Transforming Everyday Life into Extraordinary Ideas
Canadian Longitudinal Study on Aging as a Platform for Research on Healthy Aging

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Seoul, South Korea, November 9th, 2016
Talk Outline

- Canadian Longitudinal Study on Aging (CLSA) as platform for research on aging
- Why do we need Large Comprehensive Longitudinal Studies?
  - Multi-Morbidity
    - Data harmonization
  - Heterogeneity of the Aging Population
- CLSA Data and Sample Access
Population aging

- Due to declining fertility and increasing longevity (demographic transition)
- Unprecedented, accelerating, shifts will be permanent
- Profound implications for human life, including health
Gender and Aging

- NUMBERS
- MORBIDITY
- POVERTY
Trends in Global Aging

Percent of Population Aged 65 & Over: History and UN Projection

- 1950: 4% (Developed World), 4% (Developing World)
- 1970: 8% (Developed World), 4% (Developing World)
- 1990: 12% (Developed World), 4% (Developing World)
- 2010: 14% (Developed World), 5% (Developing World)
- 2030: 19% (Developed World), 6% (Developing World)
- 2050: 26% (Developed World), 15% (Developing World)

Source: UN (2005)
### Number of Years for Percent of Population Age 65 or Older to Rise from 7% to 14%

<table>
<thead>
<tr>
<th>More developed countries</th>
<th>Less developed countries</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>France</strong> 1865-1980</td>
<td><strong>Azerbaijan</strong> 2000-2041</td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td><strong>Sweden</strong> 1890-1975</td>
<td><strong>Chile</strong> 1998-2025</td>
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<td><strong>Australia</strong> 1938-2011</td>
<td><strong>China</strong> 2000-2026</td>
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<td><strong>United States</strong> 1944-2013</td>
<td><strong>Jamaica</strong> 2008-2033</td>
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<tr>
<td><strong>Canada</strong> 1944-2009</td>
<td><strong>Tunisia</strong> 2008-2032</td>
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<tr>
<td><strong>Hungary</strong> 1941-1994</td>
<td><strong>Sri Lanka</strong> 2004-2027</td>
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<td><strong>Poland</strong> 1966-2013</td>
<td><strong>Thailand</strong> 2003-2025</td>
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</tr>
<tr>
<td><strong>United Kingdom</strong> 1930-1975</td>
<td><strong>Brazil</strong> 2011-2032</td>
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<tr>
<td><strong>Spain</strong> 1947-1995</td>
<td><strong>Colombia</strong> 2017-2037</td>
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<tr>
<td><strong>Japan</strong> 1970-1996</td>
<td><strong>Singapore</strong> 2000-2019</td>
</tr>
</tbody>
</table>

* Dates show the span of years when percent of population age 65 or older rose (or is projected to rise) from 7 percent to 14 percent.

“Population aging is unquestionably the most important demographic force of the first half of the twenty-first century”.

(Schoeni FR, Ofstedal MB. “Key Themes in research on the Demography aging” Demography, 47, 2010: S5-S15)
## Population Totals in Canada by Age Group and Year

<table>
<thead>
<tr>
<th>AGE</th>
<th>MALES</th>
<th>BOTH SEXES</th>
<th>FEMALES</th>
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1991 TOTALS: 13938100 (MALES), 28117600 (BOTH SEXES), 14179500 (FEMALES)
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Population aging

Canada shows its age as seniors outnumber children for first time

ERIC ANDREW-gee
The Globe and Mail
Published Tuesday, Sep. 29, 2015 9:50PM EDT
Last updated Wednesday, Sep. 30, 2015 8:07AM EDT
CLSA Leads

Lead Principal Investigator
Parminder Raina (McMaster)

Co-principal Investigator
Christina Wolfson (McGill)

Co-principal Investigator
Susan Kirkland (Dalhousie)
What is the Canadian Longitudinal Study on Aging (CLSA)?

