the journal of population and sustainability

vol. 9, no. 2, August 2025

The Journal of Population and Sustainability

Vol 9, No 2, 2025

Information

ISSN 2398-5496

The Journal of Population and Sustainability (JP&S) is an open access interdisciplinary journal published by The White Horse Press exploring all aspects of the relationship between human numbers and environmental issues. The journal publishes both peer reviewed and invited material. It is intended that the JP&S act as an interdisciplinary hub facilitating collaboration and furthering the development of the field. While generously supported by environmental charity Population Matters, the JP&S is entirely editorially independent and welcomes contributions from scholars with a variety of perspectives on the role of population in environmental problems. The views and opinions expressed by authors are their own and do not necessarily reflect those of the editor, the editorial board or publisher.

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Acknowledgements:

The editor would like to thank the anonymous reviewers for their assistance.

Cover images: Photos from www.pickpik.com
Design by Clare Thornhill www.flidesignltd.com

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10.3197/JPS.63799977346505

EDITORIAL

Tackling the environmental crisis: from shallow solutions to deep transformation

David Samways

In 1973, the Norwegian philosopher Arne Naess divided the then nascent environmental movement into 'shallow' and 'deep, long-range' ecology. Naess' characterisation of the shallow movement ran to just eighteen words – 'Fight against pollution and resource depletion. Central objective: the health and affluence of people in the developed countries' (Naess, 1973: 95) – while his exposition of deep, long-range ecology ran to several volumes.

At the time Naess was writing, environmental problems were largely perceived by the public and legislators as localised and amenable to technical fixes. Problems such as local air pollution and the pollution of rivers and land had been recognised as issues for centuries and tackled with local legislation and technical changes – some of which simply shifted the problem elsewhere (Markham, 2020). However, Naess highlighted more than the difference between short and long-termism; he pointed to the underlying value orientation of humankind toward nature. The historian of technology Lynn White Jr (White, 1967) had similarly singled out anthropocentrism – the notion that only human beings and their interests are morally relevant – as the root cause of humankind's environmental problems.

Despite the highly problematic conception of the relationship between orientation and action in this strand of environmental thought (Samways, 2023, 2025), its focus on deeply sedimented values and norms in socio-technical practices and the need for long-term thinking was crucial for understanding and tackling the environmental crisis. The movement toward sustainability therefore requires not only recognising that long-term human wellbeing depends on the stable

functioning of Earth's physical and ecological systems (as they have existed during the Holocene), but also cultivating the motivation to act on this understanding by revising the values and social norms implicated in environmentally unsustainable social practices – including those around fertility.

The complex drivers of the environmental crisis

As evidenced by the work of both the IPCC (Intergovernmental Panel on Climate Change) (IPCC, 2023) and IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Brondízio et al., 2019), population growth and economic expansion are the main indirect drivers of the environmental crisis. However, the relationship between these drivers, as well as other factors such as available technology, is complex.

Holdren and Ehrlich's I=PAT equation is frequently regarded as capturing the aggregate relationship between the major factors: environmental impact (I), population (P), affluence (A) – often taken as synonymous with consumption – and technology (T). In the case of climate change, technology refers to the carbon intensity of production. While IPAT remains a useful heuristic device, it does not capture the influence of social and individual values and norms on population size, consumption practices and technical choices.

Critically, it is the consumption of the rich world that is responsible for the largest proportion of emissions, both historically and at present. The IPCC estimates that the richest ten per cent of the global population are responsible for between 36 and 45 per cent of total emissions. Yet it is sobering to note that inclusion in the richest decile requires only a modest income by Western standards – in the UK, a disposable income of approximately £28,000 for the average sized household exceeds the threshold (Our World in Data, n.d.). Thus, what many middle-class families in wealthy nations consider an ordinary lifestyle actually places them among the world's highest emitters. It follows that addressing climate change cannot be framed simply as a problem of the ultra-wealthy; it requires lifestyle changes among the broad middle classes of developed countries who may not perceive themselves as particularly affluent or environmentally culpable.

The climate crisis is frequently framed as a technological problem that can be solved through cleaner energy and more efficient systems. Yet the fact that the

IPCC identifies growth in per capita consumption as the principal issue reveals that technology alone is insufficient. Instead, the deep entanglement of values and norms within social practices – cultural beliefs that equate prosperity with material accumulation, social expectations around consumption, and lifestyle patterns that prioritise individual gratification – becomes the critical factor driving environmental degradation.

Population, consumption and planetary boundaries

Gandhi famously said that 'the world has enough for everyone's need, but not enough for everyone's greed'. Recent modelling by O'Neill et al. (2018) and Schlesier et al. (2024) suggests that with changes to 'provisioning systems' – the social and technical means of transforming resources into welfare – Gandhi may well have been right, even for the UN's forecast peak population size. However, before abandoning our concern with population to concentrate solely on consumption, the definition of 'need' requires interrogation.

O'Neill et al.'s modelling suggests that, under current provisioning systems, the basic needs of 7 billion people – including the elimination of extreme poverty, sufficient nutrition, basic sanitation and access to electricity – could be met within planetary boundaries. Furthermore, with efficiency improvements in physical and social provisioning systems coupled with a focus on sufficiency, a sustainable 'good life' for all could be provided for a maximum of 7 billion people. This 'good life' includes more qualitative goals such as life satisfaction, healthy life expectancy and secondary education – standards taken for granted in the Global North.

The implications are significant: for populations exceeding 7 billion, even with improvements in provisioning systems, the life that can be provided to all within planetary boundaries shifts downwards along the qualitative scale between a good life and the meeting of basic needs. While even at the UN's projected peak population of 10.3 billion (UN, 2025) this would mean elevation for many billions to a better-than-basic-needs life, it would require global convergence toward a much lower standard of living than that currently enjoyed by populations of high and some middle-income countries.

Schlesier et al. (2024) adopt the Decent Living Standard approach, which includes meeting basic physical needs and more qualitative factors required for social

participation such as education and healthcare. They find that it would be possible to provide decent living standards to 10.4 billion people within planetary boundaries with the universal adoption of an 'essentially vegan diet', minimal consumption and complete defossilisation of energy systems.

Both models reveal that considerable transformation is required at technical and organisational levels, but substantial remoulding of values is also necessary – replacing consumerism with a focus on material sufficiency and abandoning economic growth as an intrinsic good. Moreover, both models require deeper changes in thinking, including expanding concern and sense of obligation toward culturally different and geographically distant populations, leading to resource transfer from the Global North to the Global South. This spatial expansion of concern must be accompanied by temporal expansion – a significant shift from short to long-term thinking to protect future generations' interests globally. These value shifts will be necessary at all levels of agency, from individuals to 'macro actors' such as governments and corporations.

However, even if such value shifts could be achieved, O'Neill et al.'s work suggests that providing a 'good life' for more than 7 billion people within planetary boundaries is unlikely. While Schlesier et al.'s modelling supports a much larger population, the required changes are far more ambitious. In particular, universal adoption of a vegan diet would challenge deeply sedimented habitual practices frequently intrinsic to personal and cultural identity. Meanwhile, worldwide meat consumption is rapidly growing, driven partly by population growth but most significantly by rising incomes (Ritchie et al., 2019).

Population growth thus remains a significant factor in the environmental crisis and presents a formidable challenge to providing a good life for all. How many people can be provided with a good life within planetary boundaries depends upon a complex of factors including norms and values shaping both consumption and technical choices. As Rachel Gould's contribution to this issue demonstrates, norms and values are also critical to fertility rates and population growth.

The time dimension: short-term crisis vs long-term solutions

While the longer-term mitigation effects of fertility reduction may be significant (Bongaarts and O'Neill, 2018; Wolf et al., 2021), population momentum means

that population growth is not responsive enough to available policy levers to tackle the immediate environmental crisis (Bradshaw and Brook, 2014).

George Martine's Perspective article in this issue concurs with this analysis. Martine contends that, while concerns about population growth and size remain relevant long-term, their policy significance is increasingly limited within the short-term window of opportunity presented by the current slide toward unsustainability. He notes that understanding of environmental threats has shifted beyond early debates about population growth to include complex demographic factors such as migration, aging and urbanisation – issues that have not received the same level of scrutiny regarding their environmental impacts.

Martine identifies the relentless expansion of economic throughput, driven by consumerism and a development model equating happiness with material consumption, as central to environmental degradation. This model has led to unsustainable resource exploitation and escalating environmental harm. He advocates addressing these challenges from a broad, global perspective, emphasising that climate change and other threats are deeply embedded in prevailing development paradigms and consumer culture. Without recognising consumerism's role in driving ecological damage, Martine argues, sustainability efforts will be ineffective. He further highlights how powerful economic lobbies and negationist propaganda, particularly in influential countries like the United States, entrench unsustainable practices and undermine environmental safeguards.

Martine calls for transformative increases in environmental awareness and policy action, including redefining development and societal happiness away from materialism. He warns that without bold action and global cooperation, humanity risks deepening environmental crises and facing a dystopian future marked by persistent decline and fractured governance.

Practical applications: health, resources, and inequality

While focused on averting the immediate environmental crisis, Martine's critique of growth-driven development and his call for shifting values aligns with O'Neill et al. (2018) and Schlesier et al. (2024) and their emphasis on reorienting social norms toward sufficiency. Echoing concerns that current economic paradigms fail to provide good lives for all while endangering the environment, Anastasia

Pseiridis' article explores how preventive and reversive medicine (PRM) might help address both resource and consumption challenges globally.

Pseiridis notes that, despite technological advances increasing total global biocapacity by 22 per cent since 1961, rapid population growth has led to a 54 per cent reduction in per capita biocapacity. In many low-income countries, per capita ecological capacity has fallen by over seventy per cent, even as these populations strive to escape deprivation. She argues that the dominant economic system misallocates resources, prioritising production for those with purchasing power, leading to consumption patterns that exceed planetary boundaries and create ecological deficits. Overconsumption and population growth together intensify resource scarcity and reduce per-person ecological space, complicating efforts to ensure well-being without further environmental harm.

In this context, Pseiridis explores the tension between medicine's ethical aim to reduce suffering and ecological-economic realities limiting the delivery of good lives for all. She observes that while wellbeing often improves with increased material means, rising income and consumption also generate negative health and environmental impacts. Defining a 'good life' in both moral and material terms, Pseiridis cites estimates suggesting global production would need to expand two- to ten-fold to achieve this for everyone.

Pseiridis argues that PRM can both augment the global resource base and shift consumption and production patterns toward more sustainable outcomes, positioning PRM as an accessible 'sustainability technology'. She highlights additional benefits, especially for aging populations: by increasing healthy life years, PRM supports more productive and dignified aging, eases pressures on tax and pension systems, and reduces caregiving burdens on families. Widespread PRM adoption also produces positive externalities, as improved health reduces costly disease management and helps make good lives more accessible, particularly in low-income communities. However, to neutralise 'rebound effects', Pseiridis advocates pairing PRM with pricing policies that reflect true societal costs. She concludes that PRM should be embraced as 'Consumption and Production Medicine' to support global sustainability and well-being.

Case studies: India and Israel

Aalok Chaurasia's contribution addresses one of the key qualitative indicators of a 'good life' – healthy life expectancy, measured by life expectancy at birth (LEB). Chaurasia observes that while increasing human longevity contributes to global population growth,[1] its uneven distribution across and within countries raises concerns for sustainable development. His study examines wide disparities in LEB gains across sixty mutually exclusive population groups in India between 1976 and 2020.

The findings show that LEB increases varied dramatically – from over 24 years among rural females in Uttar Pradesh to under 7 years among urban males in Punjab. While part of this variation may stem from a ceiling effect (where higher baseline LEB limits further gains), significant inequality persists even after adjusting for this factor. Comparison with the UN's medium model mortality trajectory shows that nearly two-thirds of groups gained less than expected.

Chaurasia demonstrates that 77 per cent of this heterogeneity is attributable to state-level and population sub-group factors, with the remaining 23 per cent due to group-specific factors. Despite general mortality improvements, some groups experienced increases in mortality at older ages – particularly in urban Punjab, Odisha, Gujarat, and Karnataka – dampening LEB gains. Conversely, most improvements were driven by reductions in child and young-age mortality, largely due to targeted maternal and child health programmes.

Chaurasia critiques India's health policies for overlooking internal disparities. While the 2017 National Health Policy aimed to raise national LEB to seventy by 2025 – a goal largely achieved – it failed to address uneven progress. India's mixed healthcare system, heavily focused on rural preventive care and under-serving urban and elderly populations, has contributed to this imbalance. He calls

1 While increasing life expectancy at birth does lead to population growth, the contribution to that growth is dependent upon where in the life-course that increase falls. The rapid population growth experienced over the last 200 years has been almost entirely due to reduced child mortality and the multiplier effect of a larger number of children surviving to adulthood and having children themselves. In contrast, years added after family building have no multiplier effect and, in a hypothetical society with a stable replacement level of fertility, once the increase in longevity has reached a ceiling, population size will stabilise at a new higher level.

for decentralised, data-informed health planning, including population group-specific health goals, as a strategic pathway toward reducing disparities and accelerating national population health improvements.

This country-level analysis demonstrates how inequality in meeting key 'good life' indicators depends heavily on provisioning system details and delivery contexts. While preventative care has significantly impacted LEB in rural areas of India, rapidly urbanising populations require revised provision methods.

Shifting from health outcomes to reproductive behaviour, Rachel Gould's research article explores how values and norms influence fertility, focusing on Israel – a demographic outlier among developed nations where population growth is driven more by above-replacement fertility than immigration. While economic growth typically correlates with declining birth rates, Israel's total fertility rate (TFR) remains high – 2.9 in 2024 compared to the OECD average of 1.5 – despite sustained economic development.

Gould argues that social influences, including family expectations, peer group norms and community values, play more significant roles in reproductive behaviour than economic factors alone. Drawing on national survey data, she analyses how perceptions of ideal and community family sizes interact with demographic variables to sustain high fertility. She identifies social conformity within subpopulations and peer influence strength as central to explaining why large families remain normative in Israeli society. These dynamics can limit individual autonomy and hinder fertility decline, despite broader environmental and sustainability concerns.

Gould's research also highlights the long-term impact of pronatalist policies and the lack of political will to address demographic growth, which is projected to reach 20 million by 2065. While external threats often dominate national discourse, population expansion – and its implications for resources, infrastructure and environment – receives limited attention.

Gould calls for culturally sensitive, socially informed approaches to population policy, recommending focus on individual fertility motivations and social networks rather than relying solely on economic incentives. Her study contributes to

understanding how deeply embedded social norms shape reproductive choices and hinder demographic transition in Israel.

Critical perspectives and conclusions

Our final contribution is my own review of Robin Attfield's latest book, *The Ethics of the Climate Crisis* (2024), which draws on his decades-long contribution to environmental philosophy and offers a timely, rigorous ethical analysis of climate change. While the book provides valuable insights into climate ethics, it takes a notably different position from the contributions in this issue by giving a somewhat disappointing lack of attention to population growth as both a driver and potential mitigator of longer-term emissions.

Taken together, the contributions in this issue underscore a recurring theme: sustainability is not merely a technological or economic challenge – it is fundamentally a moral and cultural one. Addressing the environmental crisis requires rethinking the values intrinsic to our social practices, the systems that support our lives, and the assumptions that shape our collective future. From Naess's foundational distinction between shallow and deep ecology to contemporary analyses of consumption patterns, health provisioning and reproductive behaviour, the evidence consistently points toward the need for profound transformation in how we understand and organise human society in relation to planetary boundaries.

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10.3197/JPS.63799977346504

PERSPECTIVE

Changing perceptions of barriers to sustainability: Population, consumerism and power politics

George Martine[1]

Abstract

This paper examines shifting perceptions of the primary barriers to global sustainability, focusing on three key dimensions: population growth, consumerism and power politics. While population growth has historically been viewed as a critical threat, its actual impact is mediated by unequal patterns of production and consumption. Consumerism, driven by globalised capitalism, emerges as a more decisive factor, entrenched in unsustainable development models. However, the most pressing obstacle today is the rise of denialist power politics, exemplified by the rhetoric and actions of leaders like Donald Trump, which undermine multilateral agreements and environmental policies. Drawing on scientific data, historical analysis and geopolitical critique, the paper argues that avoiding socio-ecological collapse requires urgent systemic and cultural transformations. It concludes that the narrowing window for effective action demands radical innovations in global governance and redefinitions of progress beyond material growth.

Keywords

Sustainability, consumerism, power politics, population growth, climate crisis.

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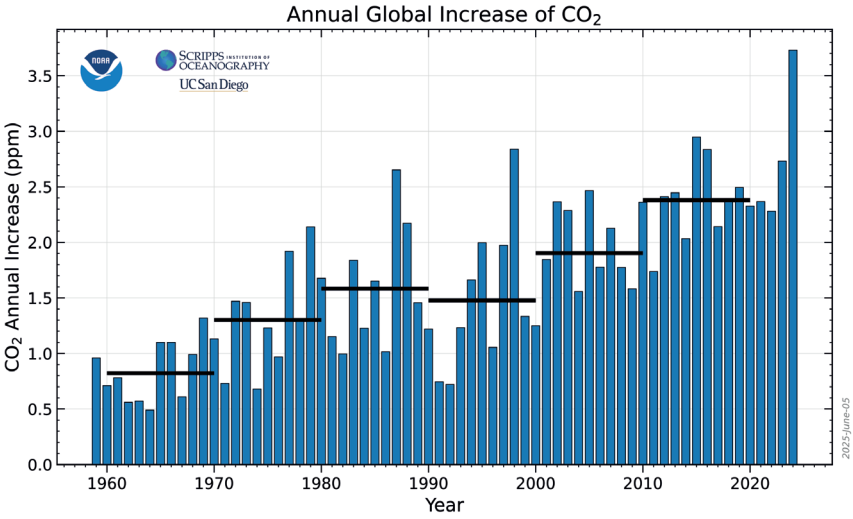
A vulnerable planet

Climate change and its implications comprise a matter of extraordinary importance and urgency for the future of human life on this planet. In 2024 alone, some 393 hazard-related 'natural' disasters impacted 167.2 million people; they caused 17,753 fatalities and economic losses of US$241.95 billion (Centre for Research on the Epidemiology of Disasters 2025). The scientific evidence regarding the origins, intensification and dire consequences of ongoing environmental transformations is overwhelming, despite the mystifying efforts of a powerful lobby that refutes such knowledge. The essential fact is that our civilisation is running on an unsustainable path – the increasing use of fossil fuel energy for the purposes of producing and consuming more stuff, in a process that is construed as 'development' (Hinkle 2020, *passim*). Consequently, as shown in Figure 1, the proportion of carbon dioxide in the Earth's atmosphere is growing steadily and was accelerated to new heights in 2024, when it grew by an unsustainable 3.75 parts per million, or about 50% more than in pre-industrial times.

In the short term, this process is multiplying the frequency and potency of 'natural' catastrophes – such as extreme heat, cyclones, tornadoes, hurricanes, wildfires, floods, tsunamis, droughts and pollution. Over the medium term, biodiversity loss, melting ice caps and sea level rises, declines in agricultural production, food and water insecurity, heat-related illnesses and the disruption of economic activities are all inevitable under the present course of our civilisation. Escalation of this devastating framework is expected to soon reach tipping points that will obstruct the planet's capacity to provide humankind an ambiance for a sustainable future. Moreover, the worst impacts will be felt on people in the world's more vulnerable regions, marked by poverty, inequality and instability. The need for global outlooks and actions aimed at reducing the threat of ecological chaos is eminent, but has not materialised into effective and viable policies.

Reversing this course and achieving sustainability is still possible by reducing greenhouse gas emissions and improving carbon removal technologies, but this would require a significant quickening of global awareness and effective action – commodities that are currently at a low ebb. Nevertheless, ignoring global environmental limits is extremely hazardous, given that several intertwined planetary boundaries are already under threat, as repeatedly warned by, *inter alia*, the Stockholm Resilience Centre (Richardson et al. 2023) and the Science Based Targets (2023).

Figure 1. The proportion of carbon dioxide in the Earth's atmosphere



SOURCE: NOAA VIA LAN ET AL. 2025

Reversing this course and achieving sustainability is still possible by reducing greenhouse gas emissions and improving carbon removal technologies, but this would require a significant quickening of global awareness and effective action – commodities that are currently at a low ebb. Nevertheless, ignoring global environmental limits is extremely hazardous, given that several intertwined planetary boundaries are already under threat, as repeatedly warned by, *inter alia*, the Stockholm Resilience Centre (Richardson et al. 2023) and the Science Based Targets (2023).

Current science warns us that humankind has a small window of opportunity – perhaps two to three decades – for reversing the present course by taking significant steps towards sustainability and thus avoid passing 'the point of no return' (Hansen et al. 2025). Reputable gauges, such as the Ecological Footprint indicator – which estimates that we are currently using the planet's resources at a rate that is 1.75 times what would be sustainable – convincingly reiterate the fact that humankind is mining much more of the Earth's resources than is sustainable (Global Footprint Network s.d.). This process is created by, and further promotes, inequality. Thus, according to Schöngart et al. (2025), 'We found that the wealthiest

10% contributed 6.5 times more to global warming than the average, with the top 1% and 0.1% contributing 20 and 76 times more, respectively.' Huge carbon emissions from the richest segments of contemporary society are destroying the world we know, but the impacts are hardest on people living in poverty, especially in the Global South, who have the least resources to protect themselves (Khalfan et al. 2023).

This wanton and unequal exploitation of our planet's capacity undermines the resilience of the very ecosystems on which humanity depends and endangers the continuity of our modern 'way of life'. It is estimated that more than half of the human-made greenhouse warming is caused by deforestation and the burning of fossil fuels (Hansen et al. 2025). This is a dire warning, but it also points out a pathway of needed actions to reverse our unsustainable course. Nevertheless, as increasingly observed, powerful lobbies and decision-makers not only refute the scientific evidence but also promote the evisceration of even the most basic initiatives that can help shield the world from environmental chaos.

What are the main causes of our civilisation's charge towards this environmental debacle? Over the last six decades, mounting recognition of environmental threats has led to differing perceptions as to the main obstacles and pathways to sustainability. The primary concern of these analyses and actions have shifted drastically over time.

Starting in the 1960s, much attention was focused on the imminent and adverse impacts that *population growth* was bound to have on environmental resources. This topic remains high on the list of issues that are commonly discussed in any popular debate about the environmental crisis but, as will be shown here, the concern with growth alone does not necessarily lead to effective policies for reducing environmental stress in the immediate future, although it is critical for longer term human welfare.

Initial surges of environmental awareness also gave rise to a concern with throughput growth and *consumerism* as of the late 1960s. This showed that exploiting natural resources and energy while transforming them into wastes for the purpose of achieving economic growth constitutes the very core of our much-desired 'development' – and thus of environmental threats. Increasing

consumption is an essential stimulus for this generalised pursuit. The critical importance of these processes has been greatly enhanced by the globalisation of production and consumption.

However, the greatest menace to environmental well-being for future generations now stems from recent *power politics*[2] that negate both the climate threat and the need for effective action in the environmental sphere, while also annihilating the existing collaborative framework for effective global action. This paper will deal with the relative importance of these three threats to sustainability in the current historical moment.[3]

Population growth and size

Although all population dynamics – growth, distribution and composition – are relevant to sustainability, most policy attention has been focused on population growth. Other aspects of population dynamics and their consequences for the environment – such as the effects that the demographic transition, changing age structures and urbanisation have had on human society – are also important, but their analysis would take us too far afield in a paper that centres on the main issues that have delayed effective actions towards sustainability.[4]

Shortly after World War Two, social scientists observed a rapid rise of population growth in 'underdeveloped' countries and perceived this trend as an impediment to those countries' economic expansion, while also providing a favourable ambiance for the spread of Communism. Hence, in the context of the Cold War, geopolitical motives led to the imposition of population control measures as a means of promoting market-based development in such countries.[5] Some decades later, however, the recognition of a near-zero correlation between population growth and *per capita* economic growth eventually deflated such

2 Power politics' here refers to efforts aimed at prioritising self-interests to the detriment of others and to the disposition to use aggression to protect such interests. For a contemporary discussion see Goddard et al. (2024), *passim*.

3 This text builds on several years of research and action on various aspects of sustainability. A list of main articles produced can be found at https://docs.google.com/document/d/1_v9fWC2dCf4dqsWF28UtGoUSsCxGTBZy/edit?tab=t.0.

4 For a preliminary discussion of the relations between the composition and spatial distribution of population on the one hand and environmental issues on the other, see Martine (2009).

5 Cf. Martine (2024) for a review of the trajectory of population control policies.

aggressive stances towards the reduction of population growth (Bongaarts and Hodgson 2022: 85).

Meanwhile, the linkages between population and environment in the context of development began to receive considerable scholarly and public attention, leading to the popular belief that demographic growth needed to be sharply curtailed in order to promote sustainability. Biologists and ecologists began to take over the neo-Malthusian flag in the 1960s, and have continued to draw attention to the detrimental impacts of population growth on sustainability. It is true that the world's population has grown dramatically, from around 2.5 billion to 8.2 billion between 1950 and 2025. Moreover, it is undeniable that, *ceteris paribus*, a larger population imposes greater constraints on nature's resources. Nevertheless, the apparently obvious correlation between population growth and environmental impacts is anything but direct (Bradshaw and Brook 2014).

One popular formula, which intended to encapsulate the threats posed by population growth (Ehrlich and Holdren 1971), suggested that:

Environmental Impact = Population x Affluence x Technology

This had the merit of pointing out that all three main factors – population, affluence and technology – have to be considered simultaneously in appraising the factors underlying environmental change. Nevertheless, this formulation failed to consider that each element in this equation, as well as the interactions between them, depend on a much more complex constellation of social, political, economic and institutional factors (*inter alia*: Lutz 1994; McNicoll 1995; Martine 1996).

