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# Underestimated climate risks from population ageing

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Population ageing is one of the most challenging social and economic issues facing governments in the twenty-first century[1]. Yet the compounding challenges of people living longer while also coping with the impacts of climate change has been subject to less examination. Here, we show that often-used binary definitions of"vulnerable" older communities – such as people over the age of 65 – can lead to the underestimation of future risks from extreme weather in a warming climate. Within this broad grouping, successively older age groups not only exhibit higher vulnerability to the impacts of climate extremes, but they also show more rapid growth in the future. Lower income countries are more likely to underestimate future climate risks if simplistic classifications of vulnerable older communities persist.

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The potential impacts of an ageing global population are profound. Healthcare burdens and the economic challenges associated with changing age-dependency ratios have rightly been the focus of many governments, and particularly those struggling with declining fertility rates over recent decades[1]. In the shadow of these significant challenges, the potential exacerbation of climate risks that accompany an ageing population have been overlooked.

When projecting the future evolution of climate change risks, many scenario-based analyses of the physical climate often focus on the emerging signals of climate hazards, with limited consideration of how other drivers of climate risk might also evolve[2]. Those studies which have quantified non-hazard drivers of climate risk, particularly in the context of extreme heat, have often defined locally vulnerable populations as anyone aged 65 or older[3–7], with no disaggregation of the relative differences in vulnerability therein, despite clear evidence for doing so[8,9]. For example, a recent review by Whitty and Watt (2020) found the number of health disorders affecting an average person in Scotland increases monotonically with age: while half of over 65 s have two or more health conditions, the same proportion of over 85 s have *four* or more health conditions.

Contending with multiple health disorders can compound the challenges faced by elderly individuals for a range of extreme weather events. For example, mobility challenges can impede evacuations from flood-impacted areas, while healthcare access can be restricted for weeks-to-months in the aftermath of particularly acute events[10]. Higher risks from malnutrition and dehydration emerge during drought events[11] while the risks of respiratory impacts from wildfire-related smoke exposure are similarly elevated[11]. In the context of extreme heat, Achebak and colleagues (2019) found the proportion of cardiovascular-related deaths attributed to extreme heat in Spain were three times higher for people aged over 90 than those aged 60–74 years, while those aged 75–89 years experienced twice as many deaths as the lower age cohort. Several other studies which partitioned cohorts into groups aged 65–74 and over 75 years also found similar results[12–14].

Assuming then that an average 86-year-old, who is much more likely to experience multiple health conditions than an average 66-year-old, is also more susceptible to adverse impacts from extreme weather, we can use mid-range projections from the United Nations 2019 World Population Prospects[1] to reveal how faster growth rates in these older age groups can lead to an underestimation of twenty-first century climate risks.

Grouping countries by income level (based on The World Bank's criteria), Fig. 1 presents twenty-first century population growth projections, relative to 2020, for the total population (grey), people aged over 65 (n65+, pink), 75 (purple) and 85 years old (green). Consistent with previous research[1], the total population is projected remain stable or decline in the future for higher-income regions, but all countries witness growth in older populations. However, projected growth rates for over-65s can vary significantly: high-income countries are projected to witness a 70% rise in n65+ by the end of the century, while upper-middle, lower-middle and low-income countries instead respectively show a 2.5-fold, 5-fold and 14-fold growth in n65+ by 2100.

When the lower bound of the age range used to define a 'vulnerable' population is successively increased above 65, we find estimates of future population growth also rise exponentially. Across most regions, growth rates are about 50% larger for people over 75, and nearly double that again for people over 85. Further, we find the relative share of the population in these more vulnerable age categories will grow most rapidly in lower income countries: this translates to a remarkable 30-fold increase in the number of people aged over 85 expected to be living in low-income countries by the end of the century. Such projections are particularly acute, given decision makers and non-governmental organisations operating in low-income countries can sometimes focus on socio-economic vulnerabilities related to drought at the expense of physical vulnerabilities associated with extreme heat[15,16].

