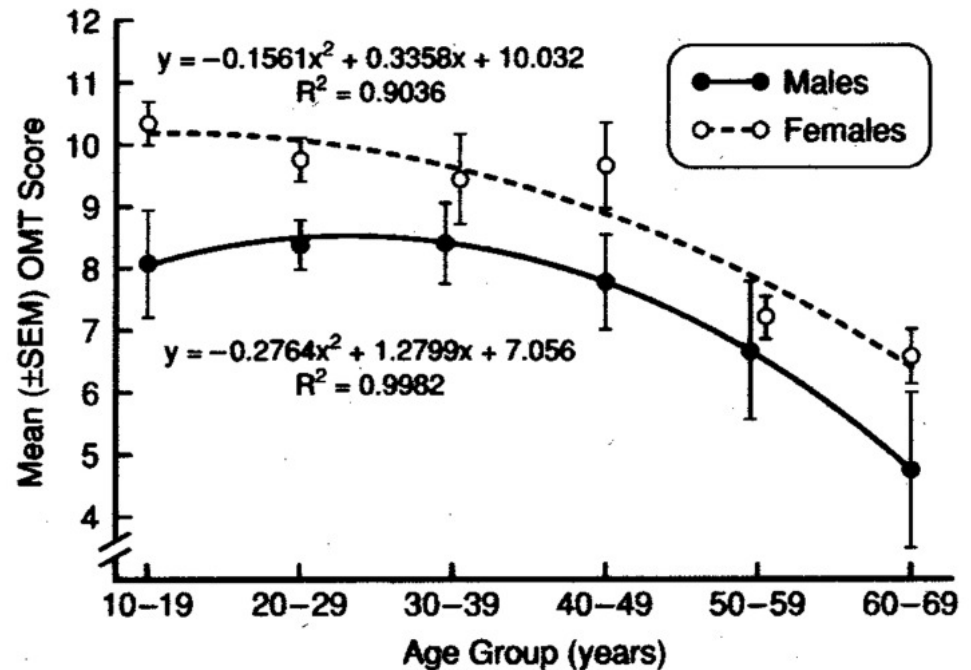
Cross-sectional and longitudinal changes in peak  $\text{VO}_2$  in ml/min and % by gender and age decade