The opinion that environmental crises stem from 'overpopulation' in low-income countries is still rampant, especially in the popular parlance. Attacking environmental issues from a demographic growth standpoint is intuitively appealing as it appears immensely easier than trying to deal with the causes of global environmental damage that are rooted in our very model of civilisation. There is a danger that 'population' ends up being a scapegoat – an offender that is readily associated with 'irrational' or 'outdated' reproductive patterns, and thus one that could apparently be dealt with much more easily than other more complex geopolitical factors (Martine 2025). Persistence of this simplism detracts

political attention from the structural dynamics that underlie our trajectory towards unsustainability. At the same time, the issue of population growth continues to generate highly-charged political emotions across countries and, consequently, it tends to be ignored in multilateral initiatives such as the IPCC and IPBES, as well as in major environmental charities such as Greenpeace and Oxfam.

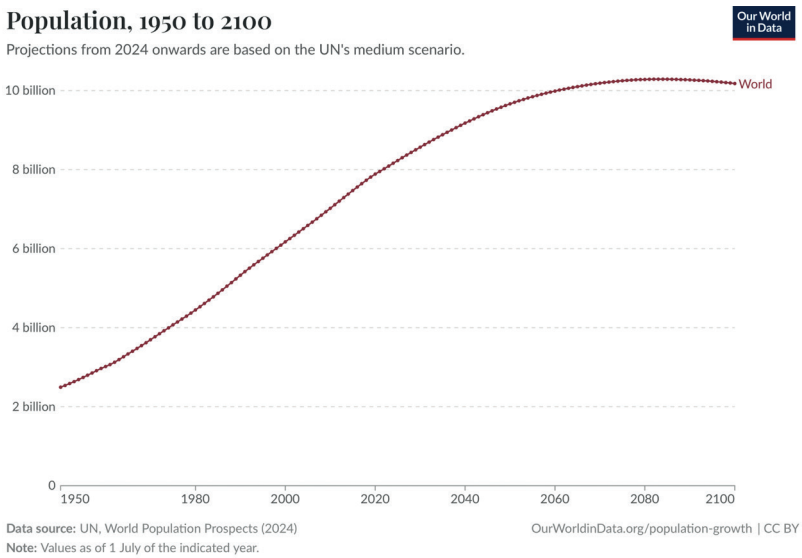
On the other hand, economists have argued that the impact of population/environment relations is primarily dependent on the concrete politico-economic realities that mark the current development scenario in specified contexts, rather than on population growth rates *per se*. Such debates between optimists and pessimists as to the relative consequences of population dynamics on the economy and on the environment were intensified and persist to this day. Population growth continues to attract attention, but the context is now different. Instead of being perceived as a hindrance to economic growth, it is now viewed primarily in relation to its impacts on environmental issues. Ultimately, though the advantage of a smaller population for environmental welfare is intuitively insightful, a systematic concern with population size as a major cause of environmental chaos does not generate effective policies in this domain, for three reasons.

First, disparities in the respective timing of population growth and environmental dynamics are critical. Thus, on the one hand, major environmental problems need to be resolved in the short term in order to avoid ecological chaos. On the other, reducing population growth, even under draconian policies, is a longer-term process that is not amenable to short-term results, due to the forces of demographic inertia wherein the demographic dynamics of previous generations inevitably continue to influence current rates of growth (Martine 2025). In this context, if one is optimistic about the world's chances of resolving its most critical environmental threats in the relatively short term, then reducing population growth rates now is crucial for long-term human welfare. A more pessimistic outlook on the probable ineffectiveness of environmental measures to be adopted before reaching irreversible tipping points would suggest the need to focus greater attention on other structural factors now; otherwise, 'long-term human welfare' could be very problematic.

Second, as shown in Figure 2, global growth rates have already undergone a remarkable structural decline from a peak of 2.3 per cent per year in 1963 to less

than 1 per cent today. Moreover, they are unlikely to experience a resurgence of growth in the foreseeable future. On the contrary, the combination of ongoing fertility declines, even in poor and high-fertility countries, the escalation of widespread political and economic strife, the increasing frequency and intensity of environmental disasters, and the predicted onslaught of further global pandemics, would suggest even further 'natural' declines in global demographic growth rates in the proximate future.

Figure 2. Population growth rate, 1950 to 2100



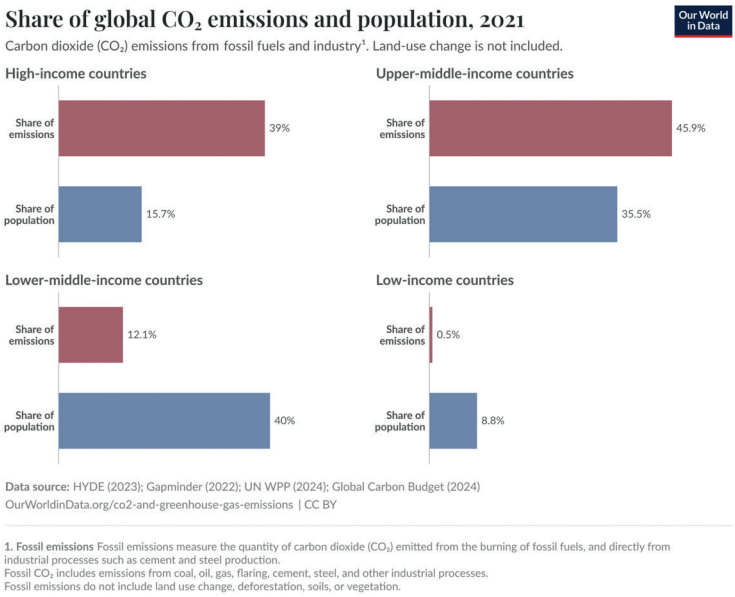
SOURCE: OUR WORLD IN DATA – RITCHIE ET AL. 2023 (CC BY 4.0)

Third, and more importantly, the actual impact of population groups on the environment is determined, not by sheer numbers, but by their relative patterns and levels of production and consumption associated with the current model of development. High population growth rates are typical of poorer population groups that have a smaller *per capita* ecological footprint than higher income countries; they do not consume, pollute or degrade in the manner, or at the rate, of the more developed countries. As shown in Figure 3, higher levels of CO_2 emissions are associated with high income and low fertility population

groups across the globe. Nevertheless, as the ecological footprint of poor countries enlarges through highly pursued 'development', their population size, accumulated during high fertility regimes, will also significantly impact global sustainability.

Ultimately, whether or not the world´s population stabilises at 7 or 10 billion, the challenge of how to achieve a high quality of life for all, or even for a majority of all peoples, given ongoing conditions of environmental degradation and inequality, will be extremely difficult (O'Neill et al. 2018). Reducing population growth is critical for longer term sustainability but it is a long-term project, even under more drastic efforts. Population and consumption are inseparable in environmental impact, but only present action can change present consumption and future population size and hence future total consumption or throughput.

Figure 3. Global CO_2 emissions by income group



SOURCE: OUR WORLD IN DATA – RITCHIE ET AL. 2023 (CC BY 4.0)

It is evident that past historical fertility patterns exert a significant influence on contemporary emission levels; however, birth control measures do not retroactively alter population size or its environmental impact (Martine 2025). For instance, despite the implementation of rigorous fertility reduction initiatives and the achievement of more moderate *per capita* emissions, China's current emissions exceed those of the United States and the European Union combined. Likewise, India, while exhibiting relatively low *per capita* emissions, ranks as the third highest in total emissions globally.

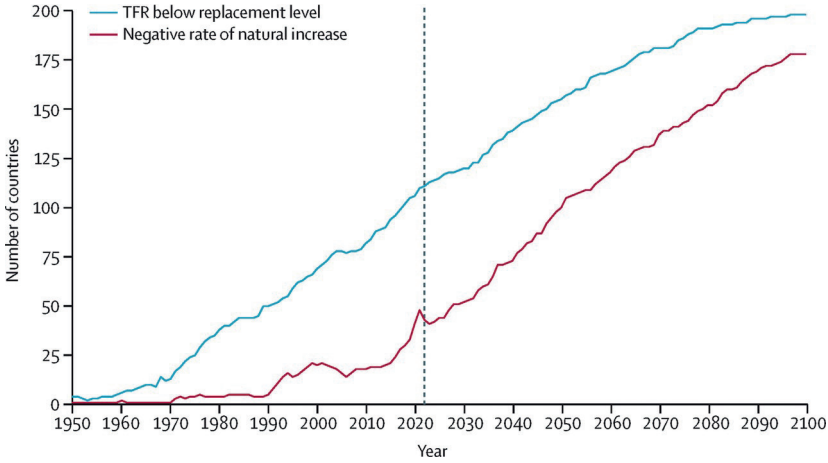
This situation underscores the critical point that current population growth rates will only be pertinent to long-term sustainability IF society manages to decouple development from resource consumption in the coming decades. However, the prospects for achieving such a decoupling in the near future appear minimal given the existing geopolitical circumstances.

The challenges of recent demographic trends

It is critical to note that while the relations between population growth and the environment continue to be significant, they are presently taking on, for pragmatic and political reasons, a very different configuration from that in earlier periods of rapid demographic growth. As shown in Figure 4, the trend towards below-replacement fertility rates is now being generalised across a wide range of countries, bringing with it serious challenges in terms of a shrinking labour force, higher dependency ratios, and stress on health and social security programs.

This evolution of population growth trends has sparked a different set of concerns and priorities in recent times. To address the challenges associated with declining birth rates, numerous developed nations are actually implementing *pro-natalist* policies. So far, these initiatives have had limited success, due to a multitude of factors – including the disenfranchisement of women, the significant opportunity costs associated with raising children in contemporary society, and the enhanced access to effective reproductive health information and practices. Observation of such negative rates of natural increase in more developed countries also brings into play another demographic dynamic of enhanced importance – namely, international migration.

Figure 4. Number of countries and territories with TFR below replacement level (2·1) and with a negative rate of natural increase, 1950–2100



SOURCE: GBD 2021 FERTILITY AND FORECASTING COLLABORATORS 2024

Indeed, in view of these global disparities in population growth rates, international migration from countries with high fertility rates could indeed serve to mitigate the population declines experienced in those with low fertility rates, thus generating substantial advantages for both sending and receiving nations in coming decades. As articulated in the *Wilson Quarterly*, 'global migration provides unequivocal economic benefits to receiving and sending countries, and to the migrants, with few if any of the cultural, criminal, or other alleged costs often cited against it' (Goldstone 2024). Nonetheless, as cautioned in a recent article in *The Lancet* (GBD 2021 Fertility and Forecasting Collaborators 2024), 'this approach will only work if there is a shift in current public and political attitudes towards immigration in many lower-fertility countries and if there are sufficient incentives in place for people to migrate from higher-fertility countries … This underscores the importance of developing ethical and effective immigration policies with global cooperation.'

Unfortunately, such a critical shift in mindsets and policy appears highly improbable in the near future, given the current rise of ethnocentrism and xenophobia in

countries that are most affected by fertility and growth declines. The reluctance of most developed countries to embrace immigration, despite declining growth and labour shortages, is remarkable. For instance, in the USA, Gallup polls indicate that, as recently as 2020, some 77 per cent of the American populace viewed immigration positively (ibid.); however, this perspective has shifted dramatically during the last few years due to the incendiary rhetoric and actions of right wing political figures who have somehow convinced a discontented electorate that the presence of immigrants is what prevents them from reaching deserved levels of prosperity.

Simultaneously, the prospect of a rapid global decline in fertility has recently enveloped issues of birth control within ultra-conservative and racially sensitive political settings, such as in the contemporary USA. Within this framework, more stringent policies restricting access to reproductive health services and abortion have been instituted with the ultimate goal of increasing fertility rates – among white people. Yet, this could well defeat its own purpose since restricted access to fertility control will primarily affect lower classes, in which non-white groups have a higher relative participation. Pro-natalist advocates now assert that larger families are beneficial not only for individuals but also for societal well-being. Elon Musk, a prominent proponent of this ideology who has, so far, sired some 14 children with multiple partners, aligns with thinkers like Simon (1981), who argue that there are no environmental constraints to economic growth and that perceived scarcity is illusory since human ingenuity within a market framework can address all environmental challenges.

Such a reaction to the alleged economic and racial disadvantages posed by the observed decline of birth rates among white women represents a significant societal regression. Historically, declining fertility rates have been associated with enhanced women's autonomy, increased education and labour force participation, as well as the overall advancement of gender equality. This fundamental progress stands at risk of being undone in the current political landscape. Attention to reproductive health is essential for women's health and gender equity, but should not be perceived as an instrument of population control. Moreover, when combined with negationist attitudes toward environmental issues, these attacks on the ability of women and families to control fertility precipitate a reversal of the broader concern with the adverse environmental impacts of unchecked population growth.

The concern with decreasing birth rates in the USA and other developed countries also brings to the fore another important demographic trend: longevity. People all over the world are living longer than before and mortality is increasingly concentrated in older age groups. Yet, basic approaches to dealing with the ageing process have not evolved in accordance to its relevance. Formal retirement ages remain well below productive life expectancy, thereby stressing social security and pension plans while also foregoing the contributions that a trained and experienced labour force could still make. On a world level, more than one third of the population is already aged over 60, with this proportion being even greater in richer countries. As recently argued by Alves (2025), this overall trend could also be perceived in positive terms. Thus, 'if the growing proportion of healthy elderly people is accompanied by social inclusion and their active and collaborative insertion in society, the elderly population will no longer be seen as a burden and their contribution will be recognised' (author's translation).

In summary, population size and growth continue to represent a significant variable in the population/environment equation, but 'population' should not be considered as a simple homogenic unit and 'population dynamics' do not constitute a self-standing influence. The advantages and disadvantages of growth are dependent on other socioeconomic and political configurations that are differentially perceived in developed and undeveloped national contexts. In any event, as argued above, with the exception of wars and cataclysms, growth and size are clearly not amenable to drastic policies or radical changes over the short term.[6] The probable evolution of demographic size is likely to be governed by the broader sweep of variable societal changes, rather than by the will of pro-natalists or controlists.

Within this framework, the process of aging constitutes another demographic dynamic that – along with immigration – should eventually be perceived in a new context, handled with an enlightened vision and transformed into a positive trend for humankind. As concerns fertility decline, it would seem probable that comprehensive societal changes prompted by long-term low fertility will eventually refocus the cultural significance of reproduction and reduce its cost for childbearing, in what might be termed as a process of 'long-term social

6 Lump sum monetary stimuli, such as those currently being offered by the Trump administration, have negligible impacts since they do not even begin to cover the costs of having and bringing up children.

rationality'.[7] Recent history has shown that wars, disasters and high mortality do tend to increase fertility levels temporarily. The same general stimuli could eventually change attitudes to childbearing and/or diminish the resistance to immigration in the context of a prolonged demographic dearth in low-fertility countries. The provision of robust social, healthcare and day-care systems, as well as cheaper housing and advanced social security capable of reversing the socio-economic costs of bearing and raising children, could eventually help to overturn the current declining birth rates, in the context of changing societal attitudes. This will not occur if, as in the current context of the USA, safety nets are systematically removed.

Throughput growth and consumerism

Modern capitalism is driven by humankind's increasing desire for material goods. As summarised by Higgs, 'Over the course of the 20th century, capitalism preserved its momentum by molding the ordinary person into a consumer with an unquenchable thirst for more stuff' (Higgs, s.d. online). Encouraging heightened levels of consumption to stimulate production lies at the heart of our development paradigm. Over the past century, the principal function of 'development' has been to safeguard, enable, implement, justify and defend economic growth and poverty alleviation through the widespread proliferation of an unsustainable model known as throughput growth – which entails the amplified extraction of materials and energy resources from the environment to manufacture goods and provide services (Daly and Cobb Jr. 1989; Goodland 1992). This paradigm is increasingly rooted in a dominant consumer culture, which not only exacerbates the drivers of climate change but also blinds societal understanding of its causes and appreciation of its effects, thus delaying the enactment of essential policy responses to mitigate its impacts.

The practice of throughput growth emerged in the early twentieth century, particularly among entrepreneurs in the United States, and was later emulated

7 As pertinently observed by the historian Toynbee, civilisations continue to grow only when they resolve one challenge and are met by another, in a continuous cycle of 'Challenge and Response'. Reduced fertility is the response to a radical shift in the value of children in modern-day society. It remains to be seen, given the current rapidly changing scenario, how and when societies will move towards reassessing progeniture and ageing, and whether adequate responses will be implemented in good time to meet the urgent threat of environmental chaos.

throughout the capitalist world. By the end of World War Two, the U.S. had established a vast industrial complex to support the war effort, and it was perceived that the abrupt dismantling of this system would threaten massive unemployment and economic recession. In response, strategies quickly evolved that prioritised mass consumption via throughput growth, thereby sustaining and expanding the efficient wartime productive framework (Assadourian 2010).

Propelled by innovative advertising campaigns and further energised by the formula of planned obsolescence – wherein the lifespan of a wide range of products and fashions is deliberately reduced in order to further accelerate production and consumption – throughput growth soon became the primary engine of the American economy. As early as 1955, Victor Lebow already remarked, 'Our enormously productive economy demands that we make consumption our way of life, that we convert the buying and use of goods into rituals, that we seek our spiritual satisfaction, our ego satisfaction, in consumption … We need things consumed, burned up, replaced and discarded at an ever-accelerating rate.' (Lebow 1955 *apud* Higgs s.d. online).

The success of consumerism as the core motivation of economic growth was quickly propagated on a world scale. It gave form, content and vigour to economic life and thereby promoted one of the greatest socioeconomic transformations in history. Its attractiveness was magnified through massive advertisement campaigns that convinced people to 'buy more stuff' than was really needed. In the process, consumerism eventually redefined the main objective of humankind's life pursuit. With increasing power and scope since the mid-twentieth century, this system has been inducing people to consume and thereby define the contours of their search for happiness, as well as the determinants of their status as individuals or social groups.

In short, the struggle to achieve happiness and social status through consumerism motivates people to increase their income in order to achieve contentment and social acceptability through the purchase of goods and services. The irony is that, although consumerism leads people to believe that well-being and success stem from ever higher consumption levels, they are never actually satiated in their quest.[8] That is, consuming more does not necessarily mean a better quality of life.

8 For a classic psychological assessment of buying for pleasure, see Kasser (2002).

The marginal utility of income tends to diminish and increased consumption does not guarantee happiness (Easterlin 2001; Assadourian 2010; Helliwell, Layard and Sachs 2012).

In retrospect, one might ask – how did this unsustainable model for modern civilisation attract support and become dominant so swiftly? The fact is that the motivation for consumption, which works effectively at the individual level, also has a strong capacity for mobilisation at the aggregate level. This explains its strength on the agenda not only of large corporations, but also of national governments and international development agencies. The very road to development and well-being proposed by governments and multilateral development agencies is to grow through ever-greater exploitation of natural resources in order to fulfil ever-increasing demands.

On the plus side, the success of consumerism as the central driver of our development paradigm has favoured job creation, poverty reduction and the widespread achievement of material well-being at previously unimagined levels worldwide. Nevertheless, the consumer culture, supported by the institutional machinery created around it to stimulate the production process and the generation of material wealth, compromises the planet's resources. Moreover, it has become so deeply rooted in the values and practices of our civilisation that it ends up manipulating people's behaviour without their noticing. As a result, awareness of the negative environmental consequences of the dominant consumerist culture is limited among the general populace, and unwelcome to policymakers. Consequently, negationist propaganda campaigns continue to deaden concern and comprehension of current global environmental menaces, while also encouraging the eradication of effective initiatives in this domain, as will be observed in the next section of this paper.

Ultimately, our development paradigm is not sustainable in the medium and long term, as has been amply demonstrated. Yet, given the undeniable success of this model in providing material welfare, no government, rich or poor, has dared to take effective measures that could threaten the continuation of this spiral. In the current context, attacking throughput growth invites political disaster. Suggesting cutbacks in consumption, when 'happiness' itself is predicated on having access to more goods, is an extremely unpopular approach and threatens

the very foundations of 'progress' and 'well-being' as they are defined today. It is no wonder that governments from all over the world, including 'leftists', defend the 'development' that will allow the population of their country to consume more and thereby raise its GNP – the widely-accredited indicator of success. Even international climate conferences hesitate to put a finger on this global environmental sore spot.

In the absence of a dramatic change in the concept of development and of the consumer culture that sustains it, the expansion of this system clearly catalyses a global ecological crisis.[9] This approach is devastating for the planet since it relies on the expanded farming of natural resources and the disposal of a greater volume of wastes, thereby generating cycles of increasingly grave environmental threats. The constant increase in consumption resulting from this quest boosts production and economic growth, generating, in the process, the various ecological problems that are emerging today. Thus, as aptly stated by Wilk (2017) – 'Without consumerism, there is no environmental crisis'.

Liberating humanity from the compulsion to consume unnecessarily would drastically alter the current trajectory of climate change. This will not be easy to achieve since consumerism is THE dominant culture of the twenty-first century, and since it is conducted, aided and abetted by THE dominant economic and political model. The real advances in material living standards achieved in the world by way of throughput growth prevent national governments and international development institutions from seriously challenging the model.

In this context, the cultural war over climate change and other environmental threats produced by throughput growth has a different nature and greater implications than the usual divergences between conservatives and liberals. It broaches issues that determine the core of our civilisation's beliefs and pursuits. People are born and raised in a world community that defines happiness, social status and success in terms of one's ability to acquire material goods. Accepting evidence as to the anthropogenic origins of an imminent climate change would

9 Degrowth and the circular economy, which involve using less of the world's resources for purposes of greater well-being, are often posited as an alternative model for development, but this has understandably garnered little political support (cf. Savini 2023). For a broad discussion of this and other proposed alternatives, cf. Belmonte-Ureña et al. (2021).

force humankind to review the lifestyles and patterns of behaviour that have conditioned individual actions since their birth. Changing these life-defining values makes it very difficult for people to reconfigure personal expectations and behaviour in light of a threat like climate change, which is still diffuse and poorly understood – despite the multiplication of intense 'natural' catastrophes.

Considering the enormous importance of technology in the very evolution and substance of consumer culture, it has also become easier to accept the negationists' propaganda and to buy into the belief that technological developments will eventually be able to sweep away all looming environmental problems – even if this involves shipping humans to Planet Mars. Thus, it is easy to understand the general predisposition to accept arguments that reassure society about its alleged guilt in climate events and that exonerate the population from changing its behaviour. For this reason, vigorous negationist propaganda campaigns, financed by the productive sectors that most contribute to environmental chaos, easily find fertile ground for their stances. Given the degree of ignorance of the general population regarding critical scientific and technological issues pertinent to environmental threats, any argument that defends the traditional consumerist society ends up being plausible and allows the use of radical means, even the provocation of trade and other types of wars, to ensure its continuity.

In sum, different to the *population growth* threat, wherein policies and impacts tend to be longer-term in nature, the perils of throughput growth are current, immense and here to stay – perhaps until the level of environmental chaos compels a drastic upheaval in our civilisation's *modus operandi*. Fundamental incompatibilities persist between the exigencies of the throughput growth model, on the one hand, and the adoption of environmentally sound domestic policies on the other.

In the meantime, huge international negationist lobbies at all levels of government systematically contribute to the lack of knowledge and commitment to the environmental agenda. Their efforts have lately contributed to the election of an American president who condones and even promotes the exploitation of natural resources, while also dismissing initiatives aimed at benefiting the environment. This distressing turn of events takes throughput growth to extreme lengths and constitutes the greatest threat to sustainability, as discussed in the next section of this paper.

Power politics and the fate of sustainability

The intensification of development's impacts on the environment demands urgent and effective global-level actions to reverse the flow of current threats and thereby achieve long-term sustainability. Such an approach would require three fundamental preconditions: a) global environmental awareness; b) respect for environmental science; and c) the capacity by nations and their leaders to look beyond immediate, self-serving objectives toward long-term, collective well-being. Each of these prerequisites is in serious jeopardy in the present geopolitical context, wherein nationalistic priorities, authoritarian tendencies and disinformation campaigns increasingly dominate the political landscape.

Despite the quasi-universal commitment to consumer-based development, environmental issues – especially those stemming from the uncontrolled expansion of CO_2 emissions and their connection to climate change – have long been acknowledged as major 'market failures'. This recognition has prompted various 'technical' schemes designed to address the problem without fundamentally altering the dominant politico-economic model. Proposed solutions include: improving energy efficiency; investing in nuclear fusion as an alternative to costly or intermittently reliable renewable energy sources; transitioning to low-carbon economies through technological innovation; deploying geo-engineering interventions to absorb anthropogenic CO_2; deflecting solar radiation; cooling the atmosphere through aerosols; and, market-based strategies like carbon pricing, swaps, cap-and-trade systems, fee-and-dividend policies and complex negotiations over global emissions targets. It has been hoped that, singly or in combination, these initiatives would enable significant reductions in greenhouse gas emissions without requiring a rethinking of global development or consumption patterns.

Though essential, the design and implementation of technological solutions to mitigate environmental threats are ultimately insufficient without supportive public awareness, political will, and the allocation of substantial financial and institutional resources for needed structural changes. Moreover, some technologies come with potentially harmful side effects. For instance, aerosols may help cool the Earth's atmosphere by reflecting solar radiation, but they also contribute to dangerous air pollution and adverse health outcomes.