“The Canadian Longitudinal Study on Aging is the largest most comprehensive research platform and infrastructure available for aging research with longitudinal data that will span 20 years from over 50,000 Canadians over the age of 45”

A research platform – infrastructure to enable state-of-the-art, interdisciplinary population-based research and evidenced-based decision-making that will lead to better health and quality of life for Canadians
Study Overview

50,000 women and men aged 45 - 85 at baseline

n=20,000
Randomly selected within provinces

n=30,000
Randomly selected within 25-50 km of 11 sites

Questionnaire
• By telephone (CATI)

Questionnaire
• In person, in home (CAPI)

Clinical/physical tests
Blood, urine (consent)
• At Data Collection Site

Interim contact, follow up every 3 years

Data Linkage (consent)
Participants (51,352)

Enrolled

Questionnaire Data (telephone and in person interviews) (>50,000)

Physical Exam and Biological Specimen (>30,000)

Data and Biological Sample Repositories

Researchers

Active Follow-up (F) Every 3 years
- Questionnaire
- Physical exam
- Biological samples

Maintaining Contact (MC) mid-wave
- Update contact information & implement Retention strategies

Passive Follow-up Every 3 years
- Health care utilization
- Disease registries
- Mortality databases
Depth and Breadth of Baseline CLSA

PHYSICAL & COGNITIVE MEASUREMENTS
- Height & weight
- Waist and hip measurements
- Blood Pressure
- Grip strength, timed up-and-go, chair raise, 4-m walk
  Standing balance
- Vision (retinal imaging, Tonometer & visual acuity)
- Hearing (audiometer)
- Spirometry
- Body composition (DEXA)
- Bone density (DEXA)
- Aortic calcification (DEXA)
- ECG
- Carotid intima-media thickness (ultrasound)
- Cognitive assessment (30 min. battery)
- Brain imaging (New)

HEALTH INFORMATION
- Chronic disease symptoms (disease algorithm)
- Medication and supplements intake
- Women’s health
- Self-reported health service use
- Oral health
- Preventative health
- Administrative data linkage health services & drugs & other administrative databases
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- Preventative health
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**PSYCHOSOCIAL**
- Social participation
- Social networks and support
- Caregiving and care receiving
- Mood, psychological distress
- Veteran’s Identifier & PTSD
- Coping, adaptation
- Injuries and consumer products
- Work-to-retirement transitions & **Workability (New)**
- Retirement planning
- Social inequalities
- Mobility-life space
- Transportation
- Built environments & Contextual Factors
- Air Pollution
- Income, Wealth and Assets
- Child Maltreatment & Elder abuse *(New)*

**LIFESTYLE & SOCIODEMOGRAPHIC**
- Smoking
- Alcohol consumption
- Physical activity (PASE)
- Nutrition (nutritional risk and food frequency)
- Birth location
- Ethnicity/race/gender
- Marital status
- Education
Biomarker data

Comprehensive Cohort (n=30,000)

Soluble Markers
Calgary Laboratory Services (n=30,000)
- Albumin
- Alanine Aminotransferase
- C-Reactive Protein, High Sensitivity
- Creatinine, serum
- Total Cholesterol, HDL Cholesterol, Calculated LDL Cholesterol, Triglycerides
- Ferritin

Genome-wide Genotyping
McGill University and Génome Québec Innovation Centre (n=10,000)
- Buffy coat DNA extracted on all 30,000
- Genotyping by the ~820K UK Biobank Axiom Array (Affymetrix)
- Imputation (~6 million SNPs) performed by Brent Richards (McGill University)

Metabolomics (n=3,000)
-Performed on participant serum in Japan using a mass spectrometry approach

DNA Methylation Profiling
UBC Genetics and Epigenetics Centre (n=2,000)
-Performed in the laboratory of Dr. Michael Kobor, UBC
- PBMCs used for DNA
-Profiling by 850K Infinium MethylationEPIC BeadChip (Illumina)