Fleg JL, et al. Circulation. 2005;112:674-682

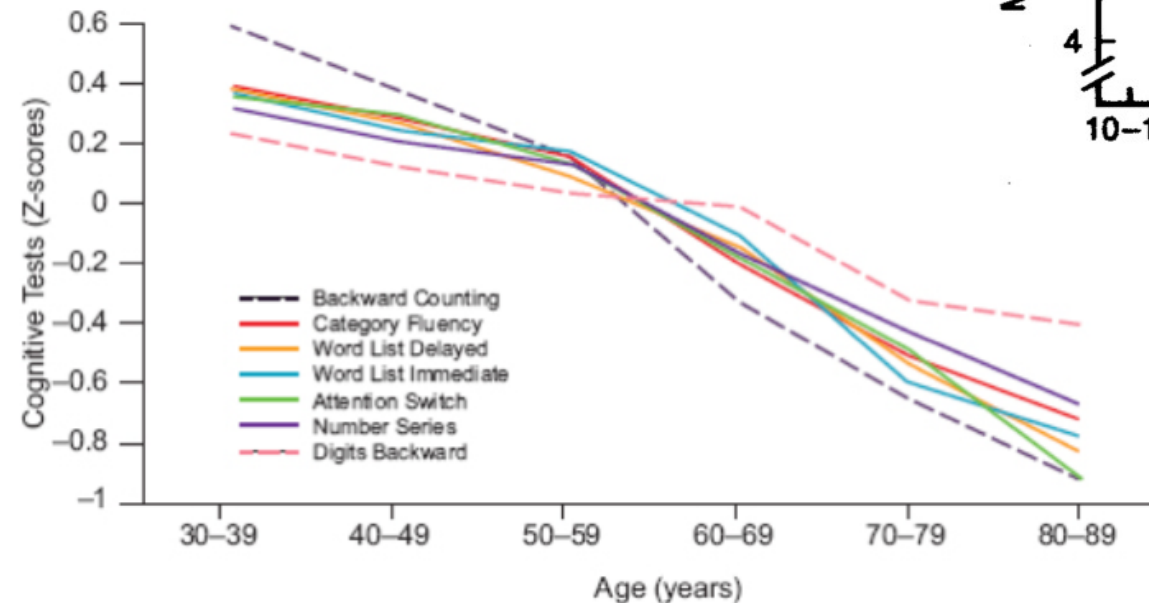
# Ageing & cognitive decline

- Test scores for men and women on a 12-item odor discrimination/memory test as a function of age



Doty RL, *Front Psychol.* 2014; 5: 20.

*Cognitive Aging: Progress in Understanding and Opportunities for Action.* National Academy of Sciences 2015