More importantly, the climate crisis is not merely a technical dilemma – it is, at its core, a deeply political issue. It raises difficult questions about conflicting rights: the rights of individuals versus the collective good; the rights of the present generation versus obligations to future generations; the rights to consumption and development in richer countries versus the developmental aspirations of poorer nations. Such fundamental tensions must be addressed to meaningfully confront climate change.

The limited window of opportunity that experts suggest still exists before reaching dangerous climate tipping points is rapidly closing. A recent report by the World Meteorological Organization (WMO 2025) warns that the world could soon experience a year that is two degrees hotter than in the pre-industrial era. Yet this urgency remains insufficiently integrated into political discourse and policy-making. Reversing the global slide toward environmental unsustainability will require acknowledging the direct link between the dominant model of economic development and the intensification of ecological crises. It will also demand rethinking our metrics for success, moving beyond gross national product (GNP) and consumption levels as the sole indicators of achievement. A more just and sustainable paradigm would embrace human solidarity, prioritise the guarantee of basic rights for all, and promote compassion in the face of growing inequalities exacerbated by climate change. It would also necessitate an empathetic concern for the fate of future generations, rather than an obsession with quarterly growth or electoral cycles.

Unfortunately, there is little indication that major actors in the global system are currently attentive to these exigencies. Most governments and international development agencies remain tenaciously focused on throughput growth and material accumulation. Simultaneously, escalating global conflicts and a dysfunctional geopolitical climate hinder cooperation, even on matters of existential importance. In particular, the rise of authoritarian populism – and most notably the return of Donald Trump to the presidency of the United States – has become a direct and formidable obstacle to global sustainability efforts.

As many political analysts and other scholars have documented, unchecked ambition, when paired with narcissism and demagoguery, can lead to extreme

and toxic outcomes.[10] Trump's second administration appears to be governed by precisely such impulses. His personal quest for power and admiration, now untethered from meaningful checks and balances, shapes his administration's approach to both national and international affairs. He has surrounded himself with sycophants, radical ideologues and media figures whose loyalty is personal rather than institutional, and who show little inclination to moderate or constrain his more dangerous impulses.

Trump's vision of global leadership appears grounded in domination, not cooperation. In a revealing 2025 interview with Parker and Scherer, Trump claimed to have rid himself of the legal and political constraints that limited him during his first term, adding ominously that 'this time, I run the country and the world'. His administration's efforts to extract payment from allies, wage reckless trade wars, and even flirt with territorial annexation have destabilised international relations and undermined American credibility. Meanwhile, his hopes of spawning a global wave of Trumpian governments have suffered significant setbacks, with far-right allies in Canada and Australia losing electoral ground, and European nations growing more unified in their opposition to his policies.

Domestically, Trump continues to erode democratic norms and institutions, attempting to delegitimise constitutional checks, attacking the independence of the judiciary, and openly entertaining the idea of seeking a third term. His administration has moved to dismantle vital sectors of the public service, attack diversity, equality and inclusion initiatives, and suppress civil liberties under the guise of anti-'woke' rhetoric. Trump has also pushed a costly bill that, according to experts, will likely make the rich even richer and cut some $1 trillion from key safety net programs.

Meanwhile, Trump's disdain for science, education and information threatens to permanently damage the institutions required to understand and combat climate change. His administration targets educational institutions, attacks media outlets, and censors books and curricula that deal with topics such as systemic racism and other inequalities, civil rights and environmental justice. In a particularly tyrannical manner, he is attempting to demolish the influence of even the most respected universities in the USA. These efforts reflect not just cultural backlash, but a calculated attempt to reshape American society along authoritarian lines.

10 Cf. for instance: Hirschi and Spurk (2021); Resta E. et al. (2023).

Particularly alarming is Trump's approach to immigration.[11] His administration demonises immigrants and seeks to radically restrict immigration from non-white countries, ostensibly to preserve a disappearing white Christian majority (Gorski and Perry 2022; Martinez and Passel 2025). This xenophobic policy is out of touch with demographic realities and with America's long history of benefiting economically and culturally from immigration.[12] Currently, it is economically harmful: America's agriculture, healthcare, construction and service sectors are already experiencing labour shortages as a result. Moreover, recent efforts to 'whiten' the population – by encouraging white South African immigration while deporting masses of Latin American and African migrants – are ethically reprehensible.

Trump's broader foreign policy is similarly destructive. He has demanded rare minerals as 'payment' for peace negotiations in Ukraine, floated the idea of converting war zones into real estate ventures, and treated international crises as opportunities for personal profit or political spectacle. Multilateralism, historically a key mechanism for addressing global challenges, is being gutted under Trump's leadership. Once the backbone of post-World War Two peace and prosperity, the multilateral system now faces unprecedented hostility from one of its founding architects. Trump has withdrawn from international agreements, undermined alliances, and attempted to bully or buy influence across the globe while also dismissing foreign aid and dismantling critical humanitarian agencies such as USAID. His disdain for collective governance is evident in his threats to annex countries like Canada and Greenland, his obstruction of UN climate frameworks, and his general scorn for international norms.

All these outrages pale in comparison to the Trump administration's complete disregard for climate change. While the world and the USA face increasingly frequent and intense climate disasters – wildfires, hurricanes, floods – Trump acts as if they didn't exist. His administration prioritises fossil fuel production, economic growth at all costs, and the rollback of hard-won environmental protections. His recent big and beautiful bill directly attacks directly attacks

11 Trump's harsh and often racially charged stance on immigration and deportation stands in stark contrast to his own family background – his grandfather was German, his mother was Scottish, and two of his three wives were immigrants.

12 Cf. for instance: Abramitzky and Boustan (2022); Porter (2024).

initiatives of previous governments aimed at reducing climate warming, in deference to the oil industry's demands.

All this is occurring at a time when the United Nations is structurally incapable of implementing basic initiatives for human welfare. The three largest powers on the UN Security Council – the United States, Russia and China – now actively undermine efforts to address climate change and other critical humanitarian initiatives. Expansionist ambitions, ideological rigidity, and competitive nationalism have replaced cooperation and mutual accountability. In this context, environmental concerns are eclipsed by short-term priorities: energy security, military build-up and nationalistic posturing. Climate change barely features in strategic discussions about Ukraine, Middle Eastern conflicts, European rearmament or even the massive demonstrations against Trumpian authoritarianism.

Despite the growing visibility and severity of climate-related disasters, the Trump administration continues to treat environmental policy as expendable. He has once again pulled the United States out of the already modest Paris Agreement, eviscerated key environmental safeguards, and dismissed renewable energy in favour of an aggressive push for fossil fuel expansion. His infamous slogan 'drill, baby, drill' has been revived with even greater intensity, sending a chilling message about America's environmental priorities. Within just the first 100 days of Trump's renewed presidency, at least 70 actions were taken or proposed that directly threaten the environment, climate and public health (NRDC 2025). These actions include disembowelling policies related to clean air and water, defunding climate adaptation programs, rolling back protections for endangered species, and dismantling climate monitoring infrastructure. The defunding of the National Oceanic and Atmospheric Administration (NOAA) and suppression of climate research marks a systematic assault on the infrastructure of knowledge while reducing the country's capacity to forecast and respond to severe weather events, thereby putting thousands of lives at risk. The consequences of this environmental negationism are likely to be profound and irreversible.

In sum, Trump's pursuit of personal power, his right-wing politics and his rejection of environmental science are colliding in a way that profoundly undermines global efforts to address the climate crisis. He has rendered the United States an unreliable partner in international climate initiatives and created a dangerous

vacuum in global environmental leadership. Ironically, in his quest to 'Make America Great Again', Trump may succeed only in accelerating one form of growth: the country's emissions of greenhouse gases. If the world continues along this path of denial and delay, climate change will not just be the defining issue of our time – it will become the defining failure of our civilisation.

Final considerations

Recognition of the character and nature of threats to environmental sustainability has evolved over time. Earlier and much-debated concerns with population growth and size continue to be relevant, but their policy implications – within the short-term window of opportunity that the current slide to unsustainability presents – are increasingly limited. Meanwhile, other demographic processes such as international and national migrations, population aging, and urbanisation, demand renewed interest in global and national policies, but they do not have the same significance, nor have they been subjected to the same level of scrutiny as growth, in relation to their environmental consequences and policy implications.

Throughput growth has long been identified as the centrepiece of major environmental threats, insofar as it is predicated on the increased appropriation and spoilage of natural resources for purposes of feeding economic growth spurred by enhanced consumerism. In the process, it has generated a civilisation wherein individual happiness and societal success is routinely measured in terms of access to material goods of dubious need. Globalisation of this model has spurred both increasing worldwide consumption and a consequent level of damages to environmental sustainability.

In discussing future perspectives and policies, it is essential to place these issues within the scope of a broader perspective, since both development and environmental concerns are inherently global. Climate change, like other threatening environmental issues, is at the mercy of cultural transformations embedded in the hegemonic development paradigm that rules the world. Until it is explicitly recognised that consumer culture drives demand and that increased production in the current format to meet this demand generates several ecological problems – which could lead to an abrupt destabilisation of the global environment – there will be no sustainability. Consumer culture and its most extreme form, consumerism, encourage and sustain the current development

trajectory, but they also trigger and accelerate the dangerous environmental changes taking place on the planet. This is the greatest ethical, ideological and existential dilemma facing humanity in the twenty-first century.

Revision of this unsustainable model and efforts to move in new directions are constantly derailed by negationist propaganda rooted in the powerful lobbies of the economic sectors that cause the greatest damage to sustainability (Aronoff 2025). Global power politics, especially the initiatives currently undertaken by the United States of America – the world's most powerful country – actually preview a drastic increase in environmental chaos. The recent election of a negationist strongman to the presidency of that country has provided lobbyists and other negationists with a powerful instrument for the disruption and dismissal of environmental concerns and policies at all levels. The consequences of ongoing assaults by this autocratic government on multilateralism and on environmental safeguards is bound to have lasting repercussions on short- and long-term sustainability for the world.

A radical increase in environmental awareness leading to effective policies is the essential starting point for the avoidance of planetary chaos. Enhanced support from environmental movements leading to political action, as well as the commitment of world leaders and multilateral agencies, is essential to this purpose. Solving this conundrum will require redefining not only 'development' but also the primarily material content of modern-day 'happiness'. However, there is little indication that such a transformation will occur in good time since consensus for critical initiatives is lacking. Multilateralism is drowning in the egotistical pursuit of additional supremacy by major powers. Global political, economic and cultural turbulences inhibit objective reflection on needed policies while obstructing the consideration and implementation of acutely-needed steps to counter a predictable global environmental chaos.

In brief, the pursuit of 'development' through the expansion of throughput growth stimulated by consumerism drives an unsustainable global system. The recognition of grave environmental threats and the willingness to engage in collaborative action to address them is essential for sustainability. It also requires significant cultural changes and dramatic reductions in consumption within a radical transformation of the development paradigm. This could only be achieved through a new global governance focused on common issues of sustainability,

justice and the pursuit of human welfare, and not simply on a patchwork of disparate and unequal national 'development' objectives.

Unfortunately, as clearly demonstrated in current global Conferences and global actions, the pursuit of throughput growth has become so ingrained in the DNA of politics, at all levels, that it inhibits effective action. The current policies and actions of the world's most powerful government particularly deviates attention from the threat of environmental chaos and further hampers vital initiatives at the global level. Eventually, persisting on consumer-based development, under a chaotic system of global governance, may very well consolidate an increasingly dystopian civilisation.

Countering the current trajectory towards unsustainability will require bold and transformative action, rooted in a more empathetic vision of 'development' – one that acknowledges the fundamental interdependence between different sectors of humanity as well as their collective relations with the natural world. It will demand the widespread adoption of technologies that: enhance the accessibility and efficiency of renewable energy while phasing out fossil fuel dependency; safeguard vital natural assets and protect fragile ecosystems; prioritise collective well-being and the pursuit of equality over individual wealth accumulation; and, strengthen the social, economic, ideological and political foundations of sustainability. The alternative is to face escalating environmental threats and to risk unravelling the very fabric of our civilisation.

Acknowledgements

The author wishes to thank Igor Cavallini Johansen, José Eustaquio Alves and Christiana Martine, and especially David Samways, editor of the JP&S, for helpful comments on an earlier version of this paper.

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RESEARCH ARTICLE

The role of medicine for the alleviation of resource scarcity: Towards a 'Consumption and Production Medicine' framework

Anastasia Pseiridis[1]

Abstract

Despite technological progress, humanity suffers from (at least) two ills: it operates beyond planetary biophysical limits and continues to face unmet needs. This paper explores the intersection of medicine, economic wellbeing and ecological sustainability in the context of global resource scarcity. A conceptual classification of resource use – reasonable, wasteful, and negative externality-induced – is introduced to better understand the consumption and production forces shaping resource scarcity. Then I explore how medicine focused on prevention and reversal can reduce resource scarcity: by shifting consumption patterns toward healthier and more sustainable lifestyles, it both augments the human and non-human resource base of the economy and reduces demand for resource-intensive and environmentally damaging uses. Thus, it is concluded that Preventive and Reversive Medicine is a powerful (albeit unacknowledged) extant technology that simultaneously reduces resource scarcity and increases well-being and, critically, contributes to the disassociation of human well-being from environmental impact. The (wanted) side-effect of this process is more leeway for the global economy to provide a good life to all within planetary limits. This, I suggest, is essentially the 'Consumption and Production Medicine' that humanity needs.

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Keywords
Lifestyle medicine, preventive medicine, reversive medicine, population health, resource scarcity, negative externalities, environmental externalities, production and consumption, SDG12, sustainability, planetary boundaries, ecological footprint.

Resource scarcity continues to be a major obstacle to the achievement of a good life for all

Medicine's main moral obligation is, broadly speaking, to reduce physical suffering (Hofmann, 2024).[2] Sometimes physical suffering stems from, or is concurrent with, economic suffering, i.e., having a smaller income than needed to have a 'good life'.[3] Sometimes, though, physical suffering may stem from lifestyle choices enabled by a larger income, as is the case with non-communicable diseases (NCDs).

A 'good life' could be defined as a comfortable but not wasteful life in the Aristotelian sense (Lianos, 2016) or as a life compatible with the 'ultimate end' of economic activity, a term encompassing material comfort but also moral and ecological soundness (Daly, 1980). Notwithstanding the difficulty of defining the content of a good life, especially in terms of produced goods, there are estimates of the amount of additional production that would bring all living people within an acceptable definition of a good life. Some suggest that global production would need to be five to ten times bigger than today (World Commission on Environment and Development, 1987; Roser, 2021). Others find that a decent life for all could be possible if the efficiency of transforming the planet's resources into (produced goods and then) human/social wellbeing, were increased by two to six times (O'Neill et al., 2018); this is essentially tantamount to suggesting that

2 The term 'medicine' is used in the text in an expansive way. It comprises the knowledge and tools that can be used to promote health of individuals and populations. The term 'preventive and reversive medicine' that will be used later does not specifically refer to an established specialty but is used to underscore that the primary goal of the use of medicine should be prevention and reversal rather than treatment of symptoms. An established specialty that gets closer to this goal is probably 'Lifestyle Medicine', mentioned later in the text.

3 The terms 'good life' (εύδαιμονία), 'decent life', and 'wellbeing' are used interchangeably in the text, mainly as reminders that consumption of produced goods and services does not automatically translate into a 'good life'. To define the product mix of the global economy that could best promote good life or wellbeing or a meaningful life (serving Daly's 'ultimate end') is beyond the scope of this paper.

global production should increase by two to six times, under the current technical efficiency of the economy.[4]

A major obstacle for further growth of global production is the scarcity of resources, i.e., not having enough resources relative to needs. Resources can be thought of as elements that can be used either directly (such as clean air) or indirectly (as inputs of production of goods and services) in the 'wellbeing' function of individuals and societies.[5] There are two transformations that take place between usable resources and a 'good life': first, resources are transformed by the economic system into products and services; then, products and services have to be transformed into well-being, the latter being similar to what Daly defined as 'ultimate end'.[6]

In this paper I attempt to provide a working framework for the imbalance between finite means and increasing global needs, and how prevention- and reversal-focused medicine can beneficially affect them – the central idea is that wellbeing is constrained by resource scarcity, i.e., the short supply of (services from) resources relative to needs.

That resource scarcity exists is one of the least debated topics in economics; in fact, it is the reason for the existence of economics: the discipline of allocating

4 It should be noted that many scholars typically acknowledge (a) the additional needs created by an expanding population, and (b) the incompatibility of increasing global output with sustainability; these observations increase the severity of the scarcity problem that will be discussed below.

5 The mainstream economic terms for resources are 'factors of production' or 'production inputs' that are used to produce material goods and services. Nevertheless, some resources increase wellbeing without being purposefully produced or exploited by the economic system (such as the beauty of unspoiled natural landscapes, biodiversity, sea breeze, clean air, clean spring waters, human relationships, peaceful societies, solitude and privacy, free space, etc.). It is not my purpose to provide a strict definition of resources here, but to use the term in a way that makes sense to most disciplines. For stricter definitions of resources and resource scarcity in economics and ecological economics, see Jones, 2018; Haddad and Solomon, 2023.

6 The concept of resources may be better understood in terms of the services (per period) that they provide, as will be illustrated in Figure 3. For example, a hectare of forest provides carbon sequestration services, flood control services, recreation services, etc.; a manager provides managerial services; a delivery truck provides transportation services for goods; a building provides shelter and functional services; and so on. However, in the text, the word 'resources' will be sometimes used instead of 'services from resources' for the sake of simplicity. For example, when we say 'resources are wasted or degraded' this means that we waste the services that could be delivered by these resources.

scarce resources to their best uses. Scarcity is broadly manifested in the price of goods. If resources were abundant, the price of 'a good life' would be such that every person could afford it. Since prehistoric times resource scarcity has arguably led to misery, wars, conflicts, migration, and colonies. With many parts of the world and population segments within rich countries lagging behind both in terms of per capita income and in various well-being indices (Jansen et al., 2024) it is not easy to support the opposite statement; i.e., that resources are plentiful.

On the other hand, it is also reasonable to believe that resources are not scarce in a definitive, permanent way. Faced with scarcity, human ingenuity seems to have augmented the effective supply of resources (resource services) so that more needs could be catered for. For example, after WWII humanity has experienced a large period of continuous growth of production volume, coupled with large increases in per capita incomes and wellbeing indices for almost everyone on the planet. Extreme poverty is now rarer, the diseases and outcomes associated with poverty (infectious diseases, maternal and child mortality, etc.) are rarer, people are more educated, and life has arguably become more comfortable for almost everyone, despite the global population increasing from 2.3 bn to more than 8. It could be reasonably expected that human ingenuity can make the global economy grow even more, until the remaining economic suffering is eradicated and everyone lives a good life.

The flaw in this belief is that it assumes the ability of the economic system to replicate the growth rate of the past; it does not take into account the negative externalities (negative impacts) of production and consumption incurred so far, or the natural (biophysical) limits within which the economic system is functioning (Costanza et al., 2015). Both of these effects reduce the ability of the economic system to deliver increasing output at the rates seen in the past. In other words, it could be that previous output growth has taken place at the expense of further growth, leaving the current population with resources that are fewer and/or of lesser quality.

Further, there is a more important flaw in the belief that growth of output has led to the reduction of economic suffering. It can be argued that the reduction of economic suffering and the increase in the people being able to afford a good life since the post-WWII period has been a *by-product* of growth, not a deliberate

achievement of the economic system. As it is structured, the economic system is rather good at allocating resources to a global product mix that is useful for those who can pay, not to those farthest away from a good life. Collective values such as sustainability and justice are not well represented in the market; thus they are under-represented in the ensuing product mix. This may be why expenditure in beauty and personal care products in the US alone (around $100 bn in 2024, (Statista, n.d.)) is larger than the financing gap for education- and health- related SDGs combined (Sachs, 2019). The economic system is not good by design at purposefully achieving a 'good life', as the allocation of resources to uses that (i) can be backed by income, and (ii) are based on individual (not social) preferences takes principal position over the allocation of resources to uses that serve ecological sustainability and justice. In terms of Daly's ends-means spectrum (see Kalimeris, 2018 for a discussion), the economic system arguably fails by conception, design and measurement to allocate human-made intermediate means (resources such as technology, knowledge, human effort and, critically, our social capital and institutions) to the best mix of intermediate ends (health, education, sustainable infrastructure) that would efficiently serve the ultimate end.

However, all these human-made means are ultimately dependent on the ultimate means: the finite stock of low-entropy matter-energy provided by the planet's natural processes. Our current production and consumption patterns, particularly those that can be characterised as 'wasteful' or 'negative-externality induced' (see below), often prioritise the expansion of intermediate means and consumption without sufficient regard for their impact on the ultimate means, i.e., on the planet into which our economic system grows within and from which it feeds. In a sense, the economy is akin to a foetus, within a womb, that grows by poisoning both its mother and the amniotic fluid. This prioritisation deficit leads to a distortion of the identity and purpose of the economic system, exacerbating resource scarcity and environmental degradation, as exemplified by the transgressions of planetary boundaries discussed below.

Indeed, a large body of literature suggests that (a) the planet (our 'ultimate' resource) is for years beyond its capacity to absorb the economy's waste and regenerate natural resources at the rate needed (even with large deficits in attaining basic 'good life' elements such as universal access to healthy food, health care and education) and (b) that the impacts of previous growth to the environment, public health and

future wellbeing are vast, expensive and difficult to reverse; climate change, sea level rise, plastic and chemical pollution, biodiversity loss and the increased risk for pandemics are cases in point (Lebreton and Andrady, 2019; UNEP and ILRI, 2020; Dasgupta, 2021; Keesing and Ostfeld, 2021; Ripple et al., 2022; Grandey et al., 2024; Ling, 2024; Schlesier et al., 2024; Symeonides et al., 2024; Luby et al., 2024; Zhu et al., 2025; Hyman et al., 2025). Thus the conditions in which the economy operates now are not as favourable as they used to be. In other words, achieving 'good lives' for all may not be as feasible as it once was. But, importantly, the current state of the planet endangers not only the rate of further growth of production, but the existence of humanity itself (Ehrlich and Harte, 2015; Barnosky et al., 2016; Bradshaw et al., 2021; Cafaro, 2022; Ceballos and Ehrlich, 2023).

The literature on planetary boundaries provides a comprehensive quantification of the negative externalities of current production and consumption. It indicates that humanity has entered a region of risk for irreversible negative outcomes: six out of nine planetary boundaries have been transgressed so far and a seventh boundary (ocean acidification) is about to be transgressed (Richardson et al., 2023). For two of the transgressed boundaries, we do not have the knowledge yet to either quantify the risks (the chemical pollution – 'novel entities' boundaries) or to measure humanity's exact impact (the 'biosphere integrity' boundary). Importantly, a transgressed boundary amplifies the impacts of human activity on other boundaries (Lade et al., 2020; Villarrubia-Gómez et al., 2024).

If we consider the whole planet as one resource, the planetary boundaries literature shows that the planet (our most essential resource) cannot sustainably provide for the *current* needs of humanity for production and waste absorption; and this is so despite many countries' shortcomings in various economic and social wellbeing goals (Fanning et al., 2022). At the same time, a world of *ad libitum* increasing human population *de facto* reduces the feasibility of achieving 'good lives for all'; thus there is a trade-off between per person wellbeing and human numbers (Daily et al., 1994; Ferguson, 2005; Pimentel et al., 2010; Lianos and Pseiridis, 2016; Dasgupta et al., 2021). Indeed, human population numbers seem to be a defining factor of the transgression rate, even in countries (such as China and India) with modest per capita incomes and per capita transgression rates (Tian et al., 2024). The transgression rate can be seen as an estimate of the intensity of resource scarcity, and both per capita consumption and population make scarcity more intense, *ceteris paribus*.

The ecological footprint literature provides similar information for the global but also the country level. This literature, examining a sub-area of planetary boundaries, compares land ('biocapacity') that is available for food, settlements, wood, and absorption of CO_2 (only) to the resource use ('footprint') caused by an economy's consumption or production each year.[7] When available biocapacity is smaller than the footprint (needs), then an ecological deficit ('overshoot') ensues. The size of the overshoot can be again taken to be an estimate of the intensity of scarcity.[8] It can be seen that since 1961, the earliest year for which ecological footprint accounting data exist, the scale of global economic production increased dramatically, which went hand in hand with an increasing intensity of overshoot and augmentation of ecological scarcity: in 1961, human needs were just 73% of biocapacity, but the needs rose to 125% in 1991 and 174% in 2021 (calculated with data in Dworatzek et al., 2024). For the world as a whole, forty per cent of global production and consumption is currently over what would be required for ecological balance, a metric that could be taken to measure the debt to future generations (Lianos and Pseiridis, 2021). And this debt to the future is steadily increasing.