These patterns of growth can be largely explained by the initial size of these populations. For rapidly-growing but mostly young countries, including many lower-income nations, a very small proportion of today's population fall within these older age ranges such that *relative* increases in cohort size can emerge very quickly. The same concept applies when considering population growth across successively older age groups in any country where life expectancies are increasing: when the initial number of people in that age group is smaller, the growth under future population scenarios will be proportionally more significant. Similar reasons also contribute (alongside other factors) to explaining why the

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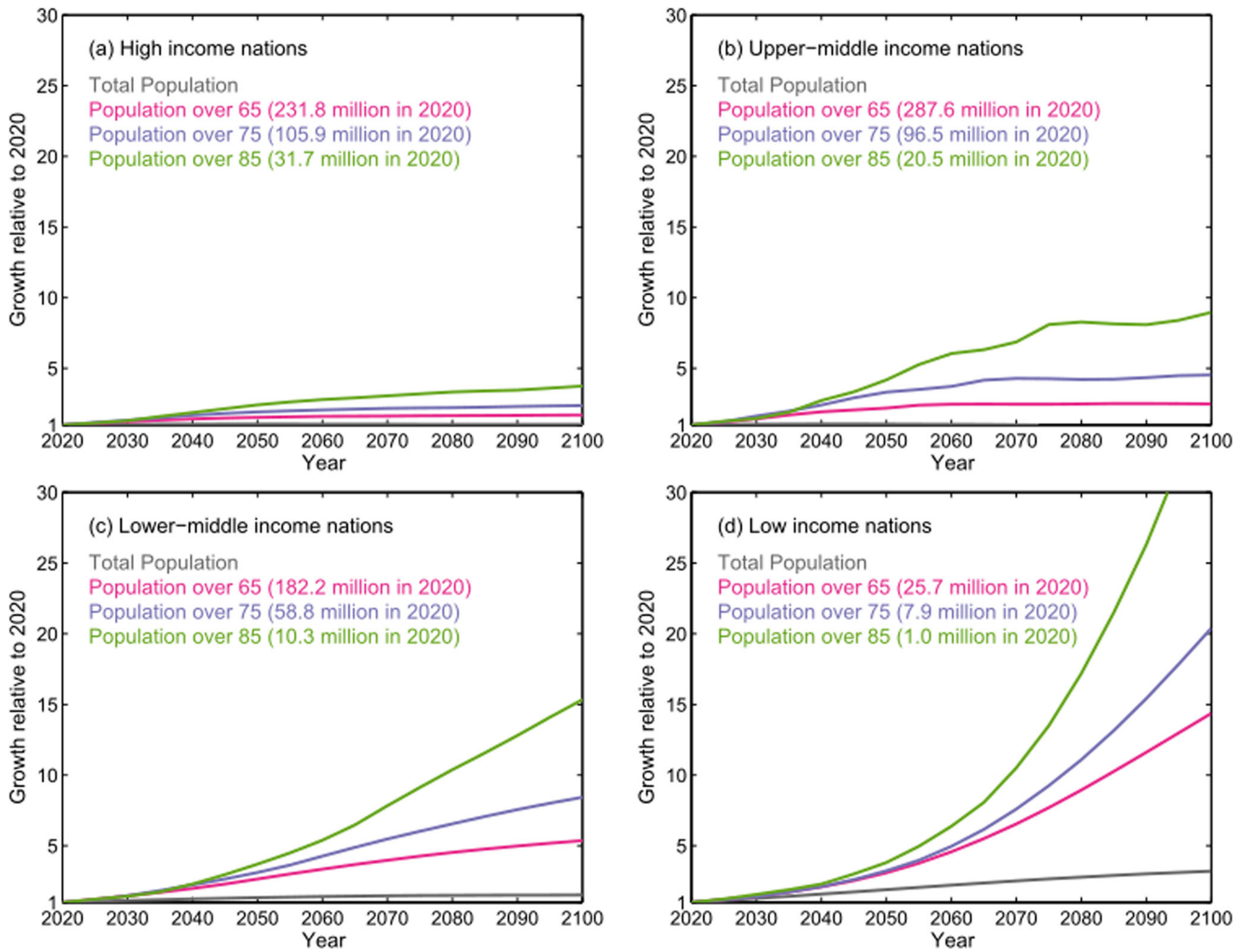


**Fig. 1 Elderly population growth in the twenty-first century for different country groupings.** Panels show projected elderly population growth under the 'medium-variant' scenario (from the United Nations' 2019 *World Population Prospects*) for four income-based country groupings, relative to a 2020 baseline (presented as a ratio).

signal of climate change can be more pronounced for the rarest extreme weather events[17].

