Advancing the Science of Population Health and Aging through Interdisciplinary Research

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The Aging Revolution

- The rapid and continuing increase in human survival.
- New scientific understanding of the ageing process.
- The changing nature of old age and its determinants.
- Expectations, adjustments and policy.
### Population Totals in Canada by Age Group and Year

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<th>FEMALES</th>
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Trends in Life Expectancy

Source: J Cairns, *Matters of Life and Death*, 1997
Maximum Lifespan in Sweden, 1861-1999

Demographic Futures

- Upward trend in life expectancy continue, cease, or reverse?
  + Effective interventions against age-related diseases
  + Improved environment for ageing
  + Life-cycle deceleration (delayed reproduction)

- Adverse effects of excess nutrition
- Adverse effects of alcohol and drug abuse
- Adverse effects of increasingly sedentary lifestyles
- Life-cycle acceleration (early maturation)
Why ageing occurs

How ageing is caused
We are not programmed to die.

We are programmed for survival but in our ancestral environment investments in reproduction were a higher priority than long-term survival.

Ageing is caused by the build-up of faults.
What is the Relationship between Ageing and Disease?

- What is ‘normal’ ageing?
- Why is the aged cell (or organ) more vulnerable to pathology?
Ageing or Disease?

- Osteoporosis
- Osteoarthritis
- Dementia
What Accounts for the Individuality of Human Ageing?
# Genetic Heritability of Human Lifespan

Cournil & Kirkwood *Trends in Genetics* 2001

## Twin Studies
- McGue et al (1993) \(0.22\)
- Herskind et al (1996) \(0.25\)
- Ljungquist et al (1998) <\(0.33\)

## Traditional Family Studies
- Philippe (1978) \(0-0.24\)
- Bocquet-Appel & Jakobi (1990) \(0.10-0.30\)
- Mayer (1990) \(0.10-0.33\)
- Gavrilova et al (1998) \(0.18-0.58\)
- Cournil et al (2000) \(0.27\)

Genes account for 25% of what determines longevity
The Aging Process

Kirkwood, 2005

Functional Impairments in Organs and Tissues leading to Age-related Frailty, Disability, and Disease

Inflammation

Accumulation of Cellular Defects

Anti-Inflamm

Good lifestyle

Good Food

Stress

Environment

Bad Food
Factors Influencing Longevity and Health

- Genes
- Nutrition
- Lifestyle
- Environment
Multi-Stage Progression of Age-Related Disease

‘Upstream’ → ‘Downstream’

Disease A
Disease B
Disease C
Scientific Evidence

- Our review identified around 70 longitudinal studies worldwide
  - Majority of these studies were studying people over the age of 65
  - Many of these 70 studies on aging collect lot of information on social factors or retirement but lack detailed information on health, especially clinical and biological measures or vice versa
Scientific Evidence

- Very few studies have looked at the aging process from a mid-life to old age perspective

- Very few population-based studies that capture the changing individual within a changing context and incorporate multiple levels of inquiry, the cell, the individual and society

- Very few studies have focused on how individuals cope or adapt to changing circumstances and how it impacts their well-being
Policy Needs

- Changing demographics #1 priority of Canadian Federal and Provincial Governments
- Healthy aging is important to the Canadian public and policy makers
- Canada differs from other countries in its:
  - health and social policy
  - health care delivery systems
  - climate, environment, geography, and
  - retirement policy and pension programs
- Seniors of tomorrow have different needs and expectations
  - major implications & challenges for the health care system and for social programs
Future of Research in Aging in Post-Genomic Era

Environmental influences
(e.g., rural, socio-economic, exercise, nutrition)

Chronic diseases
diabetes, cancer, dementia
arthritis, cardio

Aging

e.g., telomeres / oxidative stress
psychological & cognitive abilities
immune functions

