COMMENTARY

Longitudinal studies of ageing: from insights to impacts: commentary to accompany themed collection on longitudinal studies

Finbarr C. Martin[1], Román Romero Ortuño[2]

[1]Emeritus Professor of Medical Gerontology, King's College London and Emeritus Consultant Geriatrician, Guy's and St Thomas NHS Foundation Trust, London, UK
[2]Associate Professor in Medical Gerontology, Trinity College Dublin and Consultant Physician, St James's Hospital, Dublin

Address correspondence to: Finbarr C. Martin. Tel: +44 (0) 7939 845341; Email: finbarr.martin@kcl.ac.uk

Abstract

'Time is the best diagnostician': who has not thought this? In clinical practice, presentations are often subtle and decisions made in the face of a 'snapshot.' Crystal balls do not exist; yet, insights from longitudinal studies can help to recognise emerging pictures and anticipate typical trajectories.

In the multifactorial, biopsychosocial world of geriatrics, the determinants of those trajectories, and hence opportunities to modify them, can be better understood through careful longitudinal disentangling of the wider determinants of health, and this can be done at multiple levels of analysis, from molecules to society. With this collection and commentary, we highlight the approaches, scope and impacts of a selection of longitudinal studies of ageing published in *Age and Ageing* within the past 10 years.

Longitudinal studies can illuminate disease mechanisms, how declines in multiple domains of intrinsic capacity interact, how losses in one domain may influence the path of another, and in turn, how these changes translate to functional disability, or not. Observing trajectories of geriatric syndromes can suggest opportunities for optimisation and prevention in clinical practice and policy. With global opportunities for harmonising data, longitudinal studies are already offering the opportunity for cross-national comparisons and for developing hypotheses about the relative contributions of time, place and society in the trajectories of frailty, disability and quality of life. We also include studies which show how research-based longitudinal data can be synthesised or be linked to administrative datasets. We hope you find this collection as interesting and encouraging as we have.

Keywords

longitudinal, cohorts, ageing, datasets, older people

Key points

- Longitudinal studies can provide data at many levels including genetics, biomarkers, physiological impairments, functional abilities and healthcare use.
- Longitudinal studies provide data on trajectories of change in single or sequential cohorts, enabling better understanding of the impacts of ageing, cohort differences and period effects.
- Longitudinal studies can provide evidence of early predictors of later declines in health, which may be useful in public health and clinical practice.
- Harmonisation of datasets across multiple longitudinal studies can help to disentangle the contributions of time, place and society in the development of adverse health outcomes.
- Longitudinal data can strengthen or refute evidence of causal relationships suggested by cross sectional data.

Introduction

'Time is the best diagnostician': who has not thought this? In clinical practice, presentations are often subtle and decisions made in the face of a 'snapshot.' Crystal balls do not exist; yet, insights from longitudinal studies can help to recognise emerging pictures and anticipate health trajectories.

In the multifactorial, biopsychosocial world of geriatrics, the determinants of those trajectories, and hence opportunities to modify them, can be better understood through careful longitudinal disentangling of the wider determinants of health, and this can be done at multiple levels of analysis, from molecules to society. With this collection, we highlight the approaches, scope and impacts of a selection of longitudinal studies of ageing published in *Age and Ageing* over the last decade. The selection is by no means comprehensive: many excellent relevant studies could not be included. Reports of cross-sectional analyses from single waves of longitudinal studies can be illuminating and suggest hypotheses, but were out of scope for this collection.

Understanding disease mechanisms

Novel quantitative methods applied to longitudinal studies can help us understand how declines in multiple domains of intrinsic capacity may interact at several levels challenging resilience and homeostatic ability. For example, a secondary analysis of the Chinese Longitudinal Health and Longevity Study evaluated the relationship between a frailty index (FI, a model of accumulation of deficits) and mortality during 7 years of follow-up in very old people across four waves. The study suggested a limit to the number of health deficits that people can tolerate, estimated by a FI = 0.7 [1]. This finding highlights the importance of paying attention to all deficits identified during a clinical assessment. This kind of longitudinal evidence may help export the Comprehensive Geriatric Assessment model of care to non-geriatric settings, where in many cases a predominant 'single-organ' approach is still dominant despite multimorbidity and complexity being now the 'bread and butter' of clinical services.

Natural trajectories of geriatric syndromes and opportunities for optimisation

In community-dwelling older people, changes in physical functioning may be very subtle over time, and so clinicians can miss changes and opportunities for early intervention in the absence of objective markers of decline. In that regard, the *Cardiovascular Health Study* in the USA showed that the rates of change in stride length and grip strength can provide important prognostic information for late-life disability and death that are independent of the predictive value of a performance measurement obtained at a single point in time [2]. This is an example of an approach which aims at validating objective measures that may be easy to implement in real clinical practice settings. Results from longitudinal studies of ageing have offered clinicians insights as to how to optimise other important geriatric syndromes. For example,

the Australian Longitudinal Study of Women's Health reported that urinary incontinence in older women is a dynamic condition and suggested opportunities for optimisation including the management of obesity, dysuria and constipation [3].

The importance of early intervention was also highlighted by the Longitudinal Aging Study Amsterdam, which suggested that differences in frailty already develop in earlier stages of the life course and preventative strategies aimed at reducing the development and progression of frailty should be adopted early [4]. Indeed, data from the Swedish National Study of Aging and Care in Kungsholmen showed that the prognosis of older people without impairments has tended to improve over time, but not in those who already had impairments [5]. Overall, findings support the principle that it may be possible to help compression of morbidity in populations by intervening early, ideally in mid-life or before.