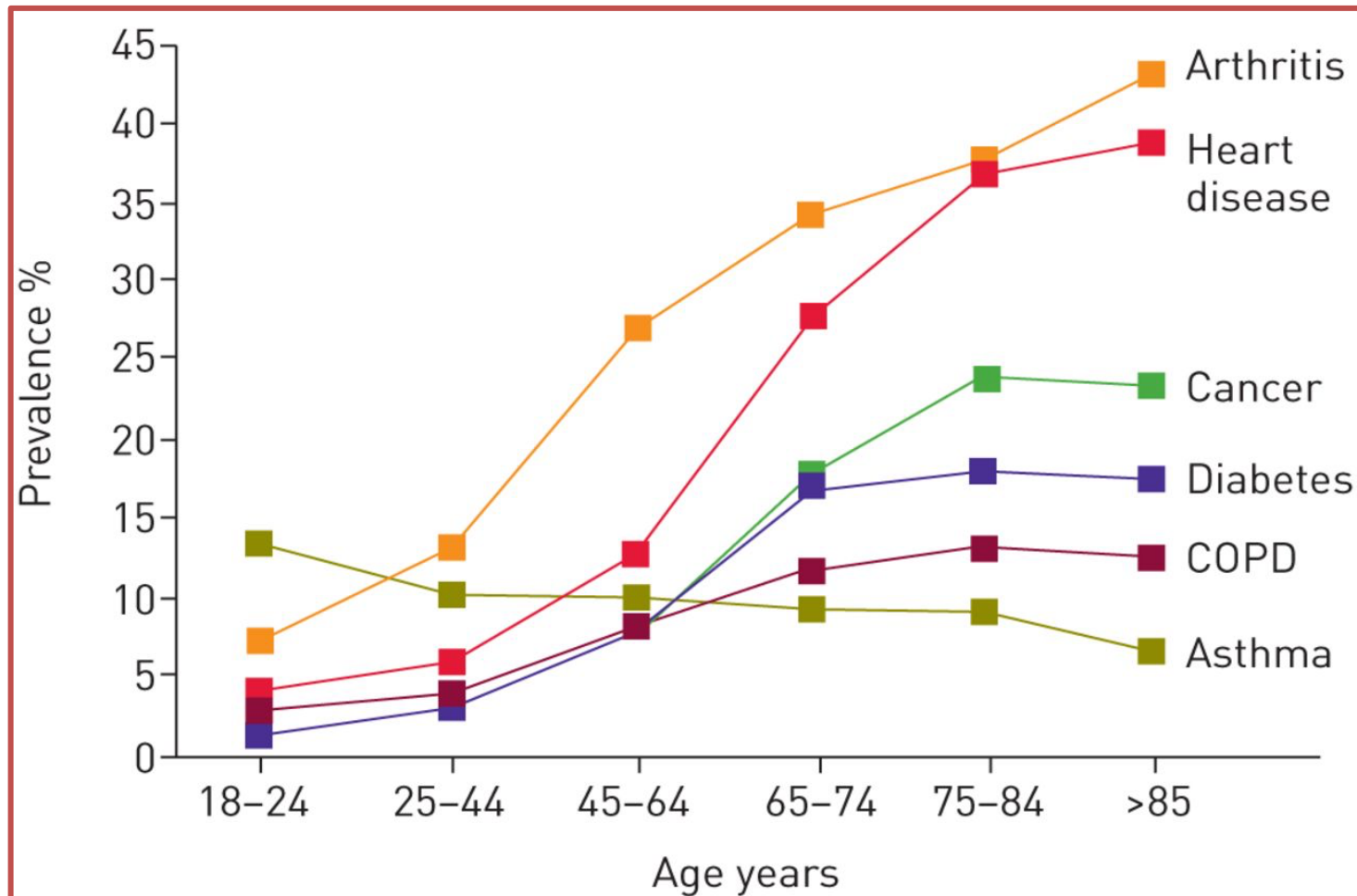


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# Ageing & prevalence