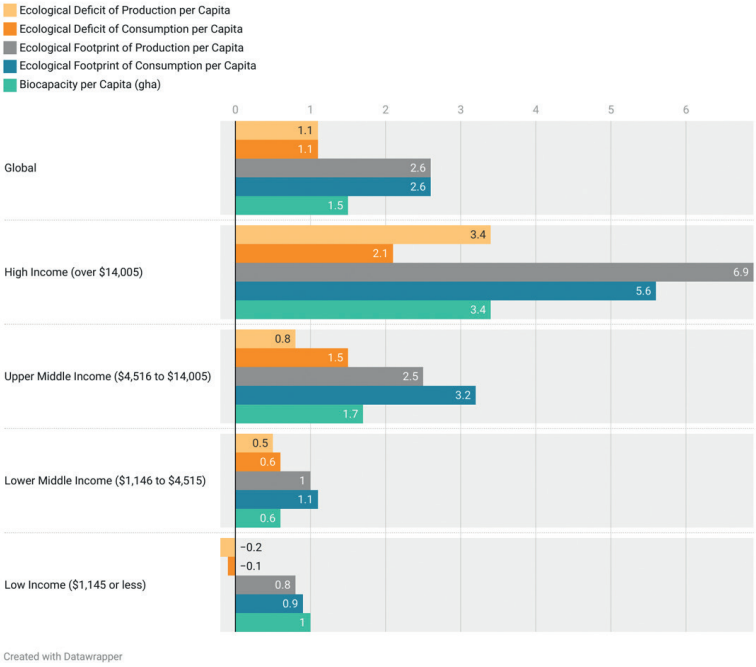
An ecological deficit means that each year's production and consumption leave the world, countries and individuals with fewer (e.g. forests) and/or degraded resources (e.g. soil and biodiversity) each year. And this happens despite (or side by side with) technological advances that supposedly reduce the per capita ecological impact of consumption and production and/or increase biocapacity. As shown in Figure 1, only the low-income countries still, as a group, consume and produce within their means, but these are also the countries that are most in need to increase their level of consumption so that they, too, achieve a good life.

7 Biocapacity and footprints are measured in a standardised artificial metric called 'global hectare'. A global hectare is a hectare of average global productivity. A country with lower-than-average productivity 'owns' fewer global hectares than its geographical area. Also, the footprints are measured in required hectares of global average productivity, not in the country's productivity. At the country level, the ecological footprint of consumption will be larger than that of production in countries that consume a lot of foreign biocapacity embedded in imports; it will be smaller than that of production in countries exporting more biocapacity than they import – see Figure 1 and its note. Of course, a country can have a deficit in both consumption and production.

8 As the market does not cater to the needs of those without income to support purchases, both a planetary boundary transgression rate and the ecological overshoot rate underestimate the actual chasm between needs and means.

As mentioned above, this type of scarcity is exacerbated when population increases. The country ecological footprint accounts show that this is the case with 90% of countries and the planet as a whole. At the global level, although between 1961 and 2023 global biocapacity has increased by 22% (arguably due to technological progress and increases in technical efficiency), the increase of population size resulted in a 54% reduction of global *per capita* biocapacity. In all but one of the low-income countries that I studied, the per capita biocapacity diminished dramatically within the same years (e.g. in DR Congo from 14 to 1.9 global hectares, an 86% loss; in Central African Republic from 22.1 to 6.6 global hectares, a 70% loss), leaving each person with fewer ecological resources to cover their (desired to increase) needs.[9]

Figure 1. Resources (biocapacity) vs needs (either for consumption or for production), and intensity of scarcity (ecological deficit) in 2023 (per person, in global hectares)



9 The list of 176 countries studied (those with quality flag + or ++) are provided in the Appendix.

Notes: The figure shows the ecological resources (biocapacity), needs (for consumption and production), and impacts (ecological deficit) in 176 countries (98% of the global population) classified along the four World Bank income groups. Income groups refer to the 2023 calendar year. Values are per person, in global hectares for 2023. If the per person biocapacity is smaller than the footprint, then a country (or the planet) is in overshoot. The global footprint of production equals that of consumption as at the global level there is no trade of biocapacity embedded in products. Thus the global consumption footprint equals the global production one. The low-income countries as a group still have a per person footprint of consumption smaller than their per person biocapacity thus present a small (but declining) ecological surplus of consumption. The high- and middle- income country groups are in overshoot. The high-income countries are net exporters of (overshooted) biocapacity, while the middle and low income groups are net importers. Compiled by the author with data from Dworatzek et al., 2024. Download link: https://www.datawrapper.de/_/9isfn/?v=4

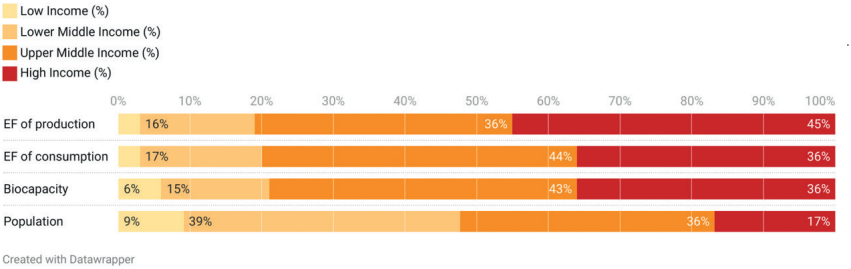
That all but one low-income countries have witnessed a decrease in per capita biocapacity[10] and most (15 of 26) are already in ecological deficit, shows that even countries with materially deprived individuals can produce and consume beyond available ecological means. Further, contrary to the global trend of increasing total biocapacity (+22% between 1961 and 2023), many countries across all per-capita income levels[11] experience a *total* biocapacity decrease as well. This, coupled with the unequal share of global biocapacity that low-income countries and lower-middle income countries own compared to their population (which makes up almost half of the global population, see Figure 2), makes a weak case for achieving peaceful and 'good' lives for all.

10 The only exception among low-income countries is *South* Soudan (for which data exist since 2012, when former Sudan was split into South Soudan and Soudan) where the per capita biocapacity has increased 1% between 2012–2023. During the same years, Soudan's per capita biocapacity decreased 18%. Among the 21 low-income countries with data since 1961, the decrease in per capita biocapacity ranged from 52% (DR Korea) to 87% (DR Congo).

11 Countries include Antigua and Barbuda, Barbados, Bolivia, Brazil, Central African Republic, Colombia, Congo, Costa Rica, Cyprus, DR Congo, Ecuador, El Salvador, Eritrea, Gabon, Gambia, Grenada, Guadeloupe, Guyana, Iceland, Japan, Liberia, Mauritania, Mongolia, New Zealand, Nicaragua, Panama, Paraguay, Samoa, Somalia, Suriname, Trinidad and Tobago.

A large body of the literature attributes the inability of the current economic system to provide good lives to all to an overconsumption focus of the wealthiest which is to the detriment of the poorest (Wiedmann et al., 2020; Kallis et al., 2025). On the other hand, individuals in the less affluent fifty per cent of the global population already live beyond some of their allocated (i.e., per person) planetary boundaries (Tian et al., 2024). It is therefore difficult to imagine the level of material consumption that could provide good lives to the current global population without creating overshoot or further transcending planetary boundaries.[12] The trade-off between wellbeing and population size make this exercise even more difficult in the face of the continuous increase of the global population (Lianos and Pseiridis, 2016; Samways 2022).

Figure 2. Share of global population, biocapacity, and ecological footprint (EF) among countries of different income levels, 2023



Notes: Low-income countries and lower-middle income countries have a share of global biocapacity that is smaller than their share of global population. Compiled by the author with data from Dworatzek et al., 2024 on 176 countries (98% of the global population) classified along the four World Bank income groups. Graph download link: https://www.datawrapper.de/_/k0F8Q/?v=6

Both perspectives (planetary boundaries and ecological footprint) show that the global economy does not serve well the good life objective, either for current or future generations. Besides degrading resources and putting humanity's future at risk, the negative impacts of global production and consumption (mis)allocate resources to uses that do not increase wellbeing; that is, instead of

12 In fact, describing a lifestyle that, if adopted by all 8 billlion humans, would keep the impact of production and consumption within the boundaries would be an interesting topic for future research.

resources being entirely used to increase humanity's wellbeing, some of them are diverted to managing damages instead. The volume of misplaced resources has been found to represent a considerable portion of production and also to result in considerably reduced subsequent volumes of production (Lianos and Pseiridis, 2021; Bilal and Känzig, 2024; Kotz et al., 2024), with both effects antagonising the positive effects of technological progress on the objective of 'good life for all'. To use a metaphor, suppose the global economy produces only bricks; many of them are used to repair damage created by how humanity produces and consumes. Therefore, the bricks left to build additional houses are limited. But also, fewer bricks can be produced each year due to resources getting fewer and fewer. These may be two reasons why it seems to be difficult to provide a good life to all either by the market or even through policies (Sachs et al., 2024).

The components of economic scarcity: resources and needs

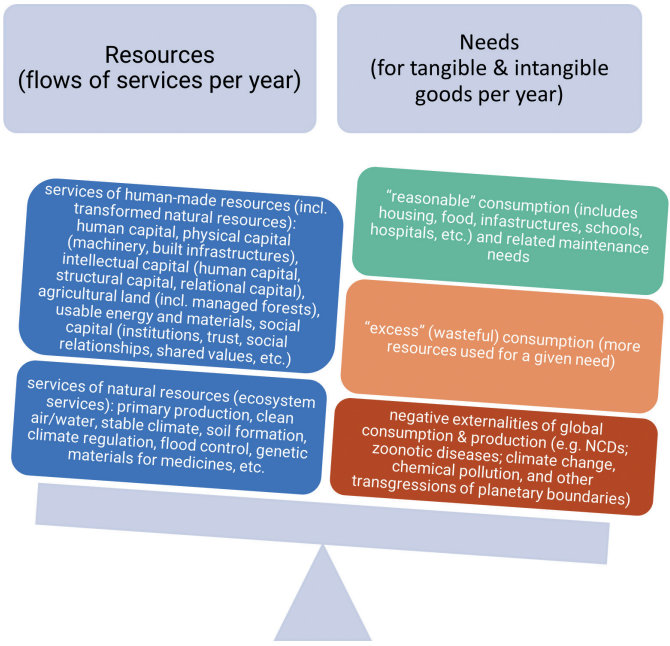
The above discussion outlines the constraints that the increasing intensity of resource scarcity puts on future wellbeing for all countries. Given resource scarcity, meaningful interventions to help ease humanity's problems should either be able to (a) increase wellbeing without augmenting resource scarcity or (b) reduce wasteful consumption and the negative impacts of the economic system so that some resources are freed from unnecessary or non-meaningful uses.

Figure 3 provides a graphical representation of resource scarcity with the use of a scale. The scale is tilted to signify that available resources (left) are not enough to meet the current needs of humanity in terms of production volume (right). The working hypothesis is that the consumption of resource services, either embodied in goods through production or in their natural form (as the air we breathe) satisfies human needs.[13]

13 As the global GDP is measured in constant prices, it can be used to compare the volume of production through the years. Economists usually assume that more needs are fulfilled with a higher GDP. However, the degree to which human needs are covered can be summarised, and arguably in a more meaningful way, with various other indices of wellbeing (see Jansen et al. 2024 for an overview), but figuring the right part of the scale as the global production volume (not value) is satisfactory for our purpose here.

Available quantities of resources can be split into two groups: human-made resources (which comprise transformed natural resources, such as usable energy and metals) and natural resources. Resources are measured as flows of services per year. Needs, in the right part of the scale, for our purposes here, can be classified into three types (Type 1, 2, and 3) according to the necessity satisfied with the consumption of products and services. This classification provides, I believe, a simple but holistic conceptual framework for the demand side of the economy which also helps consider negative externalities and overconsumption. Metaphorically, T1 consumption can be seen to represent the 'health of nations' while T2 and T3 can be seen to represent the 'illth of nations' (Daly, 2019; Merz et al., 2023).

Figure 3. Types of resources and types of consumption



Note: The graph provides a simple classification of resources and needs. Negative externalities are the environmental impacts (e.g. pollution) created by production or consumption but not borne by the producer or consumer responsible for their creation thus not reflected in market prices. Examples of the three types of consumption are provided in Figure 4.

T1. Reasonable consumption: what is necessary for a 'good life'. This type of consumption includes food, shelter and also development and maintenance of infrastructure (roads, schools, hospitals, machinery, networks of utilities, etc.) in good working condition. These needs are also called 'basic' or 'essential' needs (Haddad and Solomon, 2023). This type of consumption represents technically efficient transformation of resources into output and eventually into what we define as a good life. Production is technically efficient if a given amount of output (or wellbeing) is produced with the lowest possible amounts of inputs (resources). If production is not technically efficient, then some resources are wasted, thus some part of the volume of consumption falls within T2 consumption, see below. Reasonable consumption cannot be zero; its size depends on the per person consumption that humanity believes is acceptable, the size of the global population (as, by definition, per capita consumption equals global consumption divided by the population), and the available technology for transformation of resources (into output) into wellbeing.[14]

T2. Excess (wasteful) consumption: using more resources than needed to satisfy a given need, or producing less than maximum output with given resources. This type of consumption reflects inefficient use of global resources, i.e., wasted resources. It could be zero, but this depends on how humanity defines 'reasonable' and 'excess', how it defines the 'good life', and also on the availability of technology to all producers so that they can indeed be efficient producers. Consumption of goods and services that does not increase well-being belongs here. Goods that cannot be produced for all at the quantity enjoyed by a few, owing to their prohibitively high resource requirements and the degradation of nature they will

14 For an interesting discussion on the efficiency of this transformation see Hickel and Sullivan, 2024.

cause if they are to be universally scaled, could be included in this category (they could be called 'elitist goods').[15]

T3. Negative externality-induced consumption: resource consumption used to deal with (prevent, manage, mitigate, or offset) the negative externalities created by how we produce and consume. By definition, the market prices of goods incurring negative externalities do not reflect their full cost to society; thus individuals, societies, and governments bear these costs either concurrently or at a later stage. Market prices usually reflect only private (internal) costs to the producer or consumer, and not the (external) costs to the whole society. Taxes applied to such goods aim to make producers or consumers assume ('internalise') these external costs.

Indicative examples of the three consumption types are provided in Figure 3. Generally speaking, T3 consumption represents 'symptom-level' interventions, or an expanded version of what has been described as 'disease care' in Campbell

15 I refrain from describing those as 'luxury goods', as the latter are defined based on individuals' income elasticity of demand and not on the availability of resources to produce these versions for the global population without considerably increasing the environmental impact of production. It is reasonable to expect that the global economy has the resources (materials, human capital, factories, energy, ecosystem services) to replace many types of 'non-luxury' items produced annually with luxury ones (e.g. replace all non-designer apparel items with designer ones), without considerably degrading the state of the planet. And there might be better versions of necessities, not considered luxuries by people, which, if produced for all, might not increase resource use nor the impacts of the product category. But for some goods (luxuries or necessities regardless) it is unreasonable to expect that the global economy has the required resources to scale production for all without creating considerable additional harm to the planet. One example is the composite good named 'lifestyle of the richest 10%'; it cannot be scaled for all without causing considerable additional harm to the environment (see Tian et al 2024); in this sense, living like the top 10% can be described as elitist, as it cannot be consumed by all at the level consumed by the 10%, thus essentially precluding others from living it. Other examples of elitist goods could be organic meat, milk and eggs, and wild-caught fish; air travel for non-essential purposes; excessive housing, hotels in exclusive natural settings, yacht vacations, etc. These are for sure luxury goods for some; but, for others, they may be necessities. What is important is that they are impossible to produce for all at the quantity consumed by the 'elite' consumers with the existing resources (or without further harming the environment to create the amount of resources needed). To convey this impossibility of global scaling along with the inherent injustice that this consumption creates, I use the term 'elitist goods'; of course, alternative terms such as 'unsustainable-at-scale goods' or 'resource-prohibitive goods' might more aptly describe the same concept.

and Disla (2020). The disease is the production and consumption pattern of the global economy (Merz et al., 2023), which for one euro of additional private benefit may incur costs (including environmental, human health, societal costs) exceeding one euro. This kind of consumption should be minimal. It cannot be zero with today's technology, as almost any type and level of consumption creates negative impacts. It could be minimal, though, at the level corresponding to a global production mix that supports T1 consumption with the least negative impacts. For example, a diet change towards plant-rich diets with minimally processed foods will reduce both the resources needed for food production (agricultural land, fertilisers, usable energy, etc.) and the resources needed for the treatment of the inadvertent side-effects of food production and consumption (climate change, pollution, nitrogen runoff, diabetes, heart diseases, zoonotic diseases, etc.).[16] It will also reduce the resources needed for providing health care during natural disasters (Rifkin, 2023). As summarised by the WHO,

> What we eat and drink has an impact on both our health and the climate. This is because the production of food can lead to greenhouse gas emissions; this is referred to as the climate footprint of food. Meat, especially beef and lamb, has a high climate impact. Overall, a diet that is predominantly plant based and low in salt, saturated fats and added sugars is recommended as part of a healthy lifestyle. Such diets are widely associated with a lower risk of premature mortality and offer protection against NCDs. (WHO, 2022)

16 Plant based diets consistently feature among the changes that need to be done if food security and poverty elimination is to be sustainably achieved for the projected population in 2050 and beyond, see e.g. Gerten et al., 2020; Hickel and Sullivan, 2024. Gerten et al., 2020 quantify the necessary reduction of animal products in protein calorie terms instead of total animal calorie terms, among other major changes that should be made in production. Using FAO data, I calculate that their suggestion of 3.125% of total calories from animal protein represents a global 40% reduction compared to what is consumed today. The necessary reductions range from 33% for Asia to over 60% for North America, Europe, and Australia and New Zealand. Africa is the only continent below this figure by 30% (see Supplementary Table 1).

Figure 4. Examples of the three types of consumption that use resources

T1 - reasonable consumption (for a "good life")
• food, shelter, insurance, transportation, etc.
• provision of public goods (education, health care, urban planning, etc.)
• maintenance of public and private infrastructure (schools, hospitals, roads, housing, machinery, knowledge, etc.)
• treatment of negative externalities of reasonable consumption and associated research
T2 - wasteful (excess) consumption
• consumption as a public display of wealth (conspicuous consumption)
• "elitist" goods (e.g. free-range/organic meat/eggs/milk/fish) - see footnote
• devices or apparel designed to be non-repairable or have a short life (planned obsolescence)
• technically inefficient (wasteful) production (including use of virgin plastic, aluminum, fibers, and other recyclable materials)
• wasted food by households, food losses in production that could be avoided with current technology
• bringing water to boiling temperature without the pot lid on; using conventional pots instead of pressure cookers; consuming gasoline in idling mode
• overcooling spaces (setting temperatures below comfortable levels), cooling unoccupied rooms, or running A/C units with open windows or poor insulation
• most single-use plastic items; many cosmetics and personal care products
• some gifts; some collections (watches, jewellery, cars, houses, etc.); potlatches
• consumption of excess calories (more than needed for optimal health)
• unneeded or ineffective dietary supplements and medical procedures
• trashing usable items of footware, clothing, cosmetics, homeware, hardware
• corruption, bribes, wars, conflicts, defense, lobbying for harmful production/consumption paradigms
• research for marketing wasteful consumption; marketing of wasteful consumption
T3 - negative externality-induced consumption
• rebuilding infrastructure destroyed by climate change-induced natural disasters
• building more expensive infrastructure (including health systems) to enhance resilience to climate change impacts
• medications, equipment, and treatments for NCDs and zoonoses
• treatment of infertility and other diseases caused by exposure to environmental chemicals
• carbon capture and storage plants
• contraptions to remove plastics from the oceans; beach cleaning initiatives
• research on the treatment of negative externalities of T2 (e.g. smoking, NCDs) but also T3 consumption
• research on alternatives to harmful products (e.g. for BPA replacements)

Created with Datawrapper

Notes: The examples are indicative and are given to provide a starting point for discussion. The list reflects the author's personal ideas rather than definitive facts. What should be classified into each category is an issue open to discussion and research. Download link: https://www.datawrapper.de/_/8WNUg/?v=3

A note on technology and technological progress

Some global resources are used in research aiming to create new knowledge and/or embed knowledge into new resources, products, services, and/or production processes or even invent new markets (e.g. the market for children's cosmetics and make-up products). All these 'new' or 'improved' elements of

the economy can be accommodated under the umbrella term of 'technological progress'. Since prehistoric times, technological progress has helped increase the productivity of resources and create new ones, thereby helping to reduce the amount of resources needed for all types of consumption. Nevertheless, despite scientific progress and technological change, it seems we have achieved neither a good life for every person on this planet, nor a no-impacts global production, nor a perfectly circular global production that only feeds on recycled materials. In fact, we are planets apart from these three goals.

Technological progress is the outcome of a research process, itself using resource services, and producing waste and other negative externalities (Tomlinson et al., 2024). Research serving Type 2 consumption may well represent wasteful consumption to some degree, depending on whether humanity believes that the objective served by this research is worth the (real opportunity) cost of not using the same resource services to cover basic (T1) needs. Research on children's makeup or on creating hyper-palatable foods and advertising them to children, or aiming to improve performance of wasteful products (e.g. for heatproof plastic linings for paper single-use cups) arguably resembles more to wasteful consumption than socially meaningful, essential-needs consumption of resources.

Regardless of what humanity believes constitutes wasteful consumption, some research is exclusively carried out to treat the negative externalities of consumption and production (Type 3 consumption). A few examples appear in Figure 4. If the negative externalities of consumption and production (emissions of greenhouse gases, the use of plastics and harmful chemicals, the existence of NCDs, etc.) are to any degree avoidable, then research to 'treat' their negative effects is also avoidable to some degree. Ideally, technological progress could lead to absolute decoupling i.e., an increase in production and wellbeing would happen together with a decrease in associated negative impacts – but evidence indicates it does not (Bithas and Kalimeris, 2022).

It follows that there are two benefits in the avoidance of these two types (T2 and T3) of research:

- First, fewer resources will be needed for a given level of wellbeing. Thus, humanity could live equally well by using fewer resources, or could increase the well-being of its members with the same quantity

of resources. Currently, humanity both uses resources for research related to T2 consumption and for research on problems related to negative externalities (e.g. NCDs, climate change); it would make more sense to use the same research resources to minimise wasteful consumption and negative externalities in the first place.

- Secondly, the negative externalities to the environment and health generated by this research itself can be avoided. The research process *per se* may create negative externalities, the effects of which are difficult to quantify or even know. For example, many new chemicals for T2 and T3 uses (e.g. single-use objects, BPA replacements) are being created and disposed into the environment for research purposes – we may never know how they affect human or planetary health, especially if they do not make it into mass production.

The severity of ecological problems that humanity faces today can be seen as a manifestation of technological change that has been too weak and/or too unfocused to bring outcomes meaningful for sustainable human welfare. As mentioned above, the global economy has entered into ecological overshoot since 1970 (Dworatzek et al., 2024). At the same time, technological progress has enabled a feeble increase in global biocapacity (i.e., in resources). As mentioned above, between 1961 and 2023 global biocapacity (the resources part) has increased by a mere 22%; but the global annual ecological footprint (the needs part) has increased by 195%. Had technological change been properly focused, the increase in global biocapacity would have counteracted the increased impact of economic activity on nature, and the global economy would not be in overshoot. Similar reasoning can be applied to planetary boundaries. Therefore, even though technological progress is considered by many as a panacea to humanity's ills (see Rees 2023), the extent of its potential should be judged by whether it helps the resources vs needs balance to tilt towards the left. So far, it has not.

Treating resource scarcity with (consumption and production) medicine

The literature on planetary sustainability points to an ailing consumption and production pattern of the global economy. It can be (and has been) fairly said that the current global 'lifestyle' is unsustainable and that the goals of sustainability and good life under the business-as-usual scenario are in conflict.

In this context, there seems to be an untapped potential of medicine towards both these two goals which has recently come to be acknowledged (Hughes, 2024). Most medical specialties (cardiology, endocrinology, oncology, gastroenterology, geriatrics, etc.) have a preventive component alongside the other two (medication and procedures). However, prevention and reversal of disease remain largely neglected in medical practice, primarily due to inadequate nutrition education for doctors and misaligned incentive structures that favour treatment over prevention (Devries et al., 2014, 2017)[17]. A recently established specialty, Lifestyle Medicine, which can be administered by almost all specialties, stands out as the sole specialty that actively promotes reversal, rather than management, of disease (Lippman et al., 2024).[18]

The diseases and conditions that can be prevented or reversed by preventive and reversive medicine (PRM henceforth) are both diseases associated with poverty (infectious diseases, maternal and infant diseases) and diseases that are usually associated with rising incomes, as are usually the non-communicable diseases (NCDs). The latter are also called 'lifestyle diseases', 'Western diseases', or 'diseases of affluence' (Campbell et al., 1992); they are chronic and degenerative, are usually considered non-reversible, and their occurrence is rising: in 2050 among the ten major causes of healthy life years (or Disability-Adjusted Life Years (DALYs)) lost, the eight will be from NCDs (vs only three in the top ten in 1990, see Figure 5). Importantly, PRM can also prevent infectious diseases and improve the outcomes of their treatment (Rahmati et al., 2023; Papadaki et al., 2024). Similarly, PRM can also speed recovery from injuries and surgeries.

17 It is interesting that while Medicare covers participation in an 'intensive cardiac rehabilitation programme' aimed to reverse heart disease since 2010 (Centers for Medicare & Medicaid Services (cms.gov), 2010), this option has not yet become the standard mode of 'treatment' in the US.

18 The history of lifestyle medicine dates back to ancient years, but its modern form as an official medical specialty is quite recent. In the US, Lifestyle Medicine (LM) is 'a medical specialty that uses therapeutic lifestyle interventions as a primary modality to treat chronic conditions including, but not limited to, cardiovascular diseases, type 2 diabetes, and obesity. LM-certified clinicians are trained to apply evidence-based, whole-person, prescriptive lifestyle change to treat and, when used intensively, *often reverse* such conditions. Applying the six pillars of lifestyle medicine – a whole-food, plant-predominant eating pattern, physical activity, restorative sleep, stress management, avoidance of risky substances and positive social connections – also provides *effective prevention* for these conditions' (emphasis added).