Alternative scenarios of the future which assume greater levels of sustainable development actually show the fastest growth of vulnerable older populations. Figure 2 shows projected changes in two categories of vulnerable people—those aged over 65 and over 85 years—for three alternative storylines of socioeconomic outcomes over the twenty-first century (the Shared Socioeconomic Pathways, or SSPs[18]), alongside the 'best-guess' World Population Prospects scenario used in Fig. 1. The SSP1 scenario, generally considered the most sustainable twenty-first century development pathway, shows the fastest rates of elderly population growth by far. Meanwhile, SSP3 exhibits relatively modest growth rates, largely due to poor healthcare provisions in a scenario typified by significant climate adaptation and mitigation challenges[19]. Of course, inherently longer life expectancies under SSP1 mean these contrasting rates of older population growth between scenarios do not directly translate to differences in mortality from climate-related hazards, particularly since the proportion of deaths attributable to individual hazards will themselves change over time. But when fewer people are dying of preventable communicable diseases at an early age[20]—as is the case under SSP1—a greater fraction of the population then goes on to experience physical climate hazards at a time in their life when they are physiologically more vulnerable to the impacts of

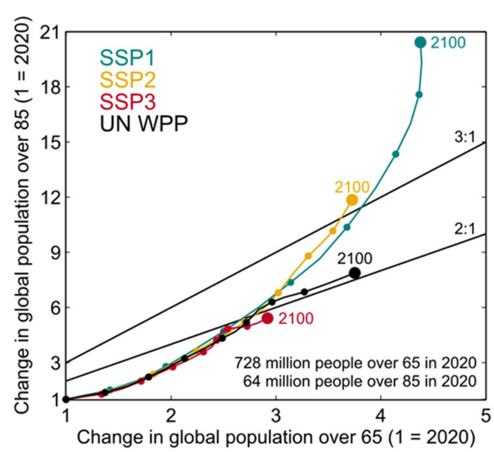


**Fig. 2 Scenario uncertainty in future elderly population growth.** Projected changes (presented as a ratio, relative to 2020) in the global population aged over 65 years (horizontal axis) and 85 years (vertical axis) for each decade between 2020 and 2100 under three Shared Socioeconomic Pathways and the median population scenario developed for the UN World Population Prospects 2019. Each circle denotes a new decade; larger filled circles show the values for 2100.

such extremes. Thus, trade-offs exist between scenarios in which a lower share of physically vulnerable populations face larger challenges through high socio-economic vulnerability, and vice versa[20,21].

Any increase in the frequency or intensity of climate-related hazards will prove particularly challenging for the most vulnerable in society. Accurately projecting the non-hazard drivers of future climate risk is therefore crucial, particularly if the relative growth of successively older populations will be most acute in lower income countries. Our results show how the collective risks from extreme weather have the potential to increase significantly in the future, even if the climate hazards themselves were to somehow remain unchanged. While sample size constraints often limit the granularity with which different age groups can be assessed in epidemiological studies of climate-health impacts, the distinct differences in age-stratified population growth revealed here should be explicitly acknowledged in future studies with binary definitions of age-related vulnerability.

Policies to encourage sustainable development will inherently help communities manage the risks of extreme weather over the coming decades[20]. However, specific policies are also needed to prepare for the challenges associated with rapidly growing older populations expected under these sustainable development pathways, beyond those existing frameworks which manage the risks of individual climate hazards for entire communities[22]. Overlooking these risks will make the prospect of living prosperously in a warmer climate even more difficult.

## DATA AVAILABILITY

The UN population data that support the findings of this study are available from The United Nations Department of Social and Economic Affairs (https://population.un.org/wpp/). The SSP population projections are available from the SSP Public Database (https://tntcat.iiasa.ac.at/SspDb/dsd).

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## AUTHOR CONTRIBUTIONS

L.J.H. and F.O. conceived the idea, L.J.H. performed the data analysis and produced the figures, both authors contributed equally to writing the manuscript.

## COMPETING INTERESTS

The authors declare no competing interests.

## ADDITIONAL INFORMATION

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