of chronic disease



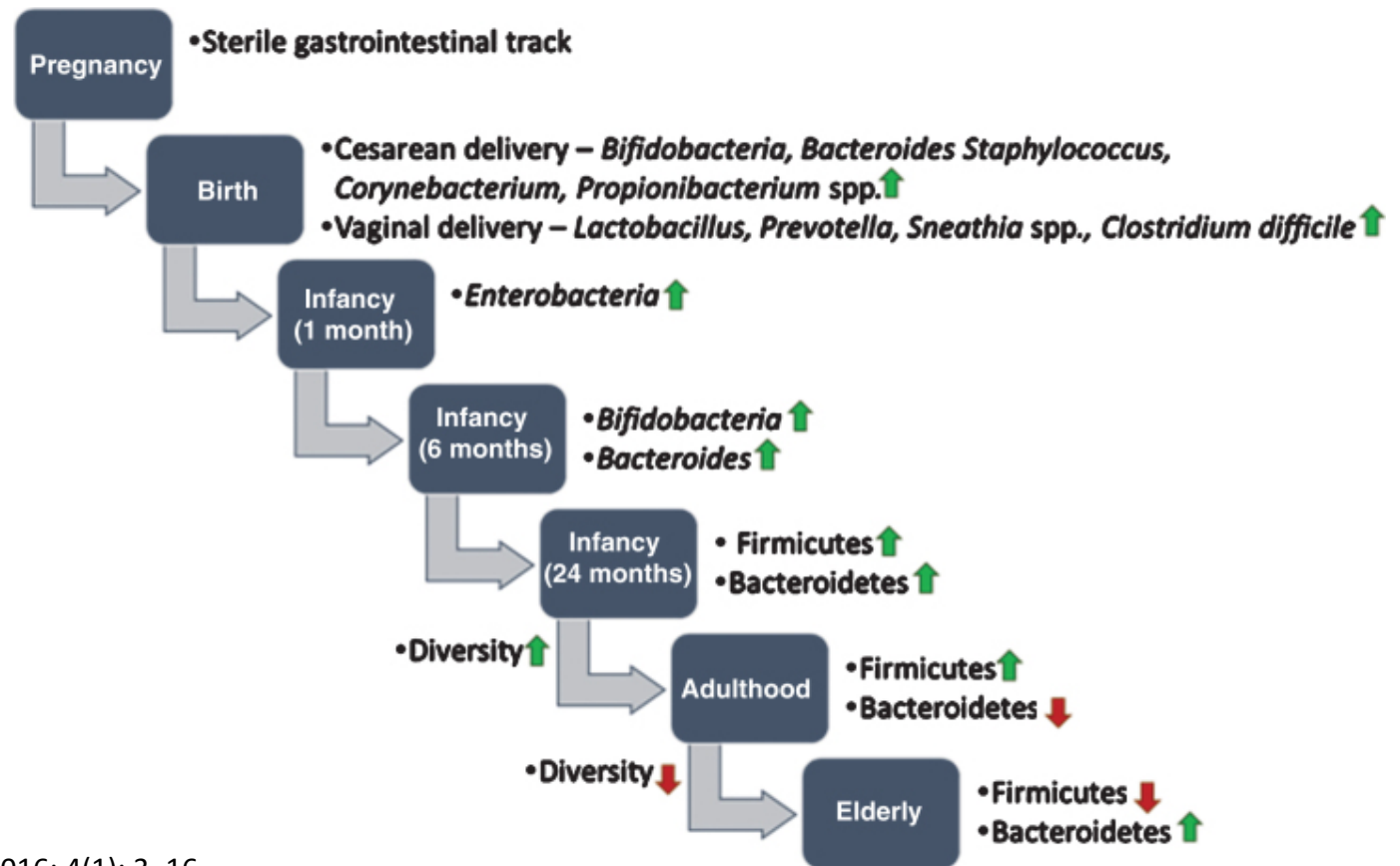
MacNee W, *Eur Respir J* 2014; 44: 1332-1352

