Understanding the determinants of healthy ageing: The Canadian Longitudinal Study on Aging

Harry Shannon
# CLSA Core team

<table>
<thead>
<tr>
<th>Role</th>
<th>Members</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead PI</td>
<td>Parminder Raina <em>(McMaster)</em></td>
</tr>
<tr>
<td>CO-PI</td>
<td>Christina Wolfson <em>(McGill)</em> and Susan Kirkland <em>(Dalhousie)</em></td>
</tr>
<tr>
<td>Key Senior Co-Investigators</td>
<td>Gerry Mugford <em>(Memorial)</em>, Helene Payette <em>(Sherbrooke)</em>, Larry Chambers and Vanessa Taler <em>(Ottawa)</em>, Harry Shannon, Cynthia Balion, Christopher Patterson, Lauren Griffith and Mark Oremus <em>(McMaster)</em>, Mary Thompson and Changbao Wu <em>(Waterloo)</em>, Debora Sheets, Lynne Young, Holly Tuokko, <em>(Victoria)</em>, Verena Menec <em>(Manitoba)</em>, David Hogan <em>(Calgary)</em>, Max Cynader, Michael Hayden and Michael Kobor <em>(UBC)</em> and Andrew Wister <em>(SFU)</em></td>
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<tr>
<td>Scientific Working Group</td>
<td>See our website – <a href="http://www.clsa-elcv.ca">www.clsa-elcv.ca</a></td>
</tr>
</tbody>
</table>
2012

European Year for Active Ageing and Solidarity between Generations 2012
Outline of talk

• Aging of the population
• Some health changes with age
• Canadian Longitudinal Study on Aging
  – Outline
  – Sampling
• Discussion points
Aging of the population in high income societies
Increase in life expectancy, 1600 - 2000
Oepen and Vaupel, Science 2002; C Finch adaptation

Phase 1
early urban

Phase 2
sanitation-nutrition

Phase 3?
regeneration
modern medicine
Social Policy Innovation

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[Graph showing life expectancy trends from 1550 to 2050 for countries like England, Norway, New Zealand, Iceland, Netherlands, Sweden, and Japan.]
### Life expectancy at age 65, 2009

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<th>Males</th>
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Source: OECD, 2011
Disability-free life expectancy after 65

8.1.2 Healthy life years at age 65, European countries, 2009

Source: OECD, 2011
Disability worldwide

Figure 3: Global years lived with disability (YLDs) per person in 1990 and 2010 for all ages, by sex

Source: Lancet, 15 Dec 2012
Historical expectation

• Genesis:  Adam  930 y
            Methusaleh  969 y
            Noah  950 y

• Psalms 90:10:
The days of our years are threescore years and ten, or even by reason of strength fourscore years
UK projection

‘Around one-third of babies born in 2012 in the United Kingdom are expected to survive to celebrate their 100\textsuperscript{th} birthday’

(UK) Office for National Statistics, March 2012
View of ageing

‘I do not hesitate to assert that the duration of the period of maturity is greatly within our control; and that, although the termination of the journey of human life is absolute and certain, yet that not only the length of that journey, but the manner of its division into various stages, and the degree of ease and pleasure with which we may travel, depend essentially on ourselves’

Barnard van Oven, 1853, cited by Cole and Edwards, in: Thane (ed), ‘The Long History of Old Age’
Historical views of ‘older workers’: first part of the 20th Century

• “women begin to break down in their thirties”

• “men [over 40] lack the essential flexibility of body and mind and suffer with impaired health”

Common attitudes of businesses described by Alsaker (1939); cited by Veit (2012)
Death in old age is inevitable but death before old age is not.

In previous centuries seventy years used to be regarded as humanity's allotted span of life and only about one in five lived to such an age. Nowadays, however, for non-smokers in Western countries, the situation is reversed: only about one in five will die before seventy and the non-smoker death rates are still decreasing, offering the promise, at least in developed countries, of a world where death before seventy is uncommon. But, for this promise to be properly realised, ways must be found to limit the vast damage now being done by tobacco & to bring home to not only the many millions of people in developed countries but also the far larger populations elsewhere, the extent to which those who continue to smoke are shortening their expectation of life by so doing. Richard Doll.
Was she really 132? World's 'oldest ever person' Antisa Khvichava dies in remote Georgian village

JOHN HALL

Monday 08 October 2012

Latest in News
Constance Briscoe arrested and questioned by police
Dawn winds hold up supersonic leap
Boris Johnson holds his own as Cameron's serious rival
US man dies after winning cockroach-eating contest
Banking giant Barclays agrees to buy ING Direct UK
Justin Lee Collins guilty of harassing ex-girlfriend
The great bardner
World's oldest person, 116, dies in Georgia

A 2010 photo shows Besse Cooper on her 114th birthday in a nursing home in Monroe, Ga. Cooper, who was the oldest person in the world, died Tuesday at the age of 116. (David Tulis/Athens Banner-Herald/Associated Press)
Nonagenarian former wrestler, Ramajit Raghav, breaks his own record after becoming father, again aged 96

Ramjit, who credits his astonishing virility to a life-long abstinence from drugs and alcohol, told reporters he: "can make love like any 25-year-old man"
‘Remind me – am I getting up or going to bed?’
“What part of Canada that I know nothing about are you from?”