~2,000 participants with matching soluble, genetic, epigenetic and metabolomic marker data
Some Observations from CLSA data
## Social Participation and Loneliness by Age & Gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total % (age 45-85)</th>
<th>Age 65+ %</th>
<th>Males Age 65+ %</th>
<th>Females Age 65+ %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desire to participate in more activities <em>(Yes)</em></td>
<td>41.7</td>
<td>31.7</td>
<td>29.7</td>
<td>33.5</td>
</tr>
<tr>
<td>How often participant feels lonely <em>(Sometimes or more)</em></td>
<td>22.7</td>
<td>23.7</td>
<td>19.1</td>
<td>28.5</td>
</tr>
</tbody>
</table>

## Community-related Activities by Age & Gender

<table>
<thead>
<tr>
<th>Frequency of any community-related activity participation</th>
<th>Total % (age 45-85)</th>
<th>Age 65+ %</th>
<th>Males Age 65+ %</th>
<th>Females Age 65+ %</th>
</tr>
</thead>
<tbody>
<tr>
<td>At least once per day (daily)</td>
<td>15.5</td>
<td>16.1</td>
<td>16.3</td>
<td>16.0</td>
</tr>
<tr>
<td>At least once per week (weekly)</td>
<td>66.6</td>
<td>67.8</td>
<td>65.6</td>
<td>69.7</td>
</tr>
<tr>
<td>At least once per month or less (monthly or less)</td>
<td>17.9</td>
<td>16.3</td>
<td>18.2</td>
<td>14.3</td>
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</tbody>
</table>
## Social Participation Types by Age & Gender

<table>
<thead>
<tr>
<th>Frequency of participation in past 12 months</th>
<th>Total % (age 45-85)</th>
<th>Age 65+ %</th>
<th>Males Age 65+ %</th>
<th>Females Age 65+ %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sports or physical activities with others</td>
<td>50.3</td>
<td>47.9</td>
<td>47.3</td>
<td>48.5</td>
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<tr>
<td>Family/friends activities outside household</td>
<td>50.2</td>
<td>46.2</td>
<td>47.0</td>
<td>52.9</td>
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<tr>
<td>Religious activities</td>
<td>22.4</td>
<td>32.3</td>
<td>28.2</td>
<td>35.9</td>
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<tr>
<td>Volunteer or charity work</td>
<td>16.9</td>
<td>22.1</td>
<td>18.1</td>
<td>25.7</td>
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<tr>
<td>Educational or cultural activities</td>
<td>10.3</td>
<td>11.6</td>
<td>10.1</td>
<td>12.9</td>
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<tr>
<td>Neighbourhood, community or social association activities</td>
<td>8.3</td>
<td>10.9</td>
<td>8.5</td>
<td>12.7</td>
</tr>
<tr>
<td>Service clubs or fraternal organization activities</td>
<td>5.2</td>
<td>7.2</td>
<td>7.5</td>
<td>6.8</td>
</tr>
</tbody>
</table>
## Perceived Barriers to Social Participation, by Age & Gender

<table>
<thead>
<tr>
<th>Reason(s) preventing more participation</th>
<th>Total % (age 45-85)</th>
<th>Age 65+ %</th>
<th>Males Age 65+ %</th>
<th>Females Age 65+ %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Too busy</td>
<td>51.7</td>
<td>31.4</td>
<td>33.3</td>
<td>28.3</td>
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<tr>
<td>Health condition/limitation</td>
<td>15.9</td>
<td>23.2</td>
<td>20.4</td>
<td>25.3</td>
</tr>
<tr>
<td>Personal responsibilities</td>
<td>15.8</td>
<td>14.1</td>
<td>10.8</td>
<td>16.7</td>
</tr>
<tr>
<td>Going alone</td>
<td>10.2</td>
<td>12.2</td>
<td>12.0</td>
<td>12.5</td>
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<td>Cost</td>
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<td>Lack of activities in area</td>
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<td>8.5</td>
<td>9.5</td>
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<td>Transportation problems</td>
<td>3.5</td>
<td>5.3</td>
<td>2.3</td>
<td>7.5</td>
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<td>Location accessibility</td>
<td>1.4</td>
<td>1.8</td>
<td>1.2</td>
<td>2.4</td>
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<tr>
<td>Language reasons</td>
<td>0.4</td>
<td>0.6</td>
<td>0.7</td>
<td>0.5</td>
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# Retirement Status