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# Ageing and the microbiome across the lifespan

- Rapid decrease in microbiome diversity with age



Kumar M, et al. *Nutr Healthy Aging*. 2016; 4(1): 3–16.





# Is ageing only about “the elderly”?

- Chronological
  - What is “old”? 55? 75? 85?
- Developmental
  - Continuous process that starts at conception, birth
- Programmed
  - Number of times a cell can divide is predetermined
- Starts at the onset of decline
  - Physical, sensory, metabolic, cognitive, social
- Starts when “damage” has accumulated to a certain point
  - Oxidative stress



Available online at [www.sciencedirect.com](http://www.sciencedirect.com)

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Mechanisms of Ageing and Development 127 (2006) 290–297

mechanisms of ageing  
and development

[www.elsevier.com/locate/mechagedev](http://www.elsevier.com/locate/mechagedev)

## When does human ageing begin?

Eugene M.G. Milne\*

*School of Population and Health Sciences, University of Newcastle upon Tyne, United Kingdom*

Received 23 March 2005; received in revised form 7 November 2005; accepted 14 November 2005

Available online 4 January 2006



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# Healthy ageing: Beyond absence of disability & disease

- *Involving freedom from disability along with high cognitive, physical and social functioning* Rowe JW, Kahn RL. *Science*. 1987, 10;237(4811):143-9.
- *The development and maintenance of optimal physical, mental, and social well-being and function in older adults* Lang JE, et al. *Prev Chronic Dis*. 2006;3(1):A17.
- *A lifelong process of optimizing opportunities for improving and preserving health and physical, social and mental wellness, independence, quality of life and enhancing successful life-course transitions.* Health Canada, Workshop on Healthy Aging November, 2001.



# “Successful” ageing

## *The Forum*

Copyright 1997 by  
The Gerontological Society of America

The Gerontologist  
Vol. 37, No. 4, 433-440

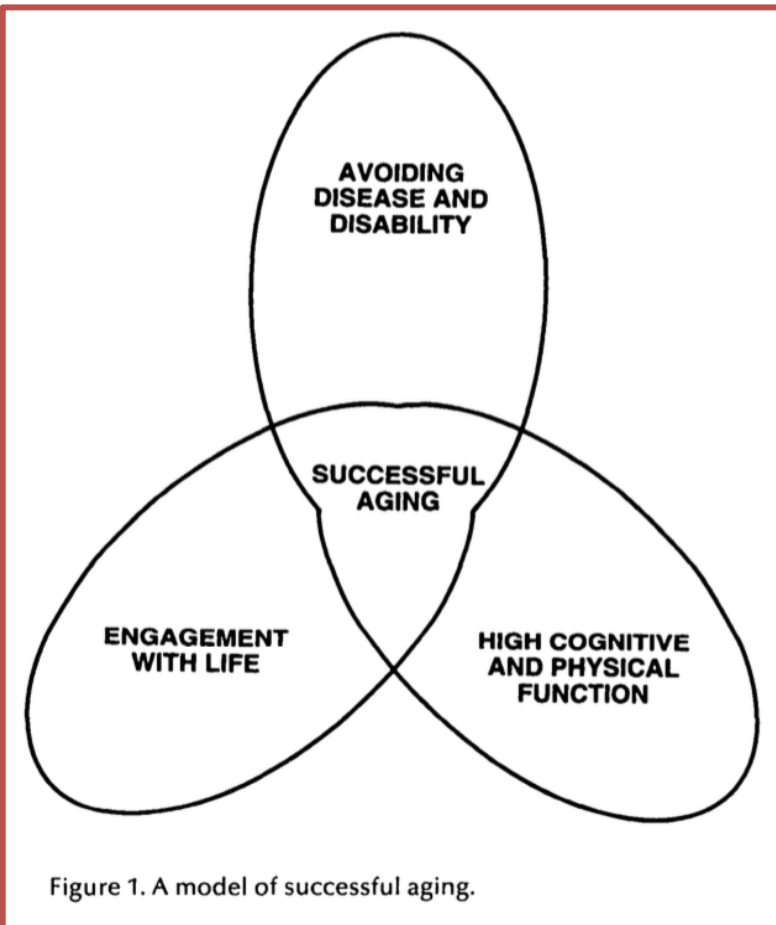
Substantial increases in the relative and absolute number of older persons in our society pose a challenge for biology, social and behavioral science, and medicine. Successful aging is multidimensional, encompassing the avoidance of disease and disability, the maintenance of high physical and cognitive function, and sustained engagement in social and productive activities. Research has identified factors predictive of success in these critical domains. The stage is set for intervention studies to enhance the proportion of our population aging successfully.