As will be elaborated below, preventive and reversive medicine has a unique potential to positively affect both sides of the scarcity balance: (a) resource availability and (b) humanity's needs for resources, especially (but not exclusively) the ones used for reasonable consumption and externality-induced consumption. The main pathway through which PRM reduces resource scarcity is through voluntary changes in the preferences and then consumption basket of individuals, especially regarding food (Campbell, 2021), which increase the health and wellbeing of individuals but are also socially beneficial locally and globally (Pseiridis, 2012; WHO, 2022; Becker and Fanzo, 2023). Table 1 provides a summary.

Table 1. The effects of preventive and reversive medicine (PRM) on the determinants of economic scarcity (resources and needs)

Availability of resources: PRM increases resource quantity and quality	**Demands on resources: PRM reduces needs**
Effect of PRM on Human Capital: Healthier children miss fewer schooling days and grow up as healthier and more productive adults (WHO, 2021; O'Donnell, 2024). Healthier working age people miss fewer workdays (fewer DALYs lost) and while at work they can be undistracted by physical discomfort or disability (Stephens and Toohey, 2018; Springmann et al., 2018; Tan et al., 2022; Rojanasarot et al., 2023; Glick et al., 2023; O'Donnell, 2024; Pinna Pintor et al., 2024; Golombek et al., 2025, 2025). A healthier elderly population is more productive, offering care and mentoring services for the young, household work, emotional support, etc., and even if this work is not counted in the official GDP, it increases the labour participation and productivity of their family members.	**Effect of PRM on Reasonable Consumption (T1)** Fewer resources would be needed for reasonable consumption – mainly for food, transport, healthcare unrelated to negative externalities (Springmann et al., 2018, 2021; Springmann, 2020, 2024; Musicus et al., 2022). Hence a smaller part of resources needs to be used for healthcare, long-term care, and related medical research. **Effect of PRM on excess consumption (T2)** A healthy diet minimizes the need for (effective and ineffective) nutritional supplements (see e.g. Abdelhamid et al. 2020). **Effect of PRM on consumption induced by negative externalities (T3)** Healthier behaviours tend to create fewer negative impacts on both individual health and the environment (Springmann et al., 2018).

On the other hand, a larger timespan lived in frail health drains financial and emotional resources out of families and the economic system and reduces the accounted productivity of those caring for the elderly, especially of female family members who are typically (and informally) burdened with their care (Swinkels et al., 2019; Xiong et al., 2020).[19] **Effect of PRM on the Environment:** Healthier behaviours tend to be less resource intensive (Behrens et al., 2017; Musicus et al., 2022). Healthier behaviours reduce environmental impacts and this in turn reduces the loss of non-human resources (soil fertility, buildings, roads, etc.) incurred by them.	**(a) Health:** Healthier behaviours (especially whole food plant based diets) result in less disease and disability (2018 Physical Activity Guidelines Advisory Committee, 2018; Campbell, 2021; Springmann, 2024). A healthier workforce and a healthier aging require fewer visits, medications, procedures, hospitalisations, research funding, and long-term care (Scarborough et al., 2011; Hallström et al., 2017; Bodai et al., 2018; Morton, 2018; Li et al., 2020; Edington et al., 2020; Livingston et al., 2021; Ahmann et al., 2024). PRM increases the ratio of life years lived in good health (Li et al., 2020) and thus reduces the timespan that health care and long-term care related to aging is needed. Healthier diets reduce the risk of new zoonoses and pandemics (UNEP and ILRI, 2020). **(b) Environment:** Healthier behaviours (especially whole food plant based diets) create fewer negative environmental impacts such as climate change, pollution, ocean acidification, water and soil contamination, sea level rise, etc. (Springmann et al., 2016, 2018; Brand et al., 2021; Li et al., 2024; Conrad et al., 2024; Springmann, 2024) thus require fewer resources for the management of these impacts.

19 PRM helps decrease the health cost of aging and reduce the excess demand for formal and informal long-term care. This is especially important in economies with aging populations in which the public cost of health care and official long-term care as a percentage of GDP is expected to rise (European Commission, 2024; Nektarios et al. 2025).

Bottom line	**Bottom line**
A healthier population (ceteris paribus) is tantamount to increased quantity and quality of human and non-human resources.	A healthier population (ceteris paribus) needs fewer resources to cover its needs.

Notes: The table presents information about available and required quantities of resource services, assuming today's technology. The monetary savings (e.g. reduction of the private and public health care costs) arising from the application of PRM are not the focus of this paper, but are briefly discussed in the concluding section. Ceteris paribus: all other things constant. Human capital can be seen as the ability of humans to be productive due to their knowledge, experience, skills, and health.

PRM versus taxes for the common good 'health'

The literature on shifting toward socially beneficial consumption behaviours advocates the adjustment of market prices through taxation, so that they convey clearer signals to consumers and businesses. Taxes have been effectively used for years for tobacco (Yurekli et al., 2016; Delipalla et al., 2022); they can be used to correct market prices for foods, too (Mozaffarian et al., 2014; Springmann et al., 2018; Springmann and Freund, 2022).[20]

Taxes may be effective, but need careful planning to bring permanent changes in the behaviour of consumers and producers (Wright et al., 2017; Burton et al., 2024; Banerjee, 2025). They may also exacerbate inequalities if they are applied on essential goods (Fremstad and Paul, 2019). Generally, taxes work by making the previous consumption bundle of an individual more expensive. Following a tax, cheaper items may be substituted for expensive items in a person's bundle. This change in behaviour does not necessarily reflect a change in preferences, i.e., in what the person finds desirable. If a person's income increases, they may revert to their previous consumption level. Taxes may also meet opposition by the public and incumbent companies on the grounds of personal freedom that is reduced by taxes. This opposition can be weakened by investing in public

20 There are a few, if any, examples of taxes aiming for the wider adoption of a whole-food, predominantly plant-based diet.

awareness: governments have in many instances stepped up to reduce the consumption of goods or promote behaviours that are deemed undesirable for the common good (e.g. infant formula feeding, smoking, unprotected sex, drunk driving) when market forces cannot deliver socially desirable results. Therefore, under proper information, the public can be made aware that some personal choices burden financially all taxpayers and that the less fortunate should also have the personal freedom to live a good life, but do not, because the personal freedom of some intensifies resource scarcity and raises the price of the 'good life'.

Fortunately, PRM can bring permanent changes in consumer preferences without the practical and political problems of taxation. Incumbent producers have no choice but to respond to a (PRM-induced) redefined expression of personal freedom of consumers by altering their product mix or line of business; thus, the transition to a different lifestyle may not be as difficult as it seems, see below.

Further, the application of PRM does not exacerbate inequalities but rather reduces them as it makes a healthy life – an essential good – more affordable. In terms of DALYs (i.e., years of full health lost due to death, disability, or ill health), low-income countries, despite a lower prevalence of NCDs, face a larger total burden of disease than rich countries (see Figure 6) on top of few per capita resources. The use of PRM can help low-income countries make better use of their scarce resources and prevent the rising NCD prevalence that comes with increasing incomes.

Preventive and reversive medicine can also reduce unequal health outcomes that are nurtured by gender and other types of discrimination. For example, females are more exposed to cleaning chemicals than males, either as professional cleaners or as own-house cleaners, as they spend more time on housework than males. The dietary component of PRM can help minimise the exposure to dangerous chemicals and also protect from the adverse effects of chemicals.[21] Further, as NCDs often require care work which is mostly provided by (unpaid) female family members (Swinkels et al., 2019; Xiong et al., 2020), the decrease in NCD prevalence and severity that is achieved by PRM will help reduce this unequal burden, too.

21 I am grateful to Eleni Prifti for pointing this out.

In sum, PRM may be the most efficient and cost-effective use of medical knowledge to reduce the years lived with disease and disability and the environmental impacts of production and consumption at the same time. Its beneficial effects come mainly through the change in the current food consumption paradigm, which is responsible for a large part of humanity's negative environmental impacts and for a considerable part of the resource use (and monetary cost) of NCDs. Therefore, PRM can be seen as a tool (or as a readily available technology) enhancing the ability of the global economic system to provide a good life to all without an increase in the scale of global production. In a sense, PRM could be the *sine qua non* technology to genuinely decouple human flourishing from environmental degradation.

The transition to an economy of real 'health care' may not be as difficult as it might seem

There is a widespread belief that if demand for a sector's output declines, then this will reduce the earnings of those (employees, business owners, and shareholders) remunerated by this sector. This is far from true: following a short period of disequilibrium created by reduced demand, a new equilibrium occurs where the resources (including human capital) that have been made redundant will soon find themselves earning similar real incomes in the same or another sector. In fact, this re-equilibration process is rather the norm: the economy is always in a constant process of 'creative destruction' spurred by never-ending innovations, as described by Schumpeter (1943). The application of PRM will be one of innumerable innovations that have spurred a round of creative destruction in the economy (e.g. personal computers, digital photography, unleaded gasoline). Maybe a difference with other innovations will be that the innovation introduced with PRM is essentially available for use to all, safe, affordable and beneficial to the whole society and the environment; and it also helps increase the wellbeing enjoyed on the same or even reduced income and quantity of resources.

During this process of re-equilibration, the medical system will continue providing medical services – but more emphasis will be given to prevention rather than management of disease; researchers investigating novel chemicals may find themselves researching ways to undo the negative effects of novel chemicals that have been produced so far; researchers investigating medications for NCDs and supplements may investigate medications for other diseases (for sure, there is no scarcity of under-serviced diseases); behavioural researchers who work on

creating addictive unhealthy foods may work on educating the public and enabling the permanent adoption of healthier lifestyles; advertisers may use their skill to advertise healthier behaviours, whole plant foods, and PRM-compatible products instead of the consumption of unhealthy foods, resource-intensive foods, or products that increase chemical exposures; workers in the animal agriculture sector will find themselves employed in the plant foods sectors; restaurants may transform their menu, and so on. It can be argued that there will be no actual losers from the adoption of PRM principles and a lower-resource-use economy in the long-term as the cost of the 'good life' will correspond to lower work effort than today.

The pressures from industry, politicians and even academia and international organisations supposedly serving the greater good to maintain the current state of affairs has always been strong (Campbell and Disla, 2020; Behrens and Hayek, 2024), but the financial benefits (avoided expenditures and/or tax revenues) to society from the application of PRM are so large that those involved in declining sectors or lines of business could be compensated for their temporary losses and still the net benefit to society would be positive (Broeks et al., 2020). This means that the enablers (medical doctors, public health professionals, hospitals, NGOs, schools, municipalities, etc.) could also be financially rewarded with part of the benefits so that more enablers join. A proper mix of incentives (taxes, subsidies, and rewards) could bring about a large self-financed positive change. Thus, sharing the benefits with the temporary losers and the enablers is a necessary part of the change as it could create a virtuous circle of acceptance and promotion of a new, socially beneficial, paradigm of consumption and production.

Concluding remarks: preventive and reversive medicine as 'consumption and production medicine'

We live in a resource-scarce world. Resource scarcity is continuously enlarged by the increasing per capita consumption of an increasing population, and the way that the economy uses its scarce resources. The current production and consumption paradigm seems unable to provide good lives for all currently; and it is highly doubtful whether all can achieve good lives without further jeopardising the environment and the future of humanity.

This paper attempted to provide a simple conceptual framework about the potential of preventive and reversive medicine (PRM) to affect both the

resource side of the economy and the production/consumption side: in short, PRM can (a) augment the resource base of the global economy and (b) change consumption behaviours and the global production composition in a meaningful (for wellbeing) and sustainable way. In a way, PRM can be seen as a 'sustainability technology' that is readily available. There are, however, a few other benefits worth a brief mention.

First, PRM is also important in managing the consequences of the increasing average age of the global population: PRM can allow more productive, active, gracious and dignified aging by increasing the years lived in good health. This will benefit the tax and pension systems as elderly can be productive and/or remain at work if they wish; it will also benefit families who are struggling with the burden of care for their sick elderly which leaves less time and fewer other resources for them and their young.

Secondly, besides the obvious wellbeing benefits accruing to individuals treated with PRM versus the alternative route of just managing NCDs, the resource savings due to PRM allow more leeway for achieving 'a good life' for all members of the global population – especially low-income countries and communities facing financing gaps in the provision of basic health services. Thus, humanity can distance itself from making the 'good life' an elitist good obtainable by only the few who can afford the management-focused treatment of NCDs be they in high-income countries or in lower-income ones.

All is not rosy, though. While potential resource savings achieved through PRM may be considerable, the associated monetary savings could be used to increase the consumption of goods with higher environmental impacts (what is described as the 'rebound effect' (Polimeni et al., 2008)). Therefore, the application of PRM should be complemented with price motives. If prices reflect the full cost or benefit to society, consumers can be enabled into more sustainable choices. Like any concerned citizen, health professionals and policymakers should promote and support appropriate taxes and subsidies on goods and behaviours (and also regulatory frameworks) that actually decrease total resource use in the economy.

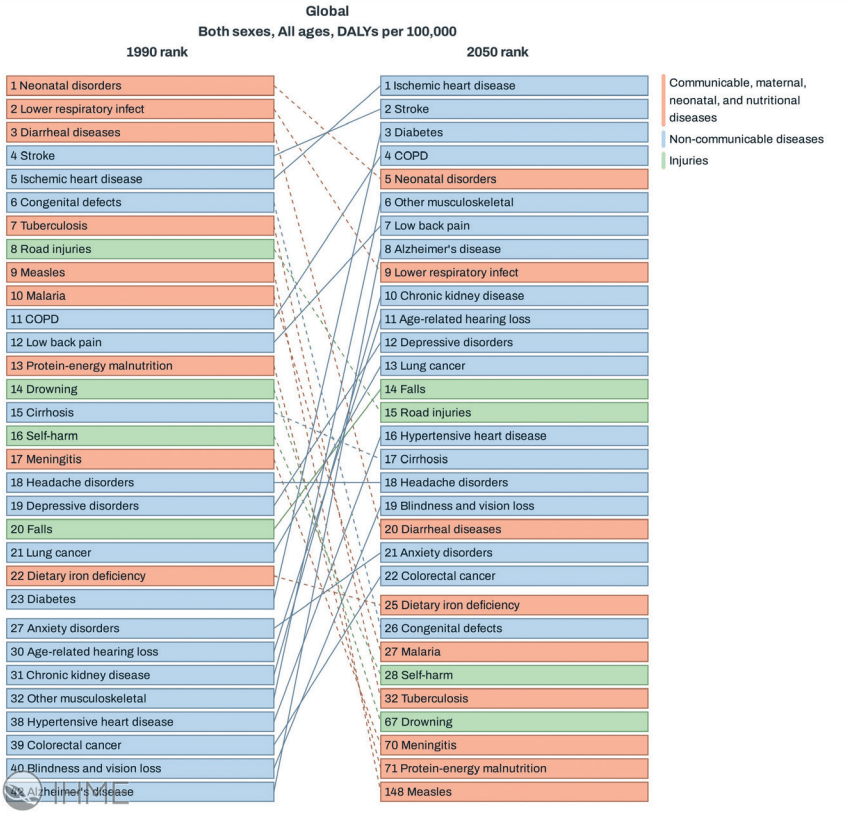
In summary, medicine focused at prevention and reversal, used in clinical practice or in public health settings, is in a unique position to help transform the

consumption pattern, the associated production pattern, and the values of society to their most sustainable (low-resource use and low-impact) versions. Therefore, it is time to view preventive and reversive medicine (PRM) as the 'Consumption and Production Medicine' that humanity needs, and administer it in mega doses to humans, governments, and institutions.

> I will apply dietetic [i.e., consumption and production] measures for the benefit of the sick according to my ability and judgment; I will keep them from **harm and injustice**.
>
> *Excerpt from Hippocratic oath, ~400 BCE. (text in brackets and emphasis added)*

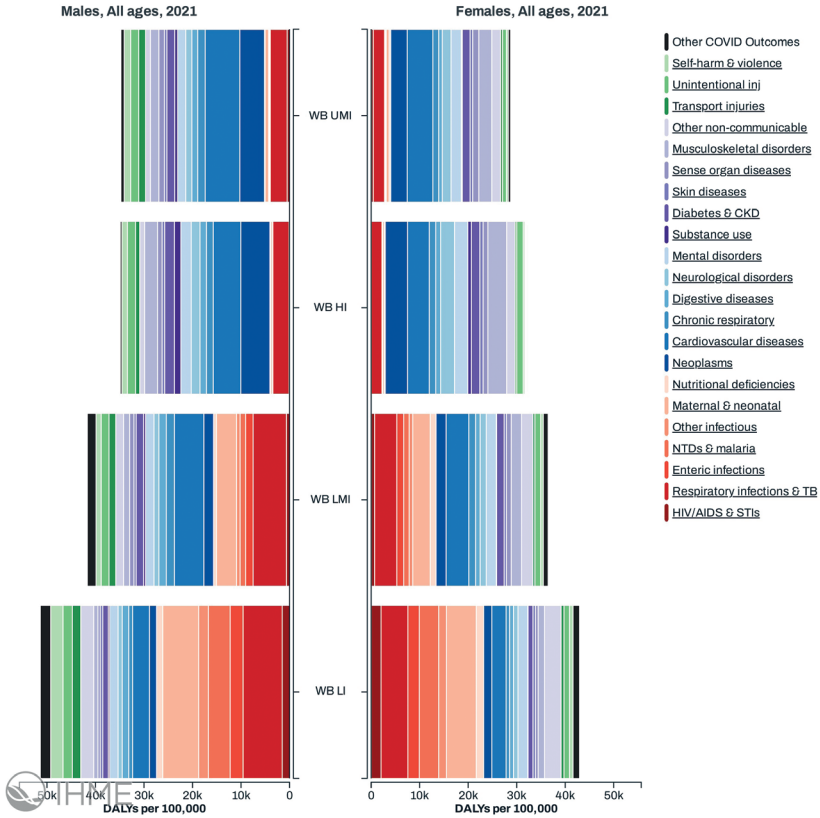
Appendix: supplementary graphs and tables

Figure 5. Projections for 2050 for main causes of DALYs lost per 100,000, all ages



Note: Figure created by author with the IHME GBD Foresight Visualization tool (https://vizhub.healthdata.org/gbd-foresight, 26 Nov. 2024).

Figure 6. DALYs lost per 100,000 by World Bank income group, all ages



Notes: Despite a lower prevalence of NCDs in low-income countries, the DALYs lost from all health causes are higher. Low-income countries have to tackle additional, albeit avoidable costs, with their limited resources. Figure created by author with the IHME GBD Compare Data tool (http://vizhub.healthdata.org/gbd-compare, 26 Nov. 2024).

Supplementary Table 1. Quantification of change in animal protein suggested by Gerten et al. using FAO Food Balances data for 2022

	Australia & New Zealand	Northern America	Europe	South America	World	Asia	Africa
Calories from all sources (FAO)	3,417	3,881	3,471	3,111	2,985	2,944	2,567
Protein from animal sources (g) (FAO)	74.0	81.9	68.1	56.3	38.1	34.3	15.5
Protein from animal sources (calories) – not provided by FAO; calculated	296.0	327.7	272.4	225.2	152.4	137.2	61.9
Calories from animal protein that should be consumed according to Gerten et al. (3.125% of total calories)	106.8	121.3	108.5	97.2	93.3	92.0	80.2
Necessary change in animal protein calories	–63.9%	–63.0%	–60.2%	–56.8%	–38.8%	–32.9%	29.6%

	Australia & New Zealand	Northern America	Europe	South America	World	Asia	Africa
Calories from animal protein as % of total calories (instead of 3.125%)	8.7%	8.4%	7.9%	7.2%	5.1%	4.7%	2.4%

Values in rows 2 and 3 are per person per day and come from FAO Food Balance Sheets for 2022, accessed 7 April 2025 (FAOSTAT, 2024). Conversion of protein grams to calories: 1 g of protein yields 4 calories. Regions listed based on last row, from largest to smallest percentage. This table does not imply that the amounts of calories per person per day are adequate or nutritious, but shows the order of magnitude of the changes in the consumption pattern that would make food supply conform to the 3.125% target set in Gerten et al. or similar ones.

Supplementary Table 2. Countries used in Graphs 1 and 2

	High income	Upper-middle income	Lower-middle income	Low income
1	Antigua and Barbuda	Albania	Angola	Afghanistan
2	Australia	Algeria	Bangladesh	Burkina Faso
3	Austria	Argentina	Benin	Burundi
4	Bahamas	Armenia	Bhutan	Central African Republic
5	Bahrain	Azerbaijan	Bolivia	Chad
6	Barbados	Belarus	Cabo Verde	Congo, Democratic Republic of

	High income	Upper-middle income	Lower-middle income	Low income
7	Belgium	Belize	Cambodia	Eritrea
8	Brunei Darussalam	Bosnia and Herzegovina	Cameroon	Ethiopia
9	Bulgaria	Botswana	Comoros	Gambia
10	Chile	Brazil	Congo	Guinea-Bissau
11	Croatia	China	Côte d'Ivoire	Korea, Democratic People's Republic of
12	Cyprus	Colombia	Djibouti	Liberia
13	Czech Republic	Costa Rica	Egypt	Madagascar
14	Denmark	Cuba	Eswatini	Malawi
15	Estonia	Dominica	Ghana	Mali
16	Finland	Dominican Republic	Guinea	Mozambique
17	France	Ecuador	Haiti	Niger
18	French Polynesia	El Salvador	Honduras	Rwanda
19	Germany	Equatorial Guinea	India	Sierra Leone
20	Greece	Fiji	Jordan	Somalia
21	Guyana	Gabon	Kenya	South Sudan
22	Hungary	Georgia	Kyrgyzstan	Syrian Arab Republic
23	Iceland	Grenada	Lao People's Democratic Republic	Togo
24	Ireland	Guatemala	Lebanon	Uganda
25	Israel	Indonesia	Lesotho	Yemen
26	Italy	Iran, Islamic Republic of	Mauritania	

	High income	Upper-middle income	Lower-middle income	Low income
27	Japan	Iraq	Morocco	
28	Korea, Republic of	Jamaica	Myanmar	
29	Kuwait	Kazakhstan	Nepal	
30	Latvia	Libyan Arab Jamahiriya	Nicaragua	
31	Lithuania	Malaysia	Nigeria	
32	Luxembourg	Mauritius	Pakistan	
33	Malta	Mexico	Papua New Guinea	
34	Netherlands	Mongolia	Philippines	
35	New Zealand	Montenegro	Samoa	
36	Norway	Namibia	Sao Tome and Principe	
37	Oman	Paraguay	Senegal	
38	Panama	Peru	Solomon Islands	
39	Poland	Republic of Moldova	Sri Lanka	
40	Portugal	Republic of North Macedonia	Tajikistan	
41	Qatar	Saint Lucia	Tanzania, United Republic of	
42	Romania	Serbia	Timor-Leste	
43	Russian Federation	South Africa	Tunisia	
44	Saudi Arabia	Suriname	Uzbekistan	
45	Singapore	Thailand	Vanuatu	
46	Slovakia	Tonga	Viet Nam	

	High income	Upper-middle income	Lower-middle income	Low income
47	Slovenia	Turkiye	Zambia	
48	Spain	Turkmenistan	Zimbabwe	
49	Sweden			
50	Switzerland			
51	Trinidad and Tobago			
52	United Arab Emirates			
53	United Kingdom			
54	United States of America			
55	Uruguay			

Acknowledgements

I would like to thank Eleni Prifti, Theodore Lianos, T. Colin Campbell, Panos Kalimeris, Asimina Christoforou, Frank Götmark, Nandita Bajaj, Stan Becker and David Samways, the Editor, for useful discussions on ideas presented here. I am also grateful to the anonymous referees for their valuable contribution in improving this paper. Errors are mine.

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10.3197/JPS.63799977346503

RESEARCH ARTICLE

Inequality in the gain in life expectancy at birth in India, 1976–2020

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Abstract

The increase in human longevity has been a factor in the increase in world population but the increase in human longevity has not been uniform across countries and within countries and this inequality is increasing, which is a matter of concern as regards sustainable development. Understanding the inequality in the increase in human longevity is important for determining appropriate health policies by providing insights into disparities in population health and mortality. This article highlights the inequality in the gain in life expectancy at birth in India in the period 1976–2020. The difference in gain in life expectancy at birth has been decomposed into gain attributed to improvement in mortality at different ages. The article calls for a decentralised approach to health policy and planning to address the challenge of differential gain in life expectancy at birth across mutually exclusive population groups within the country; and argues that a reduction of inequality in the gain in life expectancy at birth within the country may contribute to accelerating the increase in life expectancy at birth for the country, which remains low by international standards.

Keywords

Gain in life expectancy at birth, Inequality, Decomposition, Mortality, India,

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Background

The world population is estimated to have increased from around 2.5 billion in 1950 to more than eight billion in 2023 (United Nations, 2024), an increase of almost six billion over a period of seventy years. This increase in global population presents challenges for achieving development goals and ensuring sustainability. The increase in human longevity has been a factor in the increase in world population. The life expectancy at birth (LEB), the universally used indicator of human longevity, is estimated to have increased from around 46 years to more than 73 years between 1950 and 2023 (United Nations, 2024). However, this increase has not been uniform across or within countries (United Nations, 2022). Growing disparities in LEB are receiving increasing attention from the international community, as these inequalities are often unjust, beyond individual control and, in many cases, increasing. The United Nations Sustainable Development Agenda calls for healthy life and wellbeing for all at all ages (United Nations, 2015).