From: New Yorker
Age pyramid of population of Canada, 1901 (5.3 m people)

Source: Statistics Canada, 2008
Age ‘pyramid’ of population of Canada, 2006
(32.5 m people)

Source: Statistics Canada, 2008
Different cohorts in Canada’s population ‘pyramid’, 2006

Source: Statistics Canada, 2008
Population aging - worldwide

Source: U.N.
## Percentage of population over 60

<table>
<thead>
<tr>
<th>Region</th>
<th>2012</th>
<th>2050 projected</th>
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<tbody>
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<td>Africa</td>
<td>6</td>
<td>10</td>
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<tr>
<td>Asia</td>
<td>11</td>
<td>24</td>
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<td>Latin America / Caribbean</td>
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<td>24</td>
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<td>Oceania</td>
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<td>25</td>
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<td>North America</td>
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<td>27</td>
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<tr>
<td>Europe</td>
<td>22</td>
<td>34</td>
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<tr>
<td><strong>World total</strong></td>
<td><strong>11.5</strong></td>
<td><strong>21.8</strong></td>
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</table>

Source: UNFPA

Source: UK Office of National Statistics
Population ‘pyramid’ Spain 2005

Source: ‘Instituto Nacional de Estadística’ of Spain. 1st January 2005 census
MILLIONS MUST WORK FOREVER

By Sarah O'Grady

THE pensions crisis means millions of Britons will never be able to retire, an alarming report has found.

Nearly 1.5 million people who are over 65 still work. And more than half of them say they have no option but to carry on as they do not have sufficient savings.
Relationship between age and health
Musculoskeletal system

• Gradual ↓ in strength
  – In early 50s, 80% that of early 30’s
  – Mean decline 3% per year after 70
• Flexibility/mobility of joints ↓
• Bones lose calcium
  – Can be moderated by regular weight-bearing exercise
Cardio-respiratory system

• Functional breathing capacity
  – Reduced by 40% from 30 to 65
• $O_2$ exchange rate $\downarrow$
• Blood vessels lose flexibility
• Arteries thicken / harden
Hearing

• Hearing ↓, especially ability to hear high-pitched sounds
• Ability to locate source of sound ↓
• Noise-induced hearing loss irreversible
• Ability to hear conversation in noisy environment ↓
Vision

• Flexibility of lens ↓
  – Can be corrected with glasses
• Amount of light reaching back of eye ↓
  – Up to 75% loss between 20 and 50
• Dark adaptation ↓
• Colour sensitivity ↓
• More affected by glare
Skin

- Stretches less easily
- Permeability ↑
Mental processes - 1

• Peak in 30s and 40s; only small decline in 50s and 60s
• Motivation ↑
• Verbal command ↑
• With normal aging:
  – Happiness ↑
  – Negative affect ↓
  – Anxiety, depression ↓
  – Occupational stress ↓
Mental processes - 2

• Small, generally positive relationship with age with respect to personality and adjustment
• Distinguish crystallized cognition and fluid cognition
• Working memory ↓
• Difficulty in dividing attention (multi-tasking)
Other effects of aging

• More sleep problems
• Prevalence of chronic diseases ↑
• Possible prescription or over-the-counter drug abuse
• Recovery from injuries / illnesses longer
Caution

• Much of what’s ‘known’ is based on cross-sectional studies
• Also, there is greater variation in health at older ages than at younger ones (hence hypothesis that effects of ageing can be prevented)
Genetic Heritability of Human Lifespan
Cournil & Kirkwood *Trends in Genetics* 2001

<table>
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<th>Twin Studies</th>
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<td>Herskind et al (1996)</td>
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<td>Ljungquist et al (1998)</td>
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<td>Philippe (1978)</td>
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<td>Bocquet-Appel &amp; Jakobi (1990)</td>
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<td>Mayer (1990)</td>
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<td>Cournil et al (2000)</td>
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</table>

Genes account for c. 25% of what determines longevity (and disease?)
Canadian Longitudinal Study on Aging