Key Words: Aging, Cognition, Physical function, Engagement, MacArthur Foundation

## Successful Aging<sup>1</sup>

John W. Rowe, MD<sup>2</sup> and Robert L. Kahn, PhD<sup>3</sup>

Rowe JW, Kahn RL. *Gerontologist*. 1997; 37(4):433-40.

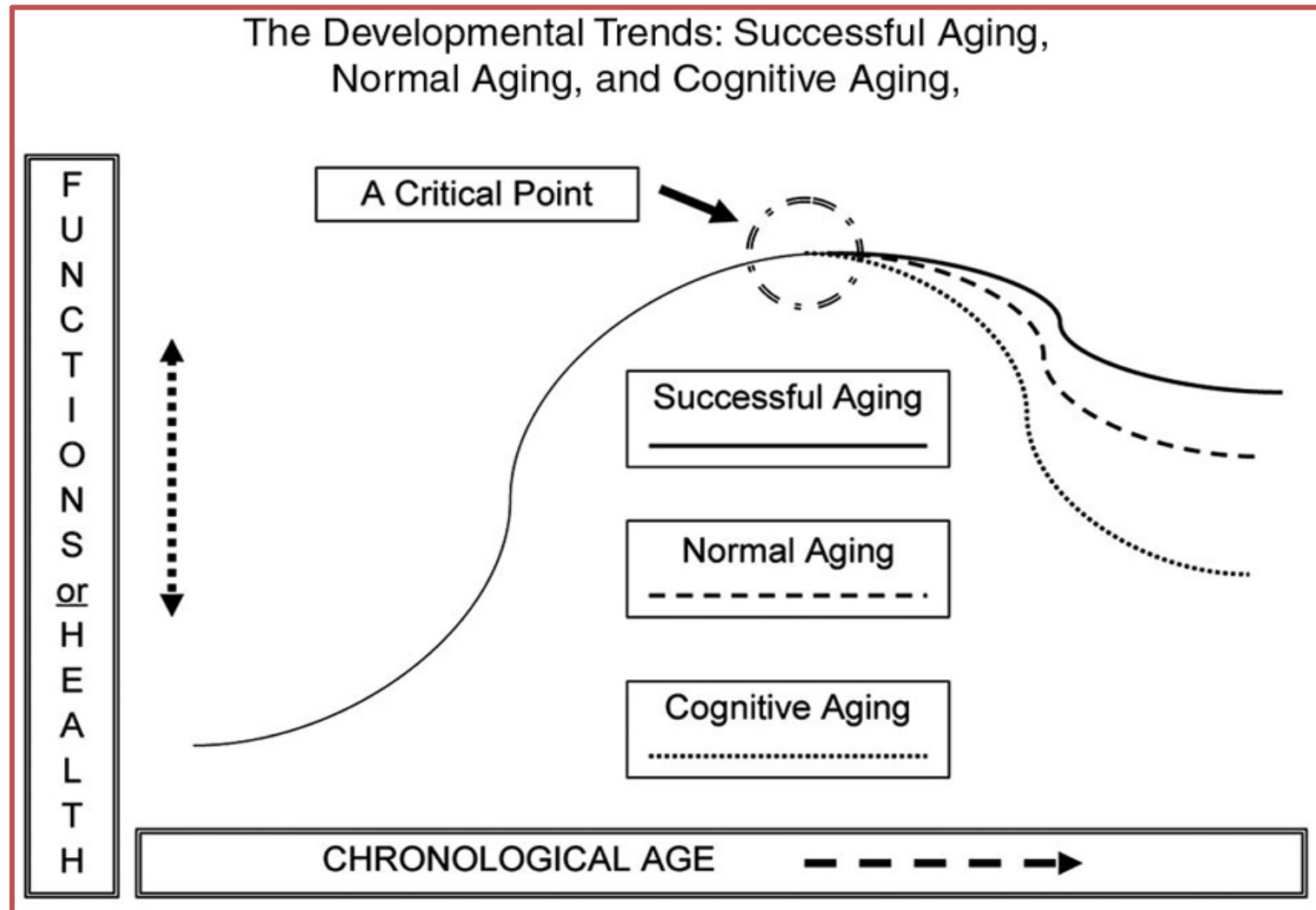


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# Mapping successful ageing

- The trajectory of function and health over time can be modified
- Successful aging is associated with a more positive trajectory
- What interventions can influence this?



Cai L, et al. *Frontiers in Aging Neuroscience* 2014; 6(31): 1 – 12.

# Healthy aging index

10-point index of successful aging

Ranging from score of 0 to 10 based on following attributes:

Education	# cardiovascular disease risk factors
Financial status	Depression
Participation in social activities	Adherence to Mediterranean diet
# yearly excursions	Frequency of physical activity
BMI	

- Higher score of successful aging associated with less use of healthcare services 95%CI: [-0.79 (-1.2 to 10.4)]
- N = 2663 elderly, 65 – 100yrs

Tyrovolas et al. *Exp Gerontol.* 2014;60:57-63





# Predictors of successful aging

## “Strong” predictors

- Age (young-old)
- Nonsmoking
- Absence of disability, arthritis, and diabetes.

## “Moderate” predictors

- Greater physical activity
- More social contacts
- Better self-rated health
- Absence of depression and cognitive impairment
- Fewer medical conditions

## “Limited”

- Gender, income, education, and marital status

- Literature review of studies examining successful aging in adults > 60 yrs
- N = 28 studies

Diet?

Depp CA and Jeste DV. *Am J Geriatr Psychiatry*. 2006;14(1):6-20.