Different arguments have been put forward to explain differences in LEB across countries. One argument is that these differences may be due to differences in social and health policies (United Nations, 2022). Health policy can play a crucial role in controlling a wide range of diseases responsible for differences in child mortality and hence in reducing inequalities in LEB as improvements in LEB are strongly related to declines in mortality in the first five years of life. Another argument points to differences in social and economic status as a key determinant of the inequality in LEB across populations. The inequality in LEB driven by social and economic differences can also manifest through access to and use of health care services and in terms of technological innovations in medicine and preventive health (Braveman et al., 2011). The inequality in LEB by social and economic status is also different for males and females (Kinge et al., 2019; Mackenbach et al., 2019; Case and Deaton, 2021).

Within-country disparities in LEB often reflect variations in socioeconomic status across different population groups. These differences manifest in many ways including unequal access to and utilisation of health care services, and differential access to and adoption of health care innovations. The within-country inequality in LEB has an impact on the country's overall LEB since this is the weighted sum of the LEB of different population groups. Historical data

on mortality also reveal that LEB and inequality in LEB are usually negatively correlated (Fuchs and Eggleston, 2018). Directing health policy towards reduction in within-country inequality in LEB may, therefore, contribute to accelerating gain in LEB in the country.

The LEB in India remains low by international standards. The country ranked 153 in LEB among 236 countries and areas of the world for which LEB estimates have been prepared by the United Nations in 2023 (United Nations, 2024). By comparison, China ranked 77, Sri Lanka 85, Bangladesh 125 and Bhutan 168. The relatively low LEB in India vis-à-vis other countries and areas of the world has implications for both demographic transition and social and economic development of the country. According to United Nations estimates, LEB in India increased from around 41 years in 1950 to 72 years in 2023, an average annual increase of around five months per year (United Nations, 2024). On the other hand, the Registrar General and Census Commissioner of India estimates that LEB increased from around 52 years during 1976–1980 to around 70 years during 2016–2020 (Government of India, 2022). Both United Nations estimates and official estimates also suggest that the gain in LEB has been faster in females than in males. Official estimates also suggest that, on average, the length of life of an Indian increased by around 5.8 months per year between 1976–1980 and 2016–2020 with male LEB rising by 4.8 months per year and female LEB by nearly six months per year.

The low level of LEB in India is associated with a high degree of disparity or inequality in LEB within the country. Estimates of LEB for 88 mutually exclusive population groups (22 states and four mutually exclusive sub-groups in each state – rural male, rural female, urban male and urban female) in India are available through the official sample registration system for the period 2016–2020 (Government of India, 2022). These estimates suggest that LEB varies from 62.6 years in rural males in Chhattisgarh to 81 years in urban females in Himachal Pradesh (Government of India, 2022). Besides rural males in Chhattisgarh, LEB is estimated to be less than 65 years in rural males in Madhya Pradesh and Uttar Pradesh whereas it has been estimated to be more than 80 years in urban females in Jammu and Kashmir (Government of India, 2022). It is obvious that reducing the inequality in LEB within the country can contribute substantially towards hastening the pace of improvement in LEB in the country.

The inequality in LEB across population groups is the result of both initial differences in LEB across population groups and differences in the gain in LEB over time. The gain in LEB is contingent upon the initial level of LEB as the relationship between initial LEB and the gain in LEB is convex, not linear – the higher the initial LEB the slower the gain in LEB (Preston et al., 1972). At the same time, improvement in LEB has also been found to be influenced by policies that advance income, health, education, sanitation and medicine, with the effects varying over age, period, cohort, place and diversity (Oeppen and Vaupel, 2002). It is therefore crucial in any analysis of the inequality in LEB gain to distinguish between the natural slowing of LEB gains due to biological limits (ceiling effect) and slowdown resulting from policy failures, inefficient healthcare systems or inadequate health technology implementation (Cardona and Bishai, 2018).

Understanding the inequality in LEB gains across population groups is important for determining appropriate health policies and interventions that contribute to reducing the inequalities in LEB gain. An understanding of the inequality in LEB gain also provides insights into disparities in health and mortality across population groups. Gain in LEB reflects cumulative improvement in mortality in different age groups throughout the life span. The relationship between LEB gains and mortality improvements in different ages of the life span is, however, complex (Pollard, 1982). The contribution of mortality decline at various ages to overall LEB gains is not uniform; it depends on the age distribution of those improvements. When mortality reductions are more evenly distributed across the lifespan, their contribution to LEB gains is generally greater than when improvements are concentrated in specific age groups (Glei and Horiuchi, 2007). Therefore, understanding inequality in LEB gains requires analysing how mortality improvements at different ages influence overall life expectancy.

LEB is also universally recognised as an indicator of population health. Inequality in LEB gain across population groups, therefore, reflects the disparity in improvement in population health across population groups, which has implications for the health policy and for the organisation of healthcare delivery services. Understanding the inequality in LEB gains helps in targeting mortality reduction efforts to their maximum efficiency by targeting population groups with poor LEB gains, thereby accelerating improvements in population health. The World Health Organization has recommended LEB as a key indicator for

monitoring health within the framework of the Sustainable Development Goals (WHO, 2023). Improving LEB is also one of the objectives of India's National Health Policy 2017 (Government of India, 2017).

Many studies have analysed disparities in LEB in India (Chaurasia, 1992; 1993a; 1993b; 2010; 2021; 2023; Navaneetham, 1993; Subramanian et al., 2006; Asaria et al., 2019; Silva-Illanes, 2024; Yadav and Yadav, 2024; Kumari and Mohanty, 2020; Jain at al., 2022; Gupta and Sudharsan, 2022; Vyas et al., 2022; Das and Mohanty, 2024) and in other countries (Singh and Siahpush, 2014; Singh and Lee, 2021; Dwyer-Lindgren et al., 2024; Liou et al., 2020; Aksan and Chakraborty, 2023; Kinge et al., 2019; Cardona and Bishai, 2018; Salami et al., 2019; Woolf, 2024; De Ramos et al., 2022; Baker et al., 2018; Dahl et al., 2021; Fuchs and Eggleston, 2018). Most of these studies have focused on the variation in LEB relative to a range of population characteristics such as region, rural-urban, income and education. It has been observed that the age pattern of mortality varied across different regions of India (Chaurasia, 1992). Further, the relative contribution of changes in age-specific survival probabilities to changes in life expectancy at birth (LEB) has also been shown to differ across Indian states (Chaurasia, 2021). There has, however, been little effort to explore the reasons behind uneven gains in LEB within India across population groups. Such an analysis has policy and programme implications as it helps in prioritising health interventions for maximum gains in population health.

This article analyses the inequality in the gain in LEB across sixty mutually exclusive population groups in India during the period 1976–2020 for which life tables are available based on India's official sample registration system. A decomposition model has been used for the analysis which decomposes the gain in LEB in a population group into a state component, which is common to all sub-groups, a sub-group component, which is common to all states, and a residual component which is specific to the population group. The article also analyses how improvement in mortality in different ages of the life span has contributed to the gain in LEB in different population groups. The analysis shows that mortality improvement in India during 1976–2020 has largely been concentrated in younger age groups and has not been dispersed across the entire life span. The concentration of mortality improvement in selected age groups appears to be a reason for the limited impact of mortality improvement on the gain in LEB in the country. Since the inequality in the gain in LEB across population

groups reflects differences in the improvement in population health in different population groups, a decentralised approach to health policy formulation and for planning and programming for the delivery of health care services is needed for accelerated improvement in population health in the country.

The article is divided into six sections. The first section describes the method adopted for the analysis while section two describes the data source. The analysis is based on the life tables constructed using the age-specific mortality rates obtained through the official sample registration system. An overview of the variation in the gain in LEB across sixty mutually exclusive population groups for which life tables are available for the period 1976–2020 is presented in section three, while section four decomposes the variation in LEB into variation common to all population groups and variation specific to each population group. This decomposition analysis reveals that most of the disparity or the inequality in the gain in LEB across mutually exclusive population groups within India is due to the variation in the gain in LEB that is common to all population groups. Section five of the article analyses the contribution of the improvement in mortality in different ages to the gain in LEB in the whole country and in different population groups within the country. Section six decomposes the difference in the gain in LEB between two population groups into gain attributed to improvement in mortality in different ages across the life span. The final section of the article summarises the findings of the analysis and discusses their implications from the perspective of the health policy and planning and the health care system.

The Method

The population is cross classified into *r* rows or states (i=1,....,r) and c columns or mutually exclusive population sub-groups in each state (j=1,...c) so that the entire population is divided into n=rxc mutually exclusive population groups. Let e_{ij} denotes the LEB and ∇_{ij} denotes the gain in LEB in sub-group j of the geopolitical unit (state) i between time t_1 and t_2 (t_2>t_1), whereas $\nabla_{..}$ denotes the average gain in LEB across n mutually exclusive population groups. Then ∇_{ij} can be written as

$$e_{ij}^2 - e_{ij}^1 = \nabla_{ij} = \nabla_{..} \times \nabla_{i.} \times \nabla_{.j} \times \frac{\nabla_{ij}}{\nabla_{..} \times \nabla_{i.} \times \nabla_{.j}} \quad (1)$$

Here, $\nabla_{i.}$ is the average of the gain in LEB across *c* population sub-groups in the state *i*; and $\nabla_{.j}$ is the average of the gain in LEB across *r* states in population sub-group *j*. Equation (1) can be written as

$$\frac{\nabla_{ij}}{\nabla_{..}} = \frac{\nabla_{i.}}{\nabla_{..}} \times \frac{\nabla_{i.}}{\nabla_{..}} \times \frac{\left(\frac{\nabla_{ij}}{\nabla_{..}}\right)}{\left(\frac{\nabla_{i.}}{\nabla_{..}} \times \frac{\nabla_{i.}}{\nabla_{..}}\right)} \tag{2}$$

or

$$\frac{\nabla_{ij}}{\nabla_{..}} = m_{i.} \times m_{.j} \times m_{ij} \tag{3}$$

where

$$m_{i.} = \frac{\nabla_{i.}}{\nabla_{..}} \tag{4}$$

$$m_{.j} = \frac{\nabla_{i.}}{\nabla_{..}} \tag{5}$$

$$m_{ij} = \frac{\left(\frac{\nabla_{ij}}{\nabla_{..}}\right)}{\left(\frac{\nabla_{i.}}{\nabla_{..}} \times \frac{\nabla_{i.}}{\nabla_{..}}\right)} \tag{6}$$

Equation (3) can be used to decompose the difference in LEB gain in a population group relative to average gain across all population groups into two components, an average component and a population group-specific component. The average component is determined by the average of the gain in all population sub-groups in a state and is determined by the multiplier m_i, and average of the gain in all states in a population sub-group and is determined by the multiplier $m_{.j}$. The component of the gain in LEB which is specific to the population group is determined by the multiplier m_{ij}.

The disparity or the inequality in the gain in LEB across *n* mutually exclusive population groups may now be measured in terms of the Theil entropy index (Shorrocks, 1980) which is defined as:

$$I = \frac{1}{n} \sum_{i=1}^{r} \sum_{j=1}^{c} \frac{\nabla_{ij}}{\nabla_{..}} \times ln\left(\frac{\nabla_{ij}}{\nabla_{..}}\right) \tag{7}$$

Since,

$$ln\left(\frac{\nabla_{ij}}{\nabla_{..}}\right) = \ln\left(m_{i.} \times m_{.j} \times m_{ij}\right) = \ln(m_{i.}) + \ln\left(m_{.j}\right) + \ln\left(m_{ij}\right) \quad (8)$$

equation (7) can be written as

$$I = \frac{1}{n}\sum_{i=1}^{r}\sum_{j=1}^{c}\frac{\nabla_{ij}}{\nabla_{..}} \times \ln(m_{i.}) + \frac{1}{n}\sum_{i=1}^{r}\sum_{j=1}^{c}\frac{\nabla_{ij}}{\nabla_{..}} \times \ln\left(m_{.j}\right) + \frac{1}{n}\sum_{i=1}^{r}\sum_{j=1}^{c}\frac{\nabla_{ij}}{\nabla_{..}} \times \ln\left(m_{ij}\right) \quad (9)$$

or

$$I = I_r + I_c + I_{rc} \quad (10)$$

where

$$I_r = \frac{1}{n}\sum_{i=1}^{r}\sum_{j=1}^{c}\frac{\nabla_{ij}}{\nabla_{..}} \times \ln(m_{i.}) \quad (11)$$

$$I_c = \frac{1}{n}\sum_{i=1}^{r}\sum_{j=1}^{c}\frac{\nabla_{ij}}{\nabla_{..}} \times \ln\left(m_{.j}\right) \quad (12)$$

$$I_{rc} = \frac{1}{n}\sum_{i=1}^{r}\sum_{j=1}^{c}\frac{\nabla_{ij}}{\nabla_{..}} \times \ln(m_{i.}) \quad (13)$$

Equation (3) can be fitted by using the polishing technique first proposed by Tukey (1977). The polishing technique is a non-parametric method that does not require any assumption about the data. The method successively sweeps the polishing function out of rows, then sweeps the polishing function out of columns, then rows, then columns, and so on, accumulates them in 'all', 'row', and 'column' registers to obtain, respectively, values of $\nabla_{..}$, $m_{i.}$, and $m_{.j}$, and leaves behind residuals (m_{ij}). The geometric mean has been used instead of median and arithmetic mean as the polishing function in the present analysis. The median is not based on all values in the dataset whereas use of the arithmetic mean is not appropriate when it is uncertain that the underlying data are statistically normally distributed. An undesirable property of the arithmetic mean is that it implies full compensability in the sense that below average values in the data can be compensated by above average values. The use of geometric mean as the polishing function is preferred as it addresses the problems associated with median and arithmetic mean.

Let *g* denotes the geometric mean of the age-specific mortality rates *m*(x). Then the gain in *e* between two points in time t_1 and t_2 ($t_2 > t_1$) may be written as

$$e_2 - e_1 = \nabla = \frac{\nabla}{\ln(g_2/g_1)} \times \ln(g_2/g_1) = K_{21} \times \ln(g_2/g_1) \tag{14}$$

where

$$K_{21} = \frac{\nabla}{\ln(g_2/g_1)} \tag{15}$$

Or

$$\nabla = \frac{K_{21}}{n} \times \sum_{x=1}^{n} \ln\left(\frac{m_2(x)}{m_1(x)}\right) = \sum_{x=1}^{n} \frac{K_{21}}{n} \times \ln\left(\frac{m_2(x)}{m_1(x)}\right) = \sum_{x=1}^{n} \nabla(x) \tag{16}$$

$$\nabla(\mathrm{x}) = \frac{K_{21}}{n} \times \ln\left(\frac{m_2(x)}{m_1(x)}\right) \tag{17}$$

Equation (16) decomposes the gain in *e* into the gain attributed to the improvement in mortality in different ages. The difference in the gain in *e* between two populations *A* and *B*, may be decomposed as

$$\nabla^{AB} = \nabla^{A} - \nabla^{B} = \sum_{x=1}^{n} \nabla^{A}(\mathrm{x}) - \sum_{x=1}^{n} \nabla^{B}(\mathrm{x}) = \sum_{x=1}^{n} \left(\nabla^{A}(\mathrm{x}) - \nabla^{B}(\mathrm{x}) \right) \tag{18}$$

Following Kitagawa (1955), we can write

$$\nabla^{AB} = \sum_{x} \frac{(K_{21}^{A} - K_{21}^{B}) \times \left(\ln\left(\frac{m_2^{A}(x)}{m_1^{A}(x)}\right) + \ln\left(\frac{m_2^{B}(x)}{m_1^{B}(x)}\right) \right)}{2n} + \sum_{x} \frac{(K_{21}^{A} + K_{21}^{B}) \times \left(\ln\left(\frac{m_2^{A}(x)}{m_1^{A}(x)}\right) - \ln\left(\frac{m_2^{B}(x)}{m_1^{B}(x)}\right) \right)}{2n} \tag{19}$$

or

$$\nabla^{AB} = \sum_{x} \left[\frac{(K_{21}^{A} - K_{21}^{B}) \times \ln\left(m_2^{A}(x) \times m_2^{B}(x)\right)}{2n} - \frac{(K_{21}^{A} - K_{21}^{B}) \times \ln\left(m_1^{A}(x) \times m_1^{B}(x)\right)}{2n} + \frac{(K_{21}^{A} + K_{21}^{B}) \times \ln\left(\frac{m_2^{A}(x)}{m_2^{B}(x)}\right)}{2n} - \frac{(K_{21}^{A} + K_{21}^{B}) \times \ln\left(\frac{m_1^{A}(x)}{m_1^{B}(x)}\right)}{2n} \right] \tag{20}$$

Let us define

$$\beta(x) = \sqrt{m^{A}(x) \times m^{B}(x)} \tag{21}$$

$$\alpha(x) = \sqrt{\frac{m^{A}(x)}{m^{B}(x)}} \tag{22}$$

then, equation (20) reduces to

$$\nabla^{AB} = \left[\frac{1}{n}\sum_x (K_{21}^A - K_{21}^B) \times \ln\left(\frac{\beta_2(x)}{\beta_1(x)}\right)\right] + \left[\frac{1}{n}\sum_x (K_{21}^A + K_{21}^B) \times \ln\left(\frac{\alpha_2(x)}{\alpha_1(x)}\right)\right] \quad (23)$$

Equation (23) is the product-ratio decomposition formula of the difference in the gain in LEB between two populations. The two components of the difference in the gain in LEB are virtually independent of each other (Tukey, 1977). The first component on the right-hand side of the equation (23) gives the contribution of the difference in the improvement in the average mortality between the two populations, measured in terms of the geometric mean age-specific mortality rates. The second component on the right-hand side of the equation (23), on the other hand, gives the contribution of the difference in the improvement in the age-specific mortality rates in the two populations measured in terms of the ratio of the mortality improvement between the two populations. The ratio of the improvement in age-specific mortality rates between two populations is argued to be the more appropriate indicator for analysing mortality difference between two populations than the arithmetic difference of the age-specific mortality rates, as the ratio is less sensitive to the level of mortality than the arithmetic difference (Bergeron-Boucher et al., 2018). It may also be noticed that equation (23) also accounts for the difference in age-specific mortality rates between the two populations at time t_1.

Data Source

The analysis is based on the life tables constructed from the age-specific mortality rates available from the official sample registration system (SRS) of India for the period 1976–1980 and 2016–2020 (Government of India, 1985; 2022). The SRS is a large-scale demographic sample survey which is based on the dual record system (Government of India, 2022). The SRS is the only source in India that provides estimates of the age-specific mortality rates for the country and for selected states of the country separately for four mutually exclusive population groups – rural male, rural female, urban male, urban female – on an annual basis. Age-specific mortality rates available from the SRS are, however, known for year-to-year fluctuations of unknown origin. To eliminate the effect of these fluctuations, it is the standard practice to use five-years average mortality rates for the construction of the life tables. An advantage of this practice is that it also augments the sample size (Government of India, 2022).

The present analysis is confined to only those fifteen states of the country for which life tables based on age-specific mortality rates from the SRS are available for the period 1976–1980 and the period 2016–2020. Estimates of age-specific mortality rates are not available for other states and Union Territories of the country either from the SRS or from any other source. Age-specific mortality rates for three states – Andhra Pradesh, Madhya Pradesh and Uttar Pradesh – for the period 1976–1980 and 2016–2020 are, however, not strictly comparable because of changes in administrative boundaries of these states. These three states, as they existed during 1976–1980 have been divided into six states Andhra Pradesh and Telangana, Chhattisgarh and Madhya Pradesh, and Uttar Pradesh and Uttarakhand respectively during the period 2016–2020. It is, however, assumed that the difference in the age-specific mortality rates resulting from the change in the administrative boundaries of these three states is only marginal and its impact on the gain in LEB in the three states is negligible. The analysis, therefore, has been carried out for the sixty mutually exclusive population groups – fifteen states and four population sub-groups in each state – rural male, rural female, urban male, urban female.

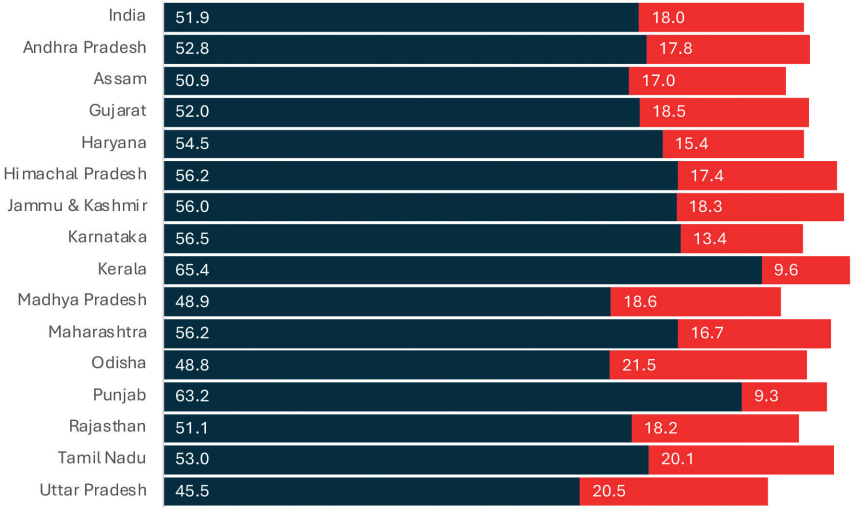
It may also be pointed out that the abridged life tables prepared by the Government of India for the period 1976–1980 are based on a different methodology from that used for the construction of life tables for the period 2016–2020 and, therefore, life tables for 1976–1980 are not comparable with life tables for 2016–2020. Moreover, age-specific death rates for the period 1976–1980 are available up to seventy years of age only whereas data for the period 2016–2020 are available up to 85 years of age. We have, therefore reconstructed the abridged life tables for the period 1976–1980 using the MORTPAK software package of mortality measurement developed and made available by the United Nations (United Nations, 2013) as the same software has been used for the construction of abridged life tables for the period 2016–2020 by the Government of India.

Gain in LEB in India 1976–2020

Table 1 presents estimates of LEB during 1976–1980 and gain in LEB during 1976–2020 in India and in its fifteen states for total population and for four mutually exclusive population sub-groups. The LEB increased by almost eighteen years in India between 1976–1980 and 2016–2020, which implies an average annual increase of less than 0.5 years per year. Among fifteen states, LEB increased by less than ten years in Punjab and Kerala but more than twenty years in Odisha, Tamil Nadu and Uttar Pradesh, with the gain being the most rapid in Odisha.

Kerala had the highest LEB during 1976–1980 while LEB was the second highest in Punjab. On the other hand, LEB was the lowest in Uttar Pradesh and the second lowest in Odisha during 1976–1980.

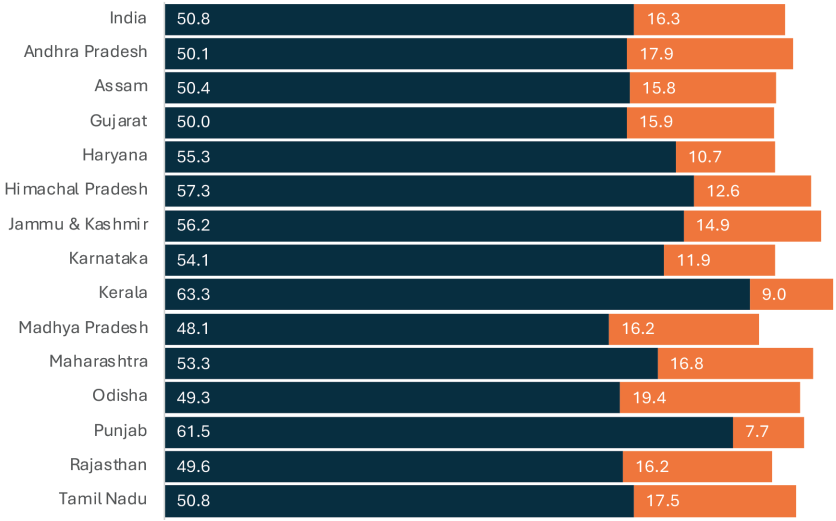
Figure 1. LEB in 1976–1980 and gain in LEB, 1976–2020 – total population



SOURCE: AUTHOR

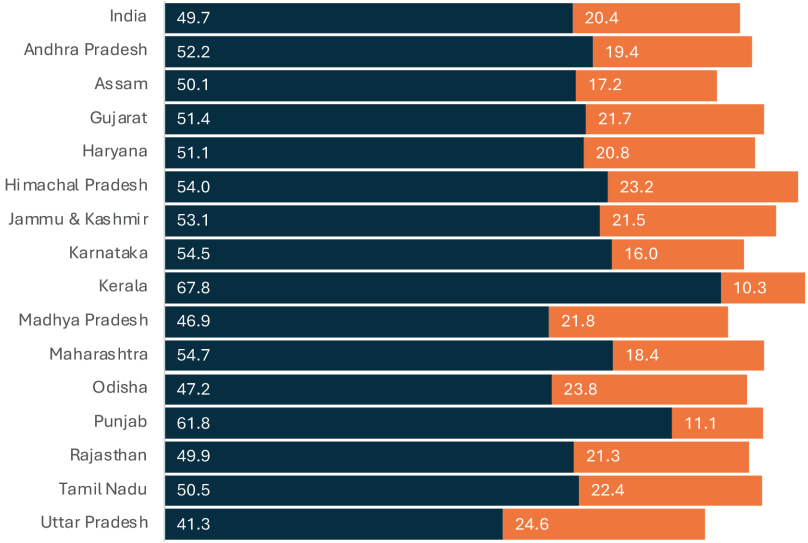
The increase in LEB has also been different in the four population sub-groups – the highest in rural females but the lowest in urban males. The LEB in urban males was almost ten years higher than that in rural females during 1976–1980. This difference reduced to less than two years during 2016–2020. The gain in LEB in urban females has been very slow in Andhra Pradesh, Assam, Karnataka and Madhya Pradesh but very fast in Haryana and Kerala. The gain in LEB in rural females has been the fastest among the four population sub-groups in thirteen of the fifteen states. There is no state where gain in LEB has been the highest in urban males among the four population sub-groups. The gain in LEB in rural females was at least twenty years in nine of the fifteen states but there is no state in which rural males equalled this gain. Similarly, there is no state where the increase in LEB in either rural males or urban males was equal to or greater than twenty years, whereas there is only one state – Haryana – in which urban females recorded an LEB gain exceeding twenty years.