Health Services Utilization

Genetics

time

infections

CLSA
ELCV
Future of Research in Post-Genomic Era

- Age-related changes—“complexity”
  - INDIVIDUAL LEVEL
  - SOCIETAL AND CONTEXTUAL LEVEL

- Innovative study design that advance science of aging and health as well as inform health and social policy

- Need for interdisciplinary long-term longitudinal studies
Methodological Challenges

Conceptual frameworks, theoretical models and analytical approaches that:

- distinguish independent, cumulative, interactive, and contextual effects, and critical and sensitive periods
- make parsimonious models from mountains of data (modeling ageing outcome and risk factor trajectories)
- handle repeat observations and missing data, hierarchical data, measurement error, latent variables.

BUT THERE ARE DANGERS OF OVER COMPLICATED METHODOLOGY!
Need clear and transparent approach
The Canadian Longitudinal Study on Aging (CLSA)

A key component of the Canadian Lifelong Health Initiative, a strategic initiative of CIHR

The Canadian National Birth Cohort
The Canadian Longitudinal Study on Aging

More than 160 researchers - 26 institutions

Multidisciplinary - biology, genetics, medicine, psychology, sociology, demography, economics, epidemiology, nursing, nutrition, health services, biostatistics, population health
Principal Investigator Triumvirate

Susan Kirkland - Dalhousie University

Parminder Raina - McMaster University

Christina Wolfson - McGill University
Innovation - Cell to Society

- Mid life to old age
- Quantitative traits
  - Physical
  - Social
  - Psychological
- Gene-environment interactions
- Disease, disability, psychosocial consequences
- Adaptation
1. To develop a Canadian multi-centre study that could determine:
   • genetic, immunologic and molecular determinants of aging
   • effect of physical exercise, nutrition and other habits
   • evolution of physical, psychological, and cognitive abilities
   • role of psychological determinants of health
   • role of social and cultural determinants of health
   • health services utilization of this population

2. To identify preventive strategies and health services that would promote healthy aging

3. To translate the findings into clinical practices, health services and policy

CIHR-IA RFP
Overall Aims of the CLSA

- To examine 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: successful aging.
- To provide infrastructure and build capacity for sustained high quality research on aging in Canada.
Examples of Few Research questions in CLSA

- What is the relative importance of mid-life and later life risk factors on changes in neuromuscular, neuroendocrine, inflammation and immune functions that underlie aging and age-related diseases?

- Do exposures early in mid-life influence the development of social inequalities in older adults and how these social inequalities relate to disease, disability or psychosocial outcomes?

- Are there common risk factors and processes that promote the development and maintenance of cognitive and physical capability across the life course, reduce chronic disease risk and improve longevity?
## Focus of Measurement

### Biomedical
- Activities of daily living/disability/injuries
- Frailty/co-morbidities
- Chronic diseases
- Cognitive function
- Mental Health
- Oral health
- Vision, hearing
- Medications
- Health Care Use
- Institutional care
- Genetics/Biology
  - Disease susceptibility/longevity genes
  - DNA repair
  - Antioxidant defence
  - Apoptosis, programmed cell death
  - Immunosenescence
  - Telomere loss
- Nutrition

### Psychosocial
- Lifestyle/behaviours
- Social networks and social support
- Values and meaning
- Everyday competence, adaptive functioning, coping
- Personality, emotion, psychopathology
- Work to retirement transitions
- Structural inequalities
- Built environments/physical environment
- Economics
- Healthy aging and well being
- Linkage to secondary data bases
  - Health care use
  - Disease registries
  - Drugs
  - Environmental
CLSA Architecture

Data collection of 30,000 (at 10 sites)
Questionnaire, Biological, Physical linkage
Follow-up over 20 years

Every 3 years age 45-84
Core National Network of Facilities

National Coordinating Centre

Manage and Coordinate; Timelines; Develop Protocols, Procedures; Training & Documentation

Operations Data / Measures / Analyses

Operations Data

Interim Follow Up

Operations

Operations Data