# Successful aging: Objective & Subjective criteria

## Objective:

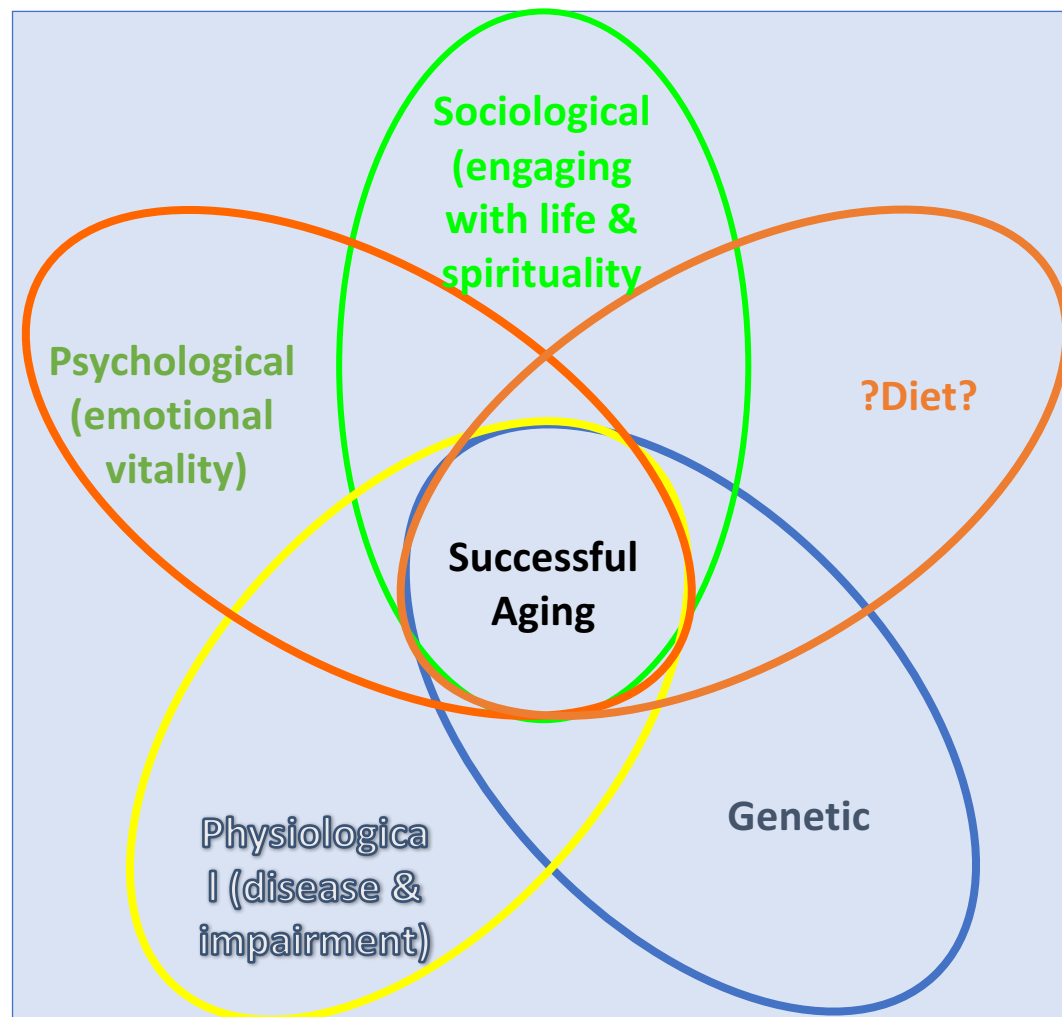
- Absence of disease & disability
- Cognitive function

## Subjective

- Active engagement with life
- Growth, adaptation, resilience
- Life satisfaction
- Self-reported healthy aging
- Independent living

Easier to measure

More challenging to measure



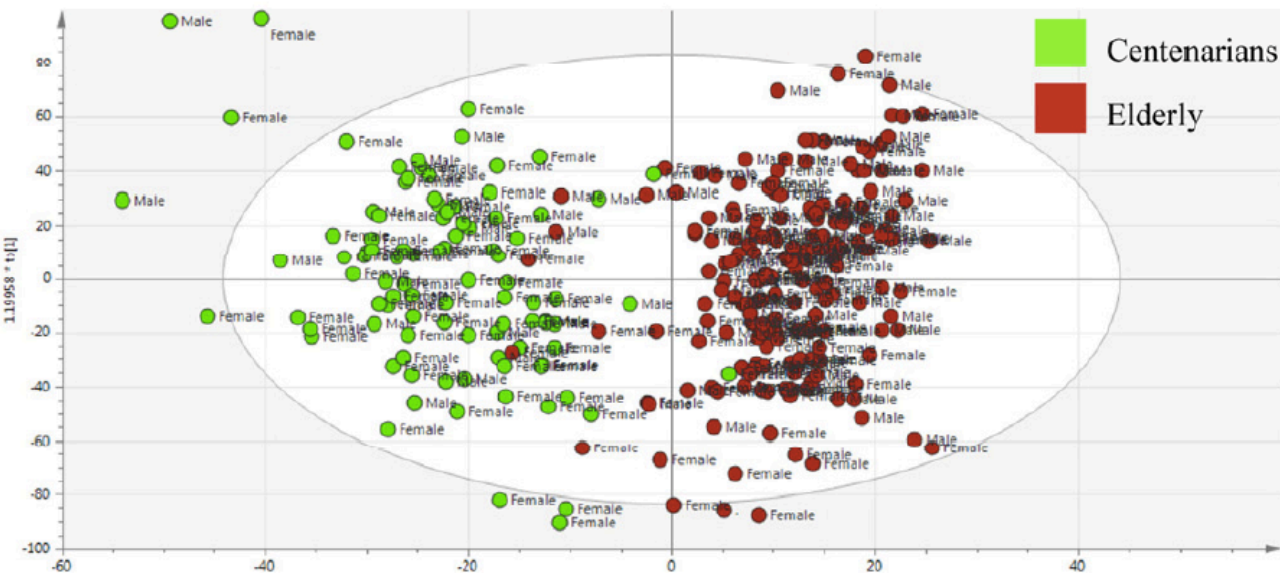
Jeste DV, et al. *World Psychiatry*. 2010;9(2):78-84.