Support from:

• Canadian Institutes for Health Research
• Canada Foundation for Innovation
• Statistics Canada
• Provinces
• Participating universities
CLSA – The Concept

A research platform which will allow researchers:

• To study aging as a dynamic process
• To investigate the inter-relationship among intrinsic and extrinsic factors from mid life to older age
• To capture the transitions, trajectories and profiles of aging, especially healthy, successful aging
• To provide infrastructure and build capacity for sustained high quality research on aging in Canada
Theories of aging

• **Rate-of-living:**
  – limited amount of energy and resources to expend in a lifetime

• **Homeostasis:**
  – after stressors, ability to return to previous (normative) level is impaired as we age

• **Life-course:**
  – biological, social, environmental factors affect nature and trajectory of aging
Innovation - Cell to Society

- Mid life to old age
- Quantitative traits
  - Physical
  - Social
  - Psychological
- Gene-environment interactions
- Disease, disability, psychosocial consequences
- Adaptation
Interdisciplinary Research Agenda

- Methods
- Sociology
- Policy
- HSR
- Psychology
- Biology/genetics
- Clinical
- Lifestyle
Overall design

• ‘Tracking Cohort’
  – 20,000 people representative of population:
    • telephone interviews only

• ‘Comprehensive Cohort’
  – 30,000 people close to (mostly < 25 km from) one of 11 Data Collection Sites across Canada:
    • home interviews
    • clinical, functional, cognitive, blood and urine measures (+ storage of blood, DNA, urine)
Overview - Follow-up

- 20+ year follow-up, until death, loss to follow-up or end of study funding
- Assessment every 3 years, first wave being collected 2012-2015
- ‘Keeping Contact’ short phone interview at mid-point between waves
- Linkage to administrative databases
- Linkage to environmental databases – e.g., air pollution, Google API
Eligibility at baseline

• Aged between 45 and 85
  – Pre- Boomers: Born between 1925 and 1945
  – Boomers: Born between 1946 and 1967

• Permanent residents, not in institution, not in Canadian Armed Forces, can be interviewed in English or French, not living on Indian reserves, living in one of provinces
Depth and Breadth of CLSA

PHYSICAL & COGNITIVE MEASUREMENTS
- Height & weight
- Waist and hip measurements
- Bioimpedance
- Arterial pressure
- Mean heart rate
- Grip strength, timed up-and-go, chair raise, 4-m walk
- Standing balance
- Vision
- Hearing
- Spirometry
- Bone density
- Aortic calcification
- ECG
- Carotid intima-media thickness
- Cognitive assessment

HEALTH INFORMATION
- Chronic disease symptoms (11 chronic conditions)
- Medication intake & compliance
- Women’s health
- Self-reported health service use
- Oral health
- Preventative health
- Administrative data linkage health services & drugs
- Other administrative databases

PSYCHOSOCIAL
- Social participation
- Social networks and support
- Caregiving and care receiving
- Mood, psychological distress
- Coping, adaptation
- Work-to-retirement transitions
- Job-demand/effort reward
- Retirement planning
- Social inequalities
- Mobility-lifespace
- Built environments
- Wealth

LIFESTYLE & SOCIODEMOGRAPHIC
- Smoking
- Alcohol consumption
- Physical activity
- Nutrition
- Birth location
- Ethnicity/race/gender
- Marital status
- Education
- Income
Participant Recruitment

Vancouver  
Victoria  
Surrey  
Calgary  
Winnipeg  
Hamilton  
Ottawa  
Montreal  
Sherbrooke  
Halifax  
St. John’s
Canadian Longitudinal Study on Aging

**CLSAs Tracking**
(n=20,000)

<table>
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<th>Age Group</th>
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<td>55-64</td>
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<td>65-74</td>
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<td>75-85</td>
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**CLSAs Comprehensive**
(n=30,000)

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Equal numbers of men and women
Potential Sampling Frames

• Canadian Community Health Survey (CCHS) Participants
• Provincial Health Registration Databases
• Random Digit Dialing (RDD)

ALL OF THE ABOVE
Dealing with low response rates

• Currently, c. 15K recruited (target 50K)
• Response rates by either Health Registry sampling or RDD appear to be c. 10%
• Also, preliminary unweighted data suggest that compared to the general population (CCHS results):
  – People more highly educated are over-represented
  – Immigrants are under-represented
• (How much) Does low response matter in a longitudinal study?
• Representativeness vs. heterogeneity in independent variables?
Data Collection Sites (DCS)

11 ACROSS CANADA

- 5 participants per day (40 weeks)
- 50 mL blood
- Urine sample
- Hematology tests (AcT DIFF, Beckman Coulter)
Storage System