<table>
<thead>
<tr>
<th>Retirement Status</th>
<th>45-64</th>
<th>65-85</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Completely Retired</td>
<td>19.6%</td>
<td>25.3%</td>
</tr>
<tr>
<td>Partly Retired</td>
<td>10.5%</td>
<td>9.4%</td>
</tr>
<tr>
<td>Not Retired</td>
<td>69.9%</td>
<td>65.3%</td>
</tr>
<tr>
<td>Retired and Returned to Work</td>
<td>9.6%</td>
<td>8.1%</td>
</tr>
</tbody>
</table>

Of those retired:

- Voluntary Retirement: n = 9,633 (78.7%)
- Health/Disability/Stress contributed to decision to retire: n = 2,922 (23.5%)
Need for Large Studies?

Few Examples
Multimorbidity

- Older adults are also at higher risk for multimorbidity (MM)

- MM is associated with increased disability and premature mortality, and health services utilization and costs

1 St John, Can Fam Physician (2014)
2 Lehnert, Med Care Res Rev (2011)
Definition and Burden of Multimorbidity (MM)

- Definition: the co-existence of two or more chronic conditions where one is not necessarily more central than the others.
- MM represents a **new and increasing** challenge for the countries and their health and social care system.
- MM often has significant impact on: quality of life, increased functional disability and premature mortality.
- Currently no clear consensus on how to operationalize MM:
  - Simple disease counts (# and type of CCs vary across studies)
  - Depending on definition prevalence of multimorbidity ranges from 13.1% to 71.8% in population-based studies.
Canadian data were harmonized with several cohorts from Europe to maximize the sample size.
METHODOLOGY

INCLUDED STUDIES:
- Canadian Study on Health and Aging (1991) n= 9008
- CHANCES consortium on Health and Aging n=18207 (EPIC Elderly (1992) n=10079; ESTHER study (2000) n=3842; Tromso study (1994) n=4286

EXPOSURE:
- Baseline information available for the following 5 prevalent, costly and preventable causes of death in high income countries:
  - Cancer, Stroke, Hypertension, Myocardial infarction, Diabetes
- Categorized into mutually exclusive groups of disease combinations

OUTCOME:
- All-cause mortality; Mean of 10y FU

ANALYSES:
- Cox proportional hazard models
  - adjusted for age, sex, tobacco smoking and education
  - Hazard (t, exposure) = \( b_1 \times \text{exposure} + b_2 \times \text{age} + \text{covariates} \)
- Rate advancement period
  - \( \text{RAP} = \frac{b_1}{b_2} \)
  - specifies the loss of years in terms of mortality risk
Estimates of rate advancement period (RAP) for overall Mortality associated with cluster of chronic diseases

- Any 1 condition: 2.09
  - Cancer: 3.33
  - MI: 4.18
  - Stroke: 4.53
  - Diabetes: 4.75
  - HBP: 1.34

- Any 2 conditions: 5.56
  - Cancer and MI: 6.27
  - Cancer and stroke: 8.62
  - Cancer and diabetes: 6.94
  - Cancer and HBP: 4.06
  - MI and stroke: 7.25
  - MI and diabetes: 4.92
  - MI and HBP: 5.68
  - Stroke and diabetes: 6.42
  - Stroke and HBP: 6.42
  - Diabetes and HBP: 10.58