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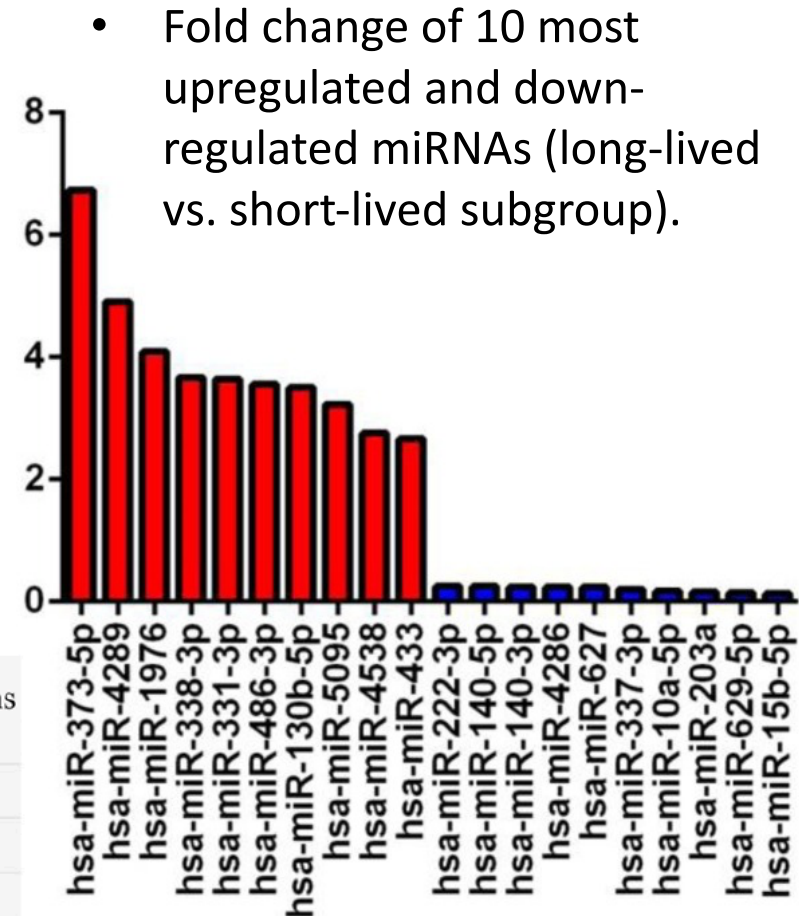
# Biomarkers of healthy ageing

- NMR metabonomics serum profiling of amino acids and lipid species
- Suggest better counteractive antioxidant capacity and membrane lipid remodelling, and phospho/sphingolipids as potential biomarkers and modulators of healthy aging



Montoliu I, et al. *Aging*. 2014 Jan; 6(1): 9–25.

Fold change  
[long-lived/short-lived cohort]



Smith-Vikos T, et al. *Aging* 2016, 8(11): 2971-2983



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# Summary

- The world's population is rapidly ageing with a majority being over age 60 by 2050, leading to among other issues, rapidly rising healthcare costs
- Ageing is a complex process characterized by changes from the molecular level to the functional level that have health consequences
- Healthy (or Successful or Graceful) ageing incorporates both objective and subjective measures of health status and quality of life
- An urgent need exists to identify interventions that can help facilitate healthy aging





**“At your age, good health is pretty much a thing of the past. My advice is, find an illness you enjoy.”**



# Thank You!

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