Figure 2. LEB in 1976–1980 and gain in LEB, 1976–2020 – rural male



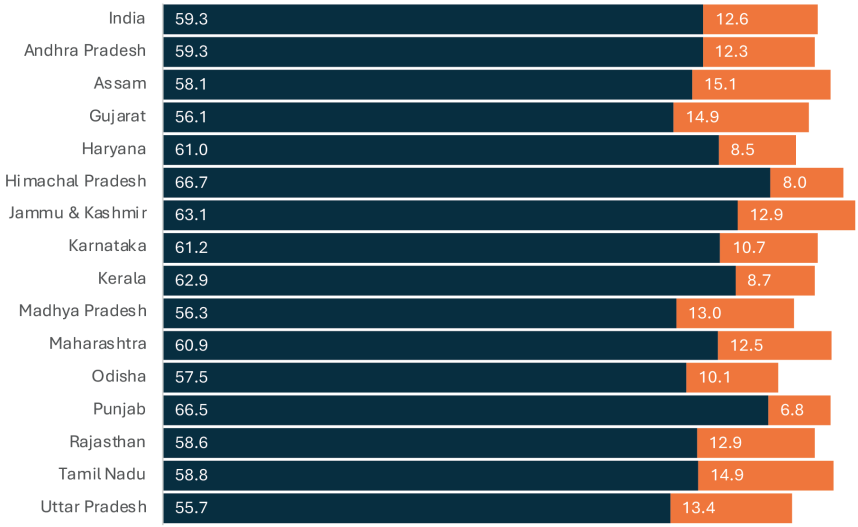
SOURCE: AUTHOR

Figure 3. LEB in 1976_1980 and gain in LEB, 1976–2020 – rural female



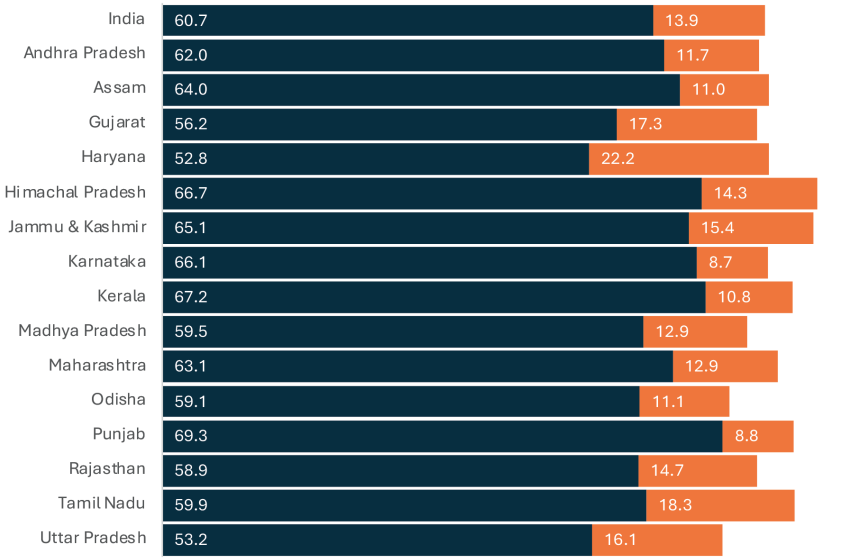
SOURCE: AUTHOR

Figure 4. LEB in 1976–1980 and gain in LEB, 1976–2020 – urban male



SOURCE: AUTHOR

Figure 5 LEB in 1976–1980 and gain in LEB, 1976–2020 – urban female

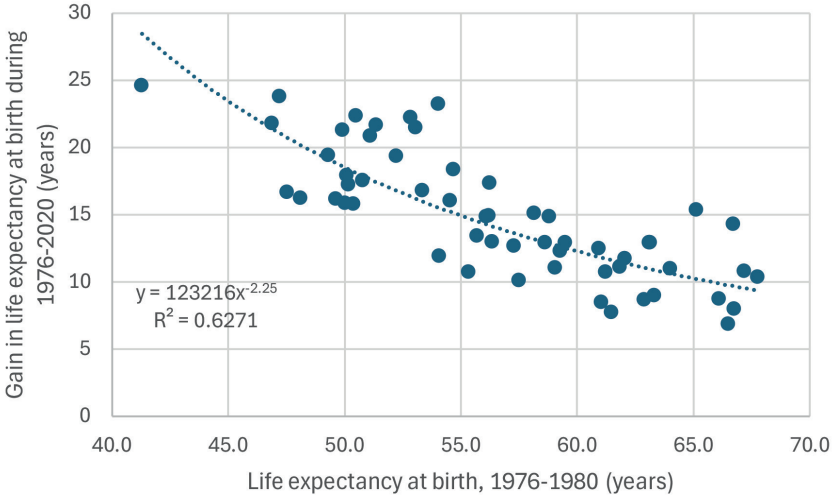


SOURCE: AUTHOR

Among the sixty mutually exclusive population groups, the gain in LEB has been the most rapid in rural females in Uttar Pradesh but the slowest in urban males in Punjab. There are eight population groups in which the gain in LEB has been less than ten years whereas in nine population groups, the gain has been at least twenty years. The within-state inequality in the gain in LEB, measured in terms of the coefficient of variation in LEB gain across four population sub-groups, has been the highest in Haryana followed by Himachal Pradesh and Odisha but the lowest in Kerala. In Haryana, LEB increased by around eight years in urban males but by more than 22 years in urban females, whereas increase in LEB in Kerala ranged between 8.7 to 10.8 years across the four population sub-groups. In many states, gain in LEB has largely been confined to specific population sub-groups only.

The gain in LEB during 1976–2020 across sixty mutually exclusive population groups appears to be associated with the level of LEB during 1976–1980 – the lower the LEB during 1976–1980 the higher the gain in LEB during 1976–2020 and vice versa – but there are notable exceptions. LEB in urban females in Jammu and Kashmir was more than 65 years during 1976–1980, while the gain in LEB has been more than fifteen years during 1976–2020. Similarly, LEB in urban females in Himachal Pradesh was 66.7 years during 1976–1980 while the gain in LEB has been more than fourteen years. LEB in rural females in Himachal Pradesh was around 54 years during 1976–1980 but the gain in LEB was more than 23 years during 1976–2020, making this group an outlier as regards gain in LEB. On the other hand, LEB in rural males in Madhya Pradesh was only around 48 years during 1976–1980 but the gain in LEB was around sixteen years during 1976–2020. Figure 1 suggests that the inequality in the gain in LEB across sixty population groups during 1976–2020 cannot be explained by the variation in LEB in these population groups during 1976–1980 alone. Other factors also appear to have contributed to the uneven distribution of LEB gains during the period 1976–1980 across sixty population groups, although initial levels of LEB have played a role in determining the extent of improvement in LEB during 1976–2020.

Figure 6. Life expectancy at birth, 1976–1980, and gain in life expectancy at birth, 1976–2020, in mutually exclusive population sub-groups in India



SOURCE: AUTHOR, BASED ON TABLE 1.

Table 1. Life expectancy at birth, 1976–1980; gain in life expectancy at birth, 1976–2020; and within-state inequality in gain in life expectancy at birth in India and states

Country/State	Life expectancy at birth 1976–80 (years)					Gain in life expectancy at birth 1976–2020 (years)					Gain inequality
	Total	Rural male	Rural female	Urban male	Urban female	Total	Rural male	Rural female	Urban male	Urban female	
India	51.9	50.8	49.7	59.3	60.7	18.0	16.3	20.4	12.6	13.9	0.189
Andhra Pradesh	52.8	50.1	52.2	59.3	62.0	17.8	17.9	19.4	12.3	11.7	0.219
Assam	50.9	50.4	50.1	58.1	64.0	17.0	15.8	17.2	15.1	11.0	0.157
Gujarat	52.0	50.0	51.4	56.1	56.2	18.5	15.9	21.7	14.9	17.3	0.149
Haryana	54.5	55.3	51.1	61.0	52.8	15.4	10.7	20.8	8.5	22.2	0.387
Himachal Pradesh	56.2	57.3	54.0	66.7	66.7	17.4	12.6	23.2	8.0	14.3	0.381
Jammu & Kashmir	56.0	56.2	53.1	63.1	65.1	18.3	14.9	21.5	12.9	15.4	0.199
Karnataka	56.5	54.1	54.5	61.2	66.1	13.4	11.9	16.0	10.7	8.7	0.225
Kerala	65.4	63.3	67.8	62.9	67.2	9.6	9.0	10.3	8.7	10.8	0.092
Madhya Pradesh	48.9	48.1	46.9	56.3	59.5	18.6	16.2	21.8	13.0	12.9	0.227
Maharashtra	56.2	53.3	54.7	60.9	63.1	16.7	16.8	18.4	12.5	12.9	0.166
Odisha	48.8	49.3	47.2	57.5	59.1	21.5	19.4	23.8	10.1	11.1	0.356
Punjab	63.2	61.5	61.8	66.5	69.3	9.3	7.7	11.1	6.8	8.8	0.186
Rajasthan	51.1	49.6	49.9	58.6	58.9	18.2	16.2	21.3	12.9	14.7	0.192
Tamil Nadu	53.0	50.8	50.5	58.8	59.9	20.1	17.5	22.4	14.9	18.3	0.147
Uttar Pradesh	45.5	47.5	41.3	55.7	53.2	20.5	16.7	24.6	13.4	16.1	0.236

SOURCE: AUTHOR

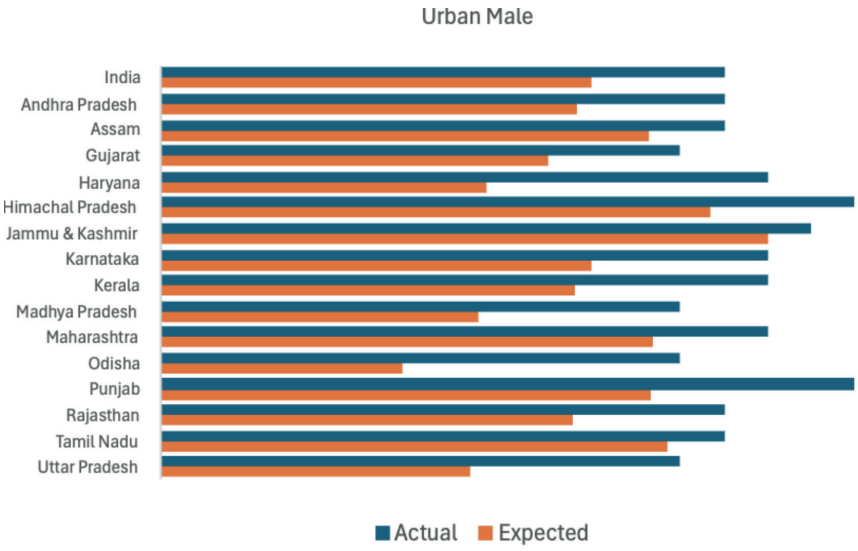
Figure 7a. Actual and expected gain in LEB in rural males

SOURCE: AUTHOR

Figure 7b. Actual and expected gain in LEB in rural females

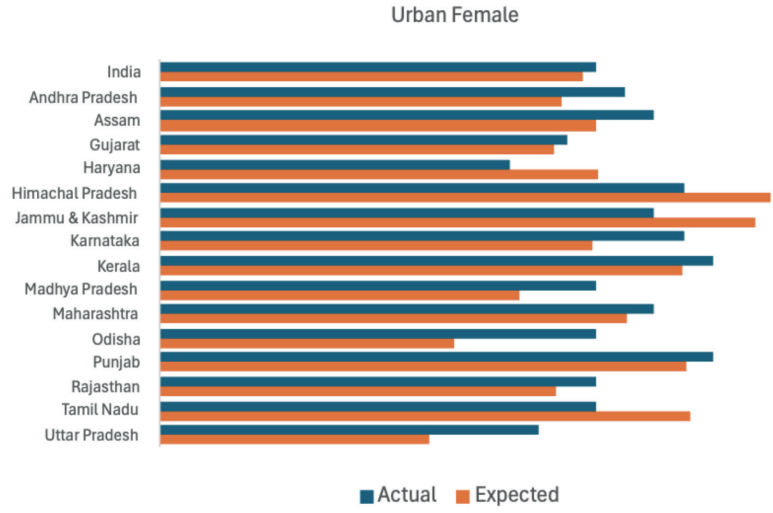
SOURCE: AUTHOR

Figure 7c. Actual and expected gain in LEB in urban males



SOURCE: AUTHOR

Figure 7d. Actual and expected gain in LEB in urban females



SOURCE: AUTHOR

Table 2. Actual and expected LEB in sixty mutually exclusive population groups within India 2016–2020

India/States	Rural male		Rural female		Urban male		Urban female	
	Expected	Actual	Expected	Actual	Expected	Actual	Expected	Actual
India	67.0	67.2	69.0	70.1	75.0	71.9	75.0	74.5
Andhra Pradesh	66.0	68.0	72.0	71.6	75.0	71.6	76.0	73.8
Assam	67.0	66.2	71.0	67.4	75.0	73.3	77.0	75.0
Gujarat	66.0	65.9	71.0	73.1	74.0	70.9	74.0	73.6
Haryana	70.0	66.1	71.0	71.9	76.0	69.5	72.0	75.1
Himachal Pradesh	71.0	69.9	73.0	77.2	78.0	74.7	78.0	81.0
Jammu & Kashmir	71.0	71.1	73.0	74.6	77.0	76.0	77.0	80.5
Karnataka	70.0	66.0	73.0	70.6	76.0	71.9	78.0	74.8
Kerala	74.0	72.3	79.0	78.1	76.0	71.5	79.0	77.9
Madhya Pradesh	64.0	64.3	67.0	68.7	74.0	69.3	75.0	72.4
Maharashtra	69.0	70.2	73.0	73.0	76.0	73.4	77.0	76.1
Odisha	66.0	68.7	67.0	71.0	74.0	67.6	75.0	70.1
Punjab	73.0	69.2	76.0	72.9	78.0	73.3	79.0	78.1
Rajasthan	66.0	65.8	69.0	71.2	75.0	71.5	75.0	73.6
Tamil Nadu	67.0	68.3	71.0	72.9	75.0	73.7	75.0	78.2
Uttar Pradesh	64.0	64.2	59.0	65.9	74.0	69.1	73.0	69.3

SOURCE: AUTHOR

The United Nations has developed model mortality improvement trajectories based on the increase in LEB in different countries of the world during the period 1950–2005 (United Nations, 2004). These model mortality improvement trajectories are expressed as annual increments in LEB at a given level of LEB in the beginning of the year but are presented as quinquennial increments labelled as very fast (VF); fast (F); medium (M); slow (S); and very slow (VS) improvement in LEB. A comparison of the gain in LEB in sixty population groups in India with the expected LEB gain based on the United Nations medium (M) mortality improvement trajectory is presented in table 2. In India, actual gain in LEB during 1976–2020 has been less than that expected under United Nations medium mortality improvement trajectory in both urban males and urban females with a substantial shortfall in urban males. In rural males and rural females, on the other hand, the actual gain in LEB has been more than the expected gain, although the difference is marginal. Similarly, the actual gain in LEB has been less than expected in 39 of the sixty mutually exclusive population groups. There is no state where actual gain in LEB in urban males has been more than the expected gain in LEB, whereas actual gain in LEB in rural females has been more than the expected gain in ten of the fifteen states. The actual gain in LEB in rural males has been more than the expected gain in LEB in seven states while actual gain in LEB in urban females has been more than expected in eleven states.

The gain in LEB in a population group can be decomposed into four factors: gain common to all sixty population groups, gain specific to the state common to all sub-groups in the state, gain specific to sub-groups common to all states and the residual gain. Table 3 presents decomposition results. The average gain in LEB across sixty population groups is around 14.2 years. The gain in LEB attributed to states and common to all sub-groups in the state ranges from -5.7 years in Punjab to 3.9 years in Tamil Nadu. Similarly, gain in LEB in different sub-groups but common to all states ranges from -3 years in urban males to 5.1 years in rural females. Finally, gain in LEB which is not explained by the common component, state component and sub-group component ranges from -3.6 years in rural males in Haryana to 8.8 years in urban females again in Haryana. In Himachal Pradesh, Karnataka, Kerala and Punjab, the state factor accounts for a loss rather than gain in LEB. Among the four sub-groups, the gain in LEB is confined to rural female only. In urban males and urban females, there is loss, not gain, in LEB, whereas there is virtually no gain in rural males. On the other hand, in 28 of the

sixty population groups, the residual component results in a loss, rather than gain in LEB. The gain in LEB determined by the grand average and the corresponding state, and sub-group effects may be perceived as the statistically normal gain in LEB for the population group. The deviation from this statistical normal may be attributed to factors that are specific to the population group.

The inequality in the gain in LEB across India's sixty mutually exclusive population groups may be attributed to three factors: inequality in the gain in LEB across states; inequality in the gain in LEB across the four mutually exclusive population sub-groups; and inequality in the residual component of the gain in LEB. The Theil entropy index, which measures the inequality in the gain in LEB relative to the expected gain in LEB, is estimated to be 0.099. This index is zero when the actual gain in LEB is the same as the expected gain in LEB in all sixty population groups and higher the inequality higher the index. Equation (10) suggests that approximately twenty per cent of the inequality in the gain in LEB across sixty population groups may be attributed to variation in the gain in LEB attributed to the residual component, while the remaining eighty per cent of the inequality is almost equally distributed between the variation in the gain in LEB across states and variation in the gain in LEB across the four mutually exclusive population sub-groups. There are twelve population groups in which the gain in LEB has been at least ten per cent higher than the expected gain in LEB due to factors specific to the population group. Similarly, there are eleven population groups in which the gain in LEB has been at least ten per cent lower than the expected gain in LEB due to factors specific to the population group. In the remaining 37 population groups, factors specific to the population group have accounted for less than ±10 per cent of the variation in the actual gain in LEB and the expected gain in LEB.

Table 3. Decomposition of the gain in LEB across sixty population groups, 1976–2020

State	Sub-group	Gain in LEB				
		Common to states and sub-groups	Specific to state	Specific to sub-group	Residual	Total
Andhra Pradesh	Rural Male	14.2	0.8	0.0	3.0	17.9
	Rural Female	14.2	0.8	5.1	-0.7	19.4
	Urban Male	14.2	0.8	-3.0	0.4	12.3
	Urban Female	14.2	0.8	-0.9	-2.3	11.7
Assam	Rural Male	14.2	0.4	0.0	1.2	15.8
	Rural Female	14.2	0.4	5.0	-2.3	17.2
	Urban Male	14.2	0.4	-3.0	3.5	15.1
	Urban Female	14.2	0.4	-0.9	-2.7	11.0
Gujarat	Rural Male	14.2	3.1	0.0	-1.3	15.9
	Rural Female	14.2	3.1	5.9	-1.4	21.7
	Urban Male	14.2	3.1	-3.5	1.1	14.9
	Urban Female	14.2	3.1	-1.1	1.2	17.3
Haryana	Rural Male	14.2	0.1	0.0	-3.6	10.7
	Rural Female	14.2	0.1	4.9	1.6	20.8
	Urban Male	14.2	0.1	-2.9	-2.9	8.5
	Urban Female	14.2	0.1	-0.9	8.8	22.2
Himachal Pradesh	Rural Male	14.2	-0.7	0.0	-0.9	12.6
	Rural Female	14.2	-0.7	4.6	5.1	23.2
	Urban Male	14.2	-0.7	-2.7	-2.8	8.0

State	Sub-group	Gain in LEB				
		Common to states and sub-groups	Specific to state	Specific to sub-group	Residual	Total
	Urban Female	14.2	-0.7	-0.9	1.6	14.3
Jammu & Kashmir	Rural Male	14.2	1.7	0.0	-1.0	14.9
	Rural Female	14.2	1.7	5.4	0.2	21.5
	Urban Male	14.2	1.7	-3.2	0.2	12.9
	Urban Female	14.2	1.7	-1.0	0.5	15.4
Karnataka	Rural Male	14.2	-2.6	0.0	0.4	11.9
	Rural Female	14.2	-2.6	3.9	0.5	16.0
	Urban Male	14.2	-2.6	-2.3	1.5	10.7
	Urban Female	14.2	-2.6	-0.7	-2.1	8.7
Kerala	Rural Male	14.2	-4.5	0.0	-0.7	9.0
	Rural Female	14.2	-4.5	3.3	-2.6	10.3
	Urban Male	14.2	-4.5	-2.3	1.5	8.8
	Urban Female	14.2	-4.5	-0.6	1.7	10.8
Madhya Pradesh	Rural Male	14.2	1.4	0.0	0.6	16.2
	Rural Female	14.2	1.4	5.3	0.9	21.8
	Urban Male	14.2	1.4	-3.2	0.5	13.0
	Urban Female	14.2	1.4	-1.0	-1.7	12.9
Maharashtra	Rural Male	14.2	0.7	0.0	1.9	16.8
	Rural Female	14.2	0.7	5.1	-1.7	18.4
	Urban Male	14.2	0.7	-3.0	0.5	12.5
	Urban Female	14.2	0.7	-0.9	-1.0	12.9

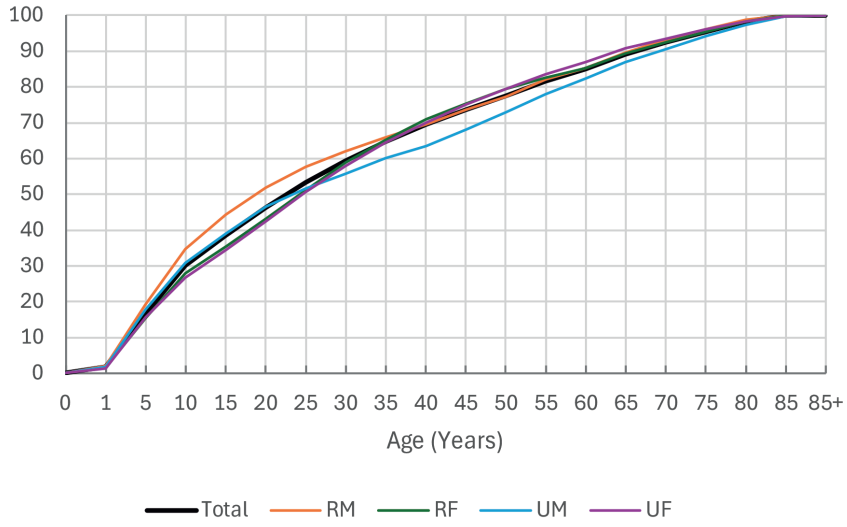
State	Sub-group	Gain in LEB				
		Common to states and sub-groups	Specific to state	Specific to sub-group	Residual	Total
Odisha	Rural Male	14.2	0.9	0.0	4.4	19.4
	Rural Female	14.2	0.9	5.1	3.6	23.8
	Urban Male	14.2	0.9	-3.1	-1.9	10.1
	Urban Female	14.2	0.9	-1.0	-3.1	11.1
Punjab	Rural Male	14.2	-5.7	0.0	-0.7	7.7
	Rural Female	14.2	-5.7	2.9	-0.2	11.1
	Urban Male	14.2	-5.7	-1.7	0.1	6.8
	Urban Female	14.2	-5.7	-0.5	0.8	8.8
Rajasthan	Rural Male	14.2	1.8	0.0	0.2	16.2
	Rural Female	14.2	1.8	5.4	-0.1	21.3
	Urban Male	14.2	1.8	-3.2	0.2	12.9
	Urban Female	14.2	1.8	-1.0	-0.3	14.7
Tamil Nadu	Rural Male	14.2	3.9	0.0	-0.5	17.5
	Rural Female	14.2	3.9	6.2	-1.9	22.4
	Urban Male	14.2	3.9	-3.0	0.4	15.6
	Urban Female	14.2	3.9	-1.1	1.4	18.3
Uttar Pradesh	Rural Male	14.2	3.1	0.0	-0.6	16.7
	Rural Female	14.2	3.1	5.9	1.5	24.6
	Urban Male	14.2	3.1	-3.5	-0.3	13.4
	Urban Female	14.2	3.1	-1.1	-0.1	16.1

SOURCE: AUTHOR

Contribution of Mortality Improvement

Table 4 gives the contribution of the improvement in mortality in different ages of the life span to the gain in LEB in different population groups. In India, mortality improvement in the first year of life accounted for a gain of 0.31 years in LEB gain during the period 1976–2020, whereas average improvement in mortality in the age group 1–4 years accounted for a gain of 0.67 years in LEB gain, which means that mortality improvement in this age group accounted for around 0.67x4=2.7 years of the gain in LEB in the country. Table 4 suggests that almost 39 per cent of the gain in LEB in the country has been the result of the improvement in mortality in the first fifteen years of life, while another 39 per cent has been the result of the improvement in mortality improvement in the age group 15-49 years. By contrast, improvement in mortality in ages seventy years and above during this period has resulted in only about seven per cent of the gain in LEB. As the result, the cumulative distribution of the proportionate contribution of the improvement in mortality in different ages of the life span to the gain in LEB has been convex (Figure 2).