Tubes

- 500-μL V bottom, screw-top tubes (Matrix Tubes, Thermo Fisher Scientific)
- Open-bottomed boxes for fast scanning
- Standard 96 well format
- Potential for ‘pick and place’ robotic retrieval and storage box compression (‘defragging’)

Microwell Plates

- 3-section GenPlates (Genvault) with FTA paper
- Standard 96 well format
- Dried overnight in GenVault FastDryer and sealed with an adhesive foil cover
Bio specimens
42 aliquots per participant
Shipping

Matrix boxes
- Pre-charged vapor shippers (−160°C)
- Weekly shipments to BBC (overnight courier)
- Equipped with data loggers

GenPlates
- Envelopes with dessicant
Quality

*Standard protocols to minimize process variation*

**Supplies**
- Received by the BBC and packaged for monthly shipments to the DCS
- Barcode labels for supplies generated at BBC
- Lot numbers and expiry dates tracked centrally

**Biospecimens**
- Scanned at each stage of processing and handling to provide a detailed history of the biospecimen
- Characteristics of samples documented
- Sample integrity maximized
  - Maximum time from collection to storage is 2 h
  - Storage at −160°C
Biorepository and Bioanalysis Centre (BBC)

HAMILTON

Biorepository

- 31 nitrogen tanks (5 million aliquots)
- Autofilled from a bulk nitrogen tank
- Cryocarts
- Personal Archive, dry storage at room temperature (humidity controlled)
- LIMS (LabWare)
- CryoMORE, (Air Liquide) safety monitoring system
Biorepository and Bioanalysis Centre (BBC)

Biorepository
- Installation May 2012
- LIMS implementation April
- Hiring BBC coordinator
Diabetes Algorithm

Self-report of physician diagnosed Diabetes

No

Taking medication

No

Definite DM

FPG

FPG 6.1-6.9

IFG*

FPG <6.1

No DM

Taking medication

Yes

FPG ≥7

FPG <6.1

Probable DM

FPG 6.1-6.9

No

FPG

6.1 - 6.9

IFG*

*If self-report is removed, then this box = ‘possible diabetes’
Participants Consent to Participate in CLSA

Physical/Psychological Data
- Neuropsychological Battery
- Performance Testing
- Anthropometric Measures
- Bone Density, Body Composition
- Aortic Calcification
- ECG
- Carotid Intimal-Medial Thickness
- Pulmonary Function
- Vision and Hearing

Biological Data
- Blood
- Urine

Questionnaire Data Processed (n=50,000)

Participants Provide Questionnaire Data

CLSA Data Collection

Potential Participants Sent Study Information

Biological Data

Stored in Biorepository and Bioanalysis Centre (BBC)

Questionnaire Data Processed

n=20,000

n=30,000

Home Interview

Telephone interview

Stored in (NCC/SAC)
Hypothetical relationship between age, worker capacity and job demands

Smith P with permission. Adapted from Ilmarinen 2002.
And then the justice,
In fair round belly with good capon lined,
With eyes severe and beard of formal cut,
Full of wise saws and modern instances;
And so he plays his part.
Shakespeare’s sixth age of man

The sixth age shifts
Into the lean and slipper'd pantaloon,
With spectacles on nose and pouch on side,
His youthful hose, well saved, a world too wide
For his shrunk shank; and his big manly voice,
Turning again toward childish treble, pipes
And whistles in his sound.
Shakespeare’s seventh age of man

Last scene of all,
That ends this strange eventful history,
Is second childishness and mere oblivion,
Sans teeth, sans eyes, sans taste, sans everything.

Jaques in *As You Like It*
Currier and Ives, 1850: women
Currier and Ives, 1850: men
Saul Steinberg, Untitled, 1954
Other longitudinal studies

• E.g., SHARE – Survey of Health, Ageing and Retirement in Europe
  – 20 countries
  – > 55,000 people
  – Data freely available

• Includes England:
  – English Longitudinal Study on Ageing (ELSA)
Availability of CLSA data

• Basic descriptive analyses to be done by core CLSA team

• Data will be readily available to ‘outsiders’
  - committee to review applications + uses of data to ensure data access & confidentiality policies of CLSA are followed

• Some access to participants will be allowed

• Includes use of blood and urine samples

• See www.clsa-eclv.ca
Discussion Points

- Value of the CLSA platform
- Data access and IP policies
- Opportunities for collaboration for the core data collection CLSA
- Opportunities for analyses of the data and biological samples
- Opportunities for sub-studies
Contact

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Canadian Longitudinal Study on Aging:
www.clsa-elcv.ca