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## SSM - Population Health

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## Article

Health inequalities and inequities by age: Stability for the Health Utilities Index and divergence for the Frailty Index<sup>☆</sup>Yukiko Asada<sup>a,\*</sup>, Jeremiah Hurley<sup>b</sup>, Michel Grignon<sup>c</sup>, Susan Kirkland<sup>a</sup><sup>a</sup> Department of Community Health and Epidemiology, Dalhousie University, 5790 University Avenue, Halifax, Nova Scotia, Canada B3H1V7<sup>b</sup> Department of Economics, Department of Health, Aging & Society, Centre for Health Economics and Policy Analysis (CHEPA), McMaster University, 1280 Main St. West Hamilton, Ontario, Canada L8S4M4<sup>c</sup> Department of Economics, McMaster University, 1280 Main St. West Hamilton, Ontario, Canada L8S4M4

## ARTICLE INFO

## Keywords:

Aging  
Inequalities  
Inequities  
Health  
Health Utilities Index (HUI)  
Frailty Index  
Canada

## ABSTRACT

Successful aging is an important policy goal in an aging society. A key indicator of successful aging of a population is whether health inequalities (differences) and inequities (unfair differences) in the population increase or decrease with age. This study investigates how health inequalities and inequities differ across age groups in the Canadian population within the equity framework of equal opportunity for health, using two popular measures of health, the Health Utilities Index Mark 3 (HUI) and the Frailty Index (FI). We use the 2009-10 Canadian Health Measures Survey. We first quantify the degree of health inequality by calculating the Gini coefficient for the distributions of the HUI and the FI within three age groups (20–44, 45–64, and 65–79 years). We then identify sources of health inequality by using regression models and decomposing inequality into ethically acceptable and unacceptable components. We finally quantify the degree of health inequity by calculating the Gini coefficient for each health measure and each age group after standardizing for fairness. We find that the magnitudes of inequality and inequity in the HUI and the FI in each of the three age groups are policy relevant. The magnitude and age-related dynamics of health inequality and inequity depend on the choice of the health measures. In all three age groups, inequality and inequity in health measured by the HUI are larger than those measured by the FI. Across the three age groups, inequality and inequity are stable in the HUI but divergent in the FI. This study contributes to the methodological development to support policies for successful aging. Examination of alternative notions of health captured by the HUI and the FI contributes to the exploration of how the fair distribution of each aspect of health may characterize a successfully aging population.

## 1. Introduction

Faced with aging populations, countries around the world strive to foster successful aging (World Health Organization, 2015). What constitutes successful aging – sometimes also referred to as healthy aging or optimal aging – is often debated, but health is indisputably an essential component of successful aging (Depp & Jeste, 2006; Rowe & Kahn, 1997). While successful aging is most commonly framed at the individual level, it can also be framed from a population perspective, which introduces a new consideration: equity in the distribution of health within a population. A successfully aging population has both a good overall level of health and a fair distribution of health (World Health Organization, 2015). Thus, when viewed from a population perspective, a key indicator of successful aging is whether health

inequalities (i.e., differences) and inequities (i.e., unfair differences) in the population increase or decrease over the life course. Achieving health equity is a widely endorsed health policy goal in many countries (Marmot, 2010; WHO Commission on Social Determinants of Health, 2008), and it applies importantly as a population ages.

Aging is more than chronological age, and two conceptions of aging predict how aging might drive health inequalities over the life course. In the first conception, aging is a process of health deterioration leading to death. Because all individuals have to die at some point and each cohort has a maximum lifespan, the deterioration process would lead to a decrease in health inequalities as a population – or more precisely, a cohort – increases in chronological age. In this conception, aging thus acts as a leveler of health inequalities, predicting convergence over the life course (Quesnel-Vallée, Willson, & Reiter-Campeau, 2015). In the

<sup>☆</sup> Our study used data collected from human subjects by Statistics Canada. The data were publicly available and legally accessible by following strict disclosure protocols according to the Statistics Canada Act. Thus, this study was exempt from the research ethics board review based on Article 2.2(a) of the Tri-council Policy Statement, *Ethical conduct for research involving humans* (TCPS2 2014) <http://www.pre.ethics.gc.ca/eng/policy-politique/initiatives/tcps2-eptc2/Default/>.

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second conception, aging is exposure to insults that accumulate over time. Differences in exposure to insults early in life likely have cumulative effects over time, leading to an increase in health inequalities as a cohort adds chronological age (Dannefer, 2003). In this conception, aging thus acts as an amplifier of health inequalities, predicting divergence over the life course.

How these two conceptions of aging drive health *inequities* over the life course is more complicated. It depends on whether one considers the deterioration and accumulation processes as unfair or fair. If one considers an unfair the mechanism through which differential deterioration occurs for different people, then, the expected convergence of health *inequalities* over the life course indicates convergence of health *inequities* over the life course. Aging acts as a leveler of health inequities and health inequalities. Analogously, if one considers the accumulation process as unfair, then, the expected divergence of health *inequalities* over the life course suggests divergence of health *inequities* as well. Aging in this case acts as an amplifier of health inequities and health inequalities. Diverse views exist as to whether to consider the deterioration and accumulation processes as unfair or fair. For example, if, following Phelan and Link, the accumulation process is driven by social conditions that influence access to critical, flexible resources (e.g., money, power, and prestige) (Link & Phelan, 1995; Phelan, Link, & Tehranifar, 2010), and these social conditions are unfair determinants of health, the accumulation process is unfair. Alternatively, if one subscribes to the view that personal choices are an unfair source of health inequality (Roemer, 1995; Segall, 2010), and personal choices importantly influence the deterioration process and accumulation processes, both processes would be fair. In this case, convergence (divergence) of health *inequalities* would not necessarily indicate convergence (divergence) of health *inequities*.