- Any 3 conditions: 10.02
  - Cancer and MI and HBP: 9.77
  - Cancer and stroke and HBP: 7.93
  - Cancer and diabetes and HBP: 6.78
  - MI and stroke and HBP: 9.74
  - MI and diabetes and HBP: 11.46
  - Stroke and diabetes and HBP: 10.18

- Any 4 conditions: 11.13
RESULTS

- At baseline, >65% of participants reported having one or more chronic conditions hypertension being the most prevalent condition.
- The period by which the rate of death was advanced increased with each additional chronic condition.
- Compared with individuals without any of the five chronic conditions, the rate of death was advanced by 2.09, 5.56, 10.02, and 11.13 years for participants with 1, 2, 3, or ≥4 conditions, respectively.
- Among combinations with the same number of conditions, there was substantial variability in RAPs.
- Some disease combinations (e.g. cancer and stroke; RAP: 8.62, 95%CI: 4.79-12.49) had a significantly greater impact on the period by which the rate of death was advanced than others (e.g. cancer and hypertension; RAP: 4.06, 95%CI: 2.88-5.25).
Rate Advancement Period

Specifies by which period the rate of death is advanced among people with a specific multi-morbidity relative to their disease free counterparts. For example, a 65 year old individual with 4+ chronic conditions has the same mortality risk as a 77 year old individual who has none of the five chronic conditions.
Large Population-based Studies that follow people over time are essential in order to sort causal relationships among demographic, biological, psychosocial and economic factors, and health (multimorbidity).

Harmonization of data sets and cross-national comparison are important, considering variability across societies, in terms of status and well-being of older persons, experiences of health and mortality, family and social support, and health care systems.
Heterogeneity of the Aging population
Physiologic and Psychosocial Reserve - Hypothetical Trajectory to Fraility, Functional Limitation & Disability

Physiologic reserve

Younger age  Time  Older age

hypothesis graph with markers at hip fracture, pneumonia, congestive heart failure, many chronic conditions, work stress, divorce, retirement, death of the spouse, functional limitation, and disability.
Frailty as an Indicator of Heterogeneity of Aging Population: Preliminary Analysis of the Canadian Longitudinal Study on Aging (CLSA)

David Kanters, M.Sc. & Lauren Griffith, PhD, 2016
What is Frailty?

• Frailty is a **state** in which there is an increase in an individual’s vulnerability for developing increased dependency and/or mortality when exposed to a stressor.

• It describes the heterogeneity among older populations

Challenges

Operational definition of frailty should further our understanding between frailty and healthy status, its biological basis, impairments and longitudinal changes and trajectories in physical function as well as the contribution of social determinants, environmental and behavioural factors (Bergman et al., J Gerontol A Biol Med Sci 2007;62:731-737)

• Need for longitudinal, population-based data with great breadth and depth

→ Canadian Longitudinal Study on Aging (CLSA)
Heat Map for Frailty by Age & Sex in CLSA

Frailty Index by Age (Females)

Simplified Frailty by Age (Males)
Frailty Indices by Age Group
## Profile of Frailty by Key Factors

<table>
<thead>
<tr>
<th>Frailty Index</th>
<th>Age</th>
<th>Sex (M)</th>
<th>Income</th>
<th>Education</th>
<th>Injury from Fall</th>
<th>Serious Injuries</th>
<th>Informal Home care</th>
<th>Formal Home Care</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frailty Index</td>
<td>0.170</td>
<td>-0.119</td>
<td>-0.339</td>
<td>-0.174</td>
<td>0.122</td>
<td>0.122</td>
<td>0.324</td>
<td>0.300</td>
</tr>
<tr>
<td>Simplified Frailty</td>
<td>0.097</td>
<td>-0.118</td>
<td>-0.259</td>
<td>-0.155</td>
<td>0.107</td>
<td>0.123</td>
<td>0.329</td>
<td>0.315</td>
</tr>
</tbody>
</table>
Fig 1. Shifting the level of population risk
**Stages of the Adult Life Cycle**