Integration of the physical and mental domains

Longitudinal studies have also explored how losses in various domains of intrinsic capacity may affect brain health. For example, The Irish Longitudinal Study of Ageing examined the relationship between baseline blood pressure (BP) and incident depression, finding that systolic BP < 130 mmHg increased the likelihood of incident depression in older adults at 2-year follow-up [6]. This result is consistent with the suggestion that first onset late-life depression may be associated with frontal vascular insufficiency and raise awareness of systolic hypotension as a potentially modifiable risk factor for late-life depression, highly relevant for the evolving guidelines of BP treatment targets in older people.

Reducing the scale and impact of dementia has become a global public health imperative, and longitudinal studies can help by identifying potentially modifiable factors. For example, combined data from the Health and Retirement Study, the English Longitudinal Study of Ageing (ELSA) and the Survey of Health, Ageing and Retirement in Europe have shown that vision and/or hearing impairments that are often easily treatable are makers of future cognitive decline [7]. In addition, and in keeping with the holistic approach to geriatric syndromes, ELSA has shown that elevated cardiovascular risk may be associated with accelerated decline in cognitive functioning, which offers additional preventative opportunities [8]. A systematic review and meta-analysis of longitudinal studies also identified mid-life obesity as a potentially modifiable risk factor of incident dementia; in the latter observation, the importance of a lifecourse approach was highlighted by the fact that late-life obesity showed a negative association with incident dementia [9]. Indeed, the 'obesity paradox' seen in regards to dementia and ageing may be easier to understand from a lifecourse perspective, in the same way as paradoxes exist in BP management.

Broadening the scope to ageing in society

In the face of global ageing demographics and the need to facilitate older people's independent living for as long as possible, the Melbourne Longitudinal Studies on Healthy Ageing Program investigated long-term factors that may limit premature or preventable entry to residential care; findings provided support for healthy lifestyle promotion, management of chronic disease and nutritional interventions; results also called for clinicians' awareness of gender-specific factors such as the size of women's social networks [10].

Socioeconomic interventions may also be of benefit; for example, findings from the Canadian Study of Health and Aging called for the routine assessment of social vulnerability by clinicians as a means to reduce the risk of adverse health outcomes in older adults [11]. On the other hand, findings reported from ELSA showed that socioeconomic inequality in self-reported health has declined with age, beyond selective mortality effects [12]; their findings underscore the vital interconnections between economic and health equity in older ages.

Longitudinal data has also helped illustrate the importance of a holistic approach in the understanding of the mechanisms of resilience. For example, analyses once again from ELSA data showed that high levels of loneliness increased the risk of becoming physically frail or pre-frail, ~4 years later [13]. Such finding can help raise awareness of the multiplicity of ways through which the perceived social environment can get 'under our skin' and cause negative health syndromes with adverse consequences not only for individuals, but also for the entire healthcare system.

In addition, longitudinal studies have the potential to help us understand the causes of 'resilient phenotypes' at the '-omics' level. The Medical Research Council Cognitive Function and Ageing Study in the UK showed an increased 10-year incident dementia risk in older people associated with genetic polymorphisms in the Apolipoprotein E gene

Table 1. Studies included in the USC Gateway to Global Ageing Data. Harmonised studies are marked with*

HRS-family studies
- HRS* (Health and Retirement Survey, USA)
- MHAS* (Mexican Health and Aging Study)
- ELSA* (English Longitudinal Study on Ageing)
- SHARE* (Survey of Health, Ageing and Retirement in Europe)
- CRELES* (Costa Rican Longevity and Healthy Aging Study)
- KLoSA* (Korean Longitudinal Study of Aging)
- JSTAR* (Japanese Study of Aging and Retirement)
- TILDA* (The Irish Longitudinal Study on Ageing)
- CHARLS* (China Health and Retirement Longitudinal Study)
- LASI* (Longitudinal Aging Study in India)
- IFLS (Indonesia Family Life Survey)
- SAGE (WHO Study on global Ageing and adult health)
- HAALSI (Health and Aging in Africa: A Longitudinal Study of an INDEPTH Community in South Africa)
- HAGIS (Pilot study for Healthy Ageing in Scotland)
- ELSI-Brazil (The Brazilian Longitudinal Study of Aging)
- NICOLA (Northern Ireland Cohort for the Longitudinal Study of Ageing)

[14]. In the future, longitudinal studies will be best positioned to address the relative importance of the wider determinants of health to explain the determinants of risk and resilience over the lifecourse, by combining data at various levels of analysis including genetics, lifestyle, socioeconomics and healthcare determinants.

Harmonisation and cross-national comparisons

With global opportunities for harmonising data, longitudinal studies are already offering the opportunity for cross-national comparisons and for developing hypotheses about the relative contributions of time, place and society in the trajectories of frailty, disability and quality of life. An example of such resource is the Gateway to Global Aging Data (https://g2aging.org, Table 1). Meta-analyses of harmonised cohort studies have been encouraged to provide timely answers to ageing research questions [15].

Combining research and administrative data

A novel approach that may help the integration of ageing research with more effective clinical practice and healthcare management is illustrated by the initiative of the Hertfordshire Cohort Study (HCS), which linked official hospital episode statistics with a longitudinal study. Their successful experience illustrates the feasibility of integrating research and real health services data within a sound ethical, confidentiality and information governance framework. Indeed, the much-discussed 'integration of care' can benefit from integration of datasets. The HCS illustrated this point by describing hospital admission patterns among middle-aged and older community-dwelling men and women, showing that 75% of men and 69% of women were admitted to hospital at least once during the 10-year follow-up period [16]; from this, lessons can be learned as to how to better plan health services and manage the increasing demand. In the future, patients may also benefit from data integration: for example, the rich 'baseline' biopsychosocial information collected from study participants could be made available at the point of care in the acute hospital to help clinicians make better and more personalised decisions, when often that pre-admission profile is unavailable.

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