Available empirical studies investigating equity and age-related dynamics of health distributions have focused almost exclusively on issues of health and socioeconomic status (Read, Grundy, & Foverskov, 2016). Such studies typically describe the bivariate relationship between health and a socioeconomic indicator (e.g., income, education, or occupation) by age, on the assumption that these social inequalities in health are inequitable. Empirical evidence is mixed, without a clear pattern of findings across a range of health measures, socioeconomic indicators, populations, types of data, and study periods. For example, in studies using longitudinal data from Europe (Stolz, Mayerl, Waxenegger, Rásky, & Freidl, 2017), England (Marshall, Nazroo, Tampubolon, & Vanhoutte, 2015), and the United States (Yang & Lee, 2010), socioeconomic inequalities in health (measured by the Frailty Index (Rockwood & Mitnitski, 2007; Searle, Mitnitski, Gahbauer, Gill, & Rockwood, 2008)) variously diverged, converged, or remained constant across age groups. While socioeconomic status is unquestionably a critical element of health inequity, it is only one element (Fleurbaey & Schokkaert, 2009). To assess why socioeconomic status is a key element and what other elements to consider, we need an ethical framework that allows us to elaborate what constitutes unfair or ethically problematic differences in health (Segall, 2010; Whitehead, 1991; Braveman, Arkin, Orleans, Proctor, & Plough, 2017; Daniels, 2008; Hausman, 2009; Norheim & Asada, 2009; Ruger, 2010; Venkatapuram, 2011). It is important to understand how health inequity more broadly conceived changes as a population ages.

A central contribution of this study is the explicit incorporation of an ethical framework in the investigation of age-related dynamics of health distributions. This study investigates how health inequalities and inequities differ among age groups in the Canadian population, using a methodological approach that explicitly and transparently accommodates alternative definitions of health inequity (Asada, Hurley, Norheim, & Johri, 2014; Asada, Hurley, Norheim, & Johri, 2015). For this study, we adopt the equity framework of equal opportunity for health. This framework originates in a philosophical theory of justice, often referred to as luck egalitarianism, which regards as unfair health inequalities due to factors beyond individuals' control, and as fair

inequalities those that result from individuals' choices (Roemer, 1995; Segall, 2010; Fleurbaey, 2008; Kanbur & Wagstaff, 2016). We adopt this framework for two reasons. First, equal opportunity for health has been gaining increasing attention in recent years in both scholarly and policy audiences (Roemer, 1995; Segall, 2010; Fleurbaey, 2008; Kanbur & Wagstaff, 2016), and substantial effort has been devoted to developing empirical approaches to implement this framework (Fleurbaey & Schokkaert, 2009, 2012; García-Gómez, Schokkaert, Van Ourti, & Bago d'Uva, 2015; García-Gómez, Schokkaert, & Van Ourti, 2013; Jusot, Tubeuf, & Trannoy, 2013; Rosa Dias, 2009; Rosa Dias, 2010; Trannoy, Tubeuf, Jusot, & Devaux, 2010). Second, conceptually, equal opportunity for health embeds a life-course perspective. Many childhood exposures and experiences considered beyond the control of an individual can have lifelong health consequences, while the range of determinants originating in individual choices increases through adulthood. Bringing a life-course perspective in empirical implementation may be informative for further development of this framework. While we adopt the equity framework of equal opportunity for health in this paper, our work is not intended to advocate exclusively for this framework. Rather, we argue for a transparent incorporation of an explicit ethical perspective of health equity beyond the focus on socioeconomic status alone. Our sensitivity analysis suggests that key findings in this paper also hold for at least one other currently debated alternative equity definition, policy amenability, which argues that health inequalities rooted in factors that are amenable to policy intervention are unfair (Norheim & Asada, 2009).

Another central contribution of this study is the use of well-validated and widely-applied measures of health – the Health Utilities Index (HUI) and the Frailty Index (FI) – in the examination of age-related dynamics of health distributions. The HUI and the FI capture health in different ways: The HUI is a measure of health-related quality of life that reflects community-based preferences (Horsman, Furlong, Feeny, & Torrance, 2003), while the FI is an indicator of frailty based on the aggregation of deficits with no weights reflecting any type of preferences (Rockwood & Mitnitski, 2007; Searle et al., 2008). We highlight alternative notions of health these measures capture as a potentially important driving force of differences in the magnitude of inequality and inequity and their age-related dynamics between the HUI and FI observed in this study. The examination of alternative notions of health captured by the HUI and the FI contributes to the exploration of how the fair distribution of each aspect of health may characterize a successfully aging population.

## 2. Methods

### 2.1. General analytic approach

This study adopts an analytic approach that we previously developed (Asada et al., 2014; Asada et al., 2015). This approach incorporates, in an explicit and transparent manner, alternative definitions of health inequity into the measurement of inequity, as described below. See Appendix 1 for technical details.

#### Step 1. Measuring health inequality

The first step uses an inequality index to quantify variation in observed health across individuals. In principle, one can use any suitable univariate inequality index. In this application, we use the widely applied Gini coefficient (see below) (Sen, 1997; Smits & Monden, 2009).

#### Step 2. Understanding sources of health inequality

The second step identifies sources of health inequality both statistically and normatively. The statistical analysis seeks to explain as much variation in health as possible with the data at hand, while the normative examination calls for ethical judgment as to which sources of

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