<table>
<thead>
<tr>
<th>Sources of Heterogeneity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative Partitions by Population Characteristic</td>
</tr>
</tbody>
</table>

**Stages of the Life Cycle**

<table>
<thead>
<tr>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Socioeconomic status</td>
</tr>
<tr>
<td>2. Ethnicity/migration</td>
</tr>
<tr>
<td>3. Geographic</td>
</tr>
<tr>
<td>4. Female/Male</td>
</tr>
<tr>
<td>5. Special Populations</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sources of Heterogeneity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Individual lifestyle</td>
</tr>
<tr>
<td>2. Physical environment</td>
</tr>
<tr>
<td>3. Social environment</td>
</tr>
<tr>
<td>4. Biology</td>
</tr>
</tbody>
</table>

Fig. 1. Model for investigation of heterogeneities in population health status
Adapted from: C. Hertzman, J. Frank, and R. G. Evans, Heterogeneities in Health Status
Fig 1. Shifting the level of population risk.
RESEARCH ON AGING IS THE FOCUS!

What else are we doing at McMaster University to complete the picture?
Proposed Focus of the MIGS: Cross-Disciplinary Research in Plasticity of Function in an Aging Population

Aging Person

Preventive: Promote Optimal Functioning
Restorative: Regain (& Maintain) Functioning & Independence
Mitigation: Slowing Further Decline

Intervention Development

Impact Evaluation
Efficacy
Cost
Scalability
Uptake

Knowledge Translation
Product/Tool/Guideline Development

Integration within Systems
Model Communities

Impact Evaluation and Translation
Public Impact
Clinical Impact
Policy Impact
Your source for healthy aging information that you can trust

PLAY VIDEO  BROWSE TOPICS

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McMaster Optimal Aging Portal

Support for the Portal is largely provided by the Labarge Optimal Aging Initiative. Help us to continue to provide direct and easy access to evidence-based information on how to manage our health conditions and to stay healthy, active and engaged as we grow older. Donate Today.
What does drawing clocks have to do with driving cars? Tests of cognitive skills that can flag older drivers who may be unsafe behind the wheel

Problems with seniors' driving have been linked to changes in their medical and functional status that are related to normal aging changes. The key is to identify drivers who are at risk.

Antioxidant vitamins for eye health? Research evidence provides clarity

Cataracts and macular degeneration commonly develop as we age. Will taking antioxidant vitamins help prevent these vision problems?
www.mira.mcmaster.ca

www.mcmasteroptimalagingportal.ca
Back To CLSA..

Accessing CLSA data
Data and Biospecimen Access

- Fundamental tenets:
  - The rights, privacy and consent of *participants* must be protected and respected at all times
  - The confidentiality and security of *data and biospecimens* must be safeguarded at all times
  - CLSA data and biospecimens are resources that will be used optimally to support research to benefit all Canadians
  - No preferential or exclusive access
CLSA as Platform for Interdisciplinary Research through collaborations: Examples

- Falls and Consumer Products (PHAC)
- Elder abuse and Child Maltreatment (PHAC)
- Air pollution and chronic diseases (funded through CARA: Health Canada)
- Veteran’s Health and PTSD (Veterans Affairs)
- Transportation, Mobility and Migration (Ontario Ministry of Transportation)
- Biomarkers and mobility (CIHR)
- MINDMAP-Urbanization and Mental Health (EU-Horizon2020)
- Epigenetic Clock and Healthy Aging
- Genetics and Chronic Disease
- Metabolomics and diabetes sub-study
- Hearing and Cognition
- Volunteerism, social engagement and baby boomers
- CLSA-Brain sub-study
praina@mcmaster.ca

CLSA funded by the Government of Canada through CIHR and CFI, and provincial governments and universities

www.clsa-elcv.ca