Figure 8. Proportionate (per cent) contribution of the improvement in mortality at different ages to the gain in life expectancy at birth, 1976–2020, in India



SOURCE: AUTHOR

Table 4. Contribution of average mortality improvement (in years) in different age-groups to the gain in life expectancy at birth (years) in India and selected states, 1976–2020

Country/State		Total gain	Age group																		
			< 1	1-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+
India	All	18.02	0.31	0.67	0.48	0.30	0.28	0.25	0.22	0.19	0.17	0.15	0.14	0.15	0.12	0.15	0.12	0.11	0.10	0.06	0.02
	RM	16.33	0.33	0.70	0.51	0.32	0.24	0.19	0.14	0.13	0.12	0.13	0.12	0.15	0.10	0.15	0.12	0.09	0.09	0.04	0.00
	RF	20.42	0.31	0.71	0.51	0.30	0.32	0.33	0.32	0.25	0.23	0.18	0.16	0.13	0.11	0.16	0.13	0.12	0.12	0.07	0.02
	UM	12.60	0.23	0.50	0.33	0.21	0.19	0.13	0.10	0.11	0.08	0.12	0.12	0.13	0.11	0.12	0.09	0.09	0.08	0.06	0.03
	UF	13.85	0.19	0.49	0.31	0.22	0.22	0.23	0.20	0.18	0.16	0.14	0.12	0.12	0.09	0.10	0.08	0.08	0.06	0.04	0.02
Andhra Pradesh	All	17.81	0.33	0.61	0.53	0.30	0.29	0.20	0.23	0.18	0.16	0.12	0.10	0.11	0.11	0.13	0.14	0.13	0.12	0.13	0.10
	RM	17.93	0.36	0.60	0.58	0.24	0.26	0.22	0.17	0.14	0.10	0.09	0.09	0.09	0.11	0.14	0.19	0.19	0.19	0.20	0.17
	RF	19.39	0.33	0.67	0.59	0.36	0.31	0.30	0.29	0.24	0.20	0.13	0.10	0.11	0.09	0.12	0.11	0.10	0.09	0.12	0.11
	UM	12.31	0.19	0.38	0.29	0.32	0.19	0.17	0.09	0.12	0.18	0.11	0.11	0.09	0.12	0.13	0.10	0.06	0.07	-0.01	-0.07
	UF	11.74	0.12	0.36	0.22	0.22	0.24	0.28	0.18	0.10	0.20	0.09	0.03	0.08	0.09	0.08	0.07	0.07	0.04	0.04	0.02
Assam	All	17.05	0.24	0.49	0.47	0.28	0.20	0.20	0.20	0.20	0.18	0.15	0.20	0.16	0.16	0.16	0.13	0.12	0.11	0.06	0.01
	RM	15.80	0.23	0.50	0.50	0.29	0.13	0.15	0.18	0.12	0.15	0.10	0.18	0.12	0.12	0.12	0.12	0.16	0.14	0.11	0.07
	RF	17.23	0.19	0.44	0.42	0.27	0.25	0.23	0.24	0.29	0.21	0.22	0.22	0.17	0.15	0.19	0.12	0.05	0.06	-0.02	-0.08
	UM	15.13	0.60	0.79	0.36	0.17	0.07	0.04	0.07	-0.02	0.04	0.14	0.19	0.19	0.20	0.22	0.20	0.15	0.15	0.11	0.06
	UF	10.98	0.33	0.50	0.37	0.01	0.11	0.19	0.27	0.14	0.14	0.14	0.10	0.10	0.10	0.10	0.05	0.02	-0.03	-0.06	-0.08
Gujarat	All	18.52	0.28	0.76	0.47	0.41	0.29	0.24	0.25	0.22	0.18	0.19	0.09	0.15	0.10	0.12	0.10	0.10	0.09	0.04	-0.01
	RM	15.89	0.25	0.77	0.51	0.37	0.22	0.11	0.14	0.14	0.11	0.16	0.09	0.15	0.07	0.13	0.12	0.09	0.09	0.02	-0.03
	RF	21.69	0.28	0.76	0.42	0.42	0.33	0.37	0.35	0.34	0.25	0.18	0.15	0.16	0.11	0.17	0.14	0.11	0.09	0.07	0.02
	UM	14.85	0.23	0.69	0.49	0.35	0.19	0.14	0.16	0.14	0.13	0.18	0.12	0.16	0.11	0.10	0.04	0.08	0.03	-0.03	-0.08
	UF	17.34	0.25	0.69	0.37	0.39	0.35	0.22	0.26	0.21	0.17	0.16	0.00	0.06	0.07	0.06	0.10	0.14	0.14	0.14	0.11
Haryana	All	15.42	0.28	0.65	0.49	0.29	0.26	0.18	0.15	0.12	0.16	0.11	0.06	0.05	0.04	0.05	0.08	0.10	0.17	0.17	0.15
	RM	10.74	0.32	0.67	0.51	0.29	0.15	-0.02	0.01	0.02	0.10	0.07	-0.03	-0.09	-0.11	0.02	0.04	0.10	0.21	0.23	0.24
	RF	20.84	0.27	0.64	0.53	0.29	0.37	0.34	0.27	0.29	0.24	0.24	0.19	0.14	0.10	0.10	0.09	0.11	0.14	0.14	0.11
	UM	8.49	0.12	0.53	0.22	0.20	0.18	0.02	0.00	-0.03	0.04	0.00	0.04	0.09	0.10	0.04	0.07	0.06	0.13	0.09	0.06
	UF	22.22	0.30	0.60	0.46	0.29	0.38	0.43	0.41	0.31	0.35	0.25	0.19	0.15	0.11	0.03	0.14	0.12	0.11	0.16	0.14
Himachal Pradesh	All	17.36	0.31	0.47	0.52	0.35	0.23	0.17	0.20	0.25	0.16	0.13	0.17	0.16	0.12	0.13	0.11	0.10	0.09	0.12	0.11
	RM	12.64	0.25	0.49	0.76	0.21	0.11	-0.01	0.09	0.20	0.10	0.06	0.13	0.06	0.06	0.06	0.04	0.08	0.04	0.09	0.08
	RF	23.24	0.36	0.46	0.40	0.47	0.31	0.32	0.32	0.30	0.26	0.22	0.25	0.27	0.18	0.22	0.19	0.14	0.16	0.18	0.16
	UM	7.95	0.28	0.42	0.06	-0.10	0.08	0.00	0.15	0.19	0.09	0.26	0.10	0.12	0.17	0.10	0.03	0.03	0.03	-0.09	-0.18
	UF	14.29	0.20	0.15	0.20	0.20	0.23	0.36	0.16	0.11	0.17	0.09	0.17	0.30	0.20	0.10	0.08	0.14	0.08	0.09	0.06
Jammu & Kashmir	All	18.30	0.17	0.69	0.34	0.20	0.24	0.28	0.26	0.16	0.19	0.17	0.15	0.15	0.13	0.14	0.16	0.17	0.18	0.15	0.09
	RM	14.90	0.20	0.66	0.39	0.26	0.23	0.14	0.10	0.06	0.08	0.10	0.08	0.12	0.10	0.10	0.14	0.16	0.18	0.14	0.09
	RF	21.52	0.15	0.68	0.31	0.21	0.34	0.40	0.35	0.22	0.25	0.24	0.20	0.18	0.16	0.18	0.17	0.19	0.20	0.14	0.05
	UM	12.90	0.08	0.87	0.22	-0.13	0.10	0.24	0.25	0.03	0.12	0.06	0.11	0.16	0.16	0.09	0.13	0.11	0.10	0.10	0.07
	UF	15.36	0.10	0.56	0.28	0.18	0.12	0.18	0.20	0.26	0.33	0.13	0.18	0.08	0.04	0.13	0.12	0.12	0.12	0.11	0.07
Karnataka	All	13.36	0.25	0.58	0.42	0.30	0.25	0.17	0.17	0.15	0.13	0.09	0.10	0.12	0.08	0.11	0.08	0.00	0.04	-0.03	-0.06
	RM	11.94	0.33	0.65	0.49	0.41	0.28	0.09	0.07	0.03	0.02	0.05	0.03	0.11	0.10	0.09	0.07	-0.02	0.05	-0.05	-0.09
	RF	16.05	0.22	0.59	0.47	0.31	0.22	0.24	0.28	0.27	0.22	0.16	0.13	0.12	0.08	0.14	0.06	0.02	0.05	-0.06	-0.12
	UM	10.72	0.21	0.40	0.21	0.14	0.17	0.02	0.04	0.13	0.12	0.04	0.16	0.16	0.04	0.06	0.14	0.06	0.10	0.15	0.15
	UF	8.74	0.13	0.41	0.24	0.14	0.24	0.18	0.10	0.13	0.11	0.06	0.08	0.04	0.06	0.09	0.02	-0.04	-0.01	-0.03	-0.03
Kerala	All	9.64	0.24	0.36	0.28	0.18	0.11	0.09	0.10	0.14	0.10	0.10	0.08	0.06	0.08	0.07	0.05	0.06	0.06	0.04	0.01
	RM	8.96	0.30	0.38	0.25	0.15	0.09	0.08	0.08	0.09	0.09	0.10	0.08	0.07	0.06	0.06	0.05	0.05	0.06	0.04	0.02
	RF	10.35	0.19	0.37	0.34	0.27	0.12	0.09	0.15	0.09	0.09	0.12	0.08	0.05	0.06	0.07	0.05	0.05	0.07	0.03	0.01

Table 4. Continued

Country/State		Total gain	Age group																		
			< 1	1-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+
	UM	8.67	0.15	0.30	0.30	0.11	0.06	0.09	0.05	0.18	0.10	0.10	0.07	0.07	0.07	0.08	0.04	0.06	0.05	0.03	0.01
	UF	10.78	0.25	0.34	0.11	0.16	0.11	0.10	0.12	0.15	0.17	0.11	0.10	0.08	0.12	0.13	0.09	0.11	0.10	0.07	0.02
Madhya Pradesh	All	18.56	0.30	0.69	0.48	0.33	0.25	0.26	0.24	0.23	0.16	0.19	0.13	0.22	0.09	0.19	0.13	0.12	0.08	0.02	-0.04
	RM	16.23	0.33	0.75	0.54	0.33	0.17	0.19	0.14	0.13	0.04	0.16	0.07	0.30	0.06	0.18	0.11	0.11	0.13	-0.04	-0.16
	RF	21.81	0.29	0.69	0.48	0.34	0.33	0.35	0.33	0.30	0.30	0.29	0.22	0.18	0.09	0.25	0.15	0.12	0.03	-0.01	-0.06
	UM	12.99	0.20	0.60	0.25	0.26	0.09	-0.04	0.00	0.11	0.03	0.07	0.07	0.17	0.12	0.08	0.17	0.20	0.21	0.25	0.24
	UF	12.90	0.16	0.42	0.21	0.30	0.18	0.21	0.23	0.22	0.19	0.16	0.11	0.09	0.06	0.09	0.04	0.07	0.02	0.02	0.01
Maharashtra	All	16.70	0.33	0.62	0.48	0.29	0.24	0.24	0.21	0.17	0.14	0.12	0.12	0.12	0.11	0.13	0.12	0.12	0.10	0.08	0.04
	RM	16.82	0.33	0.62	0.52	0.38	0.24	0.18	0.16	0.11	0.10	0.11	0.12	0.11	0.07	0.13	0.15	0.15	0.14	0.13	0.09
	RF	18.35	0.29	0.61	0.51	0.29	0.29	0.34	0.24	0.25	0.20	0.12	0.10	0.11	0.11	0.15	0.14	0.13	0.10	0.06	0.01
	UM	12.46	0.29	0.57	0.29	0.13	0.24	0.17	0.11	0.14	0.07	0.10	0.13	0.13	0.12	0.10	0.09	0.07	0.05	0.03	0.01
	UF	12.94	0.27	0.56	0.34	0.10	0.14	0.24	0.25	0.15	0.19	0.12	0.11	0.09	0.10	0.08	0.05	0.07	0.04	0.01	-0.02
Odisha	All	21.47	0.35	0.62	0.50	0.29	0.33	0.28	0.24	0.21	0.19	0.15	0.19	0.22	0.21	0.20	0.16	0.19	0.15	0.19	0.17
	RM	19.44	0.33	0.65	0.55	0.27	0.32	0.23	0.12	0.10	0.16	0.12	0.19	0.24	0.21	0.21	0.15	0.15	0.11	0.16	0.14
	RF	23.78	0.35	0.61	0.45	0.32	0.26	0.32	0.37	0.31	0.23	0.16	0.21	0.20	0.21	0.20	0.19	0.24	0.22	0.25	0.21
	UM	10.10	0.30	0.41	0.31	0.20	0.16	0.15	0.11	0.11	0.07	0.16	0.10	0.17	0.18	0.18	0.07	-0.02	-0.11	-0.18	-0.20
	UF	11.05	0.20	0.37	0.43	0.17	0.29	0.22	0.12	0.19	0.15	0.11	0.07	0.13	0.09	0.07	0.02	-0.02	-0.06	-0.09	-0.09
Punjab	All	9.26	0.45	0.79	0.48	0.37	0.22	0.13	0.16	0.09	0.04	-0.03	-0.05	-0.02	-0.12	0.02	-0.07	-0.04	-0.02	-0.04	-0.03
	RM	7.71	0.60	0.98	0.64	0.27	0.21	0.17	0.04	-0.04	-0.06	-0.09	-0.13	-0.18	-0.24	-0.03	-0.07	-0.02	0.06	0.08	0.12
	RF	11.10	0.44	0.84	0.59	0.47	0.21	0.10	0.30	0.21	0.14	0.05	-0.01	-0.06	-0.17	-0.01	-0.10	-0.08	-0.09	-0.10	-0.08
	UM	6.82	0.25	0.39	0.21	0.22	0.28	0.12	0.20	0.02	-0.02	-0.07	-0.06	0.07	0.04	0.02	0.00	-0.01	0.00	-0.02	-0.03
	UF	8.75	0.27	0.47	0.23	0.22	0.00	0.08	0.13	0.15	0.07	0.08	0.07	0.17	0.08	0.10	-0.02	0.01	-0.02	-0.03	-0.05
Rajasthan	All	18.23	0.24	0.64	0.55	0.30	0.31	0.26	0.22	0.19	0.19	0.13	0.14	0.15	0.06	0.12	0.12	0.14	0.12	0.08	0.03
	RM	16.15	0.34	0.89	0.59	0.42	0.29	0.17	0.09	0.10	0.13	0.06	0.14	0.19	0.04	0.11	0.07	0.08	0.04	-0.03	-0.09
	RF	21.28	0.21	0.54	0.60	0.21	0.35	0.35	0.35	0.29	0.29	0.19	0.15	0.14	0.03	0.17	0.18	0.19	0.17	0.11	0.04
	UM	12.91	0.11	0.40	0.39	0.26	0.16	0.07	0.14	0.08	0.12	0.11	0.12	0.07	0.09	0.13	0.10	0.12	0.11	0.14	0.13
	UF	14.69	0.10	0.49	0.37	0.31	0.30	0.15	0.17	0.11	0.13	0.20	0.06	0.09	0.07	0.01	0.07	0.13	0.16	0.18	0.16
Tamil Nadu	All	20.14	0.37	0.77	0.50	0.35	0.29	0.23	0.22	0.19	0.18	0.16	0.15	0.15	0.16	0.18	0.15	0.14	0.13	0.12	0.09
	RM	17.54	0.44	0.85	0.54	0.38	0.29	0.20	0.19	0.16	0.11	0.06	0.10	0.08	0.09	0.13	0.10	0.09	0.11	0.09	0.07
	RF	22.38	0.38	0.75	0.51	0.33	0.34	0.30	0.29	0.21	0.29	0.18	0.22	0.18	0.23	0.20	0.18	0.11	0.13	0.09	0.05
	UM	14.87	0.27	0.68	0.32	0.27	0.15	0.16	0.16	0.12	0.09	0.14	0.08	0.10	0.10	0.16	0.12	0.15	0.13	0.13	0.09
	UF	18.32	0.23	0.54	0.45	0.29	0.25	0.20	0.24	0.18	0.15	0.25	0.16	0.21	0.16	0.17	0.13	0.13	0.10	0.10	0.06
Uttar Pradesh	All	20.51	0.31	0.94	0.61	0.34	0.35	0.33	0.27	0.20	0.15	0.16	0.11	0.11	0.09	0.13	0.13	0.11	0.14	0.05	-0.02
	RM	16.68	0.32	0.94	0.62	0.39	0.32	0.21	0.16	0.08	0.08	0.14	0.10	0.12	0.08	0.11	0.11	0.04	0.05	-0.06	-0.13
	RF	24.61	0.36	1.05	0.64	0.30	0.45	0.40	0.34	0.30	0.20	0.19	0.08	0.06	0.06	0.16	0.17	0.19	0.26	0.17	0.09
	UM	13.44	0.16	0.49	0.54	0.25	0.29	0.13	0.17	0.09	0.04	0.17	0.12	0.12	0.07	0.08	0.03	0.08	0.05	0.03	0.01
	UF	16.08	0.12	0.66	0.39	0.33	0.25	0.25	0.21	0.20	0.20	0.09	0.12	0.07	0.07	0.12	0.11	0.09	0.12	0.04	-0.01

<0	0-0.1	0.1-0.2	0.2-0.3	0.3-0.4	0.4-0.5	≥0.5

SOURCE: AUTHOR

The contribution of the improvement in mortality in different age groups to the gain in LEB has also been different in different population sub-groups. In rural males, almost 45 per cent of the gain in LEB is accounted by mortality improvement in the first fifteen years of life but this proportion is less than 33 per cent in rural females. In urban males, the gain in LEB accounted by the improvement in mortality in the first fifteen years of life is found to be higher than the gain in LEB due to improvement in mortality in urban female but substantially lower than that in female in both rural and urban areas. Gain in LEB attributed to mortality improvement in the age group 50–69 years is found to be higher in males than in females in both rural and urban areas of the country. In the age group seventy years and above, on the other hand, the contribution of the improvement in mortality to the gain in LEB is found to be higher in females in the rural population but in males in the urban population.

The contribution of mortality improvement at different ages to LEB gain has also varied in different states. The proportionate contribution of the improvement in mortality in the age groups <5 years, 5–14 years, 15–49 years, 50–69 years, and 70 years and above to LEB gain is shown in Figure 3. The contribution of mortality improvement in the first five years of life to LEB gain in six states has been higher than the national average, but less than the national average in three states. The contribution of mortality improvement in ages 5–14 years was around 25 per cent in Karnataka, but only eighteen per cent in Odisha. The contribution of mortality improvement in ages 15–49 years was forty per cent in Rajasthan but only 34 per cent in Haryana and Uttar Pradesh. The contribution of mortality improvement in the age group 50–69 years was eighteen per cent in Assam and Odisha, but only seven per cent in Haryana. In the age group seventy years and above, the contribution was thirteen per cent in Odisha, but only five per cent in Madhya Pradesh. In Karnataka, there has been virtually no improvement in mortality in this age group. The male-female difference in the contribution has also been different. The contribution of male mortality improvement in the age-group 1–4 years is higher than that of female mortality in all states except Karnataka, Rajasthan, and Uttar Pradesh. In these states, contribution of urban female mortality improvement to LEB gain has been higher than that of urban male mortality. The same is the situation in 5–14 years of age, although there are exceptions, the most notable is Himachal Pradesh where mortality increased, instead of decreased, in urban males. In the 15–49 age group, the contribution of female mortality improvement

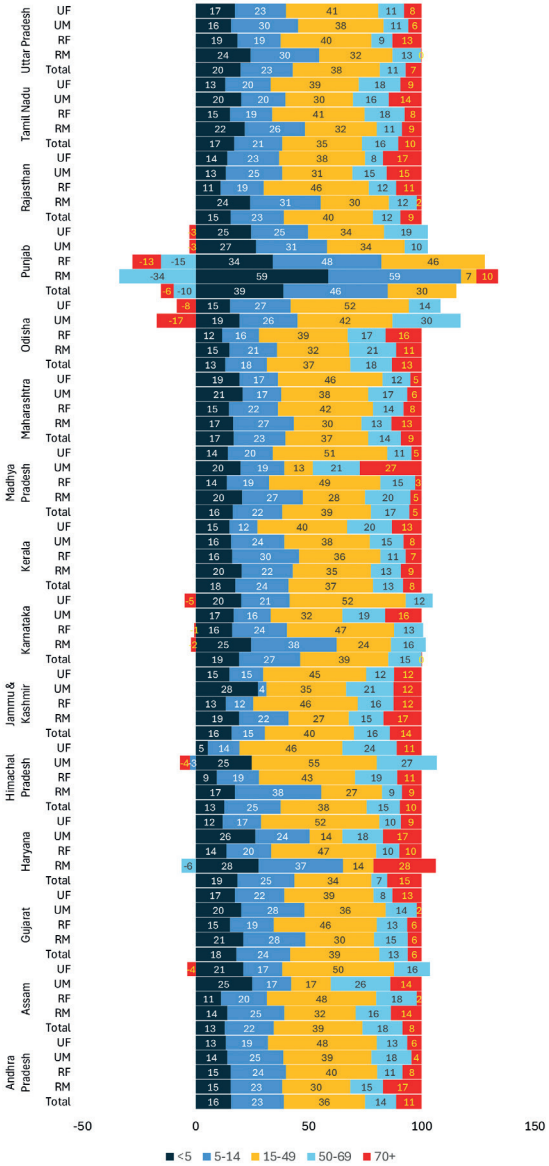
was higher than that of male mortality in all population groups except the urban population of Himachal Pradesh and Punjab. Moreover, in population aged fifty years and above, the contribution of male mortality improvement to LEB gain has, in general, been higher than the contribution of female mortality improvement, but there are important exceptions to this common pattern as may be seen in Figure 3.

Figure 3 also shows that, in some population groups, the improvement in mortality has been inconsistent. The increase in mortality in these population groups has contributed to loss, instead of gain, in LEB. In Punjab, for example, the entire gain in LEB during the reference period has been due to the improvement in mortality in ages below fifty years as mortality increased, instead decreased, in ages fifty years and above. This has particularly been the case with rural females in Punjab, whereas rural males in the age group 50–69 years have seen a marked increase in mortality, although mortality decreased in ages seventy years and above. Similarly, Odisha has seen a marked increase in mortality in ages seventy years and above in both urban males and females while mortality decreased in the state's rural population. In addition to Punjab and Odisha, mortality appears to have increased in urban females aged seventy years and above in Assam, urban males aged seventy years and above in Himachal Pradesh and in rural males and urban females aged seventy years and above in Karnataka. Mortality also increased in the age group 50–69 years in rural males in Haryana and in rural and urban males in Himachal Pradesh. The increase in mortality in these population groups has contributed to a loss, instead of a gain, in LEB. The very slow gain in LEB in Punjab during 1976–2020 can be attributed to the increase in mortality in ages fifty years and above. Similarly, gain in LEB in the urban population of Odisha would have been more rapid if mortality in the population aged seventy years and above had not increased.

Decomposition of the Difference in the Gain in LEB

The difference in the gain in LEB between two population groups can be decomposed into two nearly independent product and ratio components in conjunction with equation (19). Results of this decomposition for the four mutually exclusive population groups in India are presented in Table 5, which highlights that contributors to the differences in LEB gains vary across groups. The gain in LEB in rural females in India was 4.1 years higher than the gain in LEB in rural

Figure 9. Proportionate (per cent) contribution of the improvement in age-specific mortality rates to the gain in LEB, 1976–2020, in states of India



SOURCE: AUTHOR

males because of more rapid improvement in mortality in rural females relative to rural males in the age group 35–79 years. In ages younger than 35 years and in ages eighty years and above, mortality improvement in rural males has been more rapid than mortality improvement in rural females. On the other hand, the gain in LEB in urban females has been around 1.3 years higher than the gain in LEB in urban males due to faster improvement in urban female mortality in the age group 1–39 years. In contrast, mortality improvement in the first year of life and in ages forty years and above, has been more rapid in urban males than in urban females. The difference in the gain in LEB between rural females and rural males has been due to relatively faster improvement in female mortality in older ages (excluding the very elderly), whereas the difference in the gain in LEB between urban females and urban males has been due to relatively faster improvement in female mortality in younger ages (excluding the first year of life). Similarly, the gain in LEB in rural males has been found to be around 3.7 years more than that of urban males because mortality improvement in rural males has been more rapid than in urban males in all but four age groups. It is only in the age groups 45–49 years; 55–59 years; and eighty years and above that improvement in female mortality has been more rapid than mortality improvement in rural males. On the other hand, gain in LEB in rural females was around 6.6 years higher than the gain in LEB in urban females because mortality improvement in rural females has been more rapid than mortality improvement in urban females for all ages.

The overall difference in LEB gains between two population groups is the sum of two components: (1) the difference in average mortality improvement between the groups (the product component) and (2) the difference in the ratio of mortality improvement between the groups (the ratio component). For example, the difference in the gain in LEB between rural males and urban males is around 4.4 years due to the product component, but around -0.7 years due to the ratio component resulting in a net difference of around 3.7 years. On the other hand, difference in the gain in LEB between rural females and urban females is around 6.3 years due to the product component, but 0.3 years due to the ratio component, making the net difference around 6.6 years. In case of the difference in the gain in LEB between urban females and urban males, however, the product component accounts for a gain of -1.3 years, but the ratio component accounts for a gain of around 2.6 years so that the difference in LEB gain between two population groups is around 1.3 years.

Table 5. Decomposition of the difference in the gain in life expectancy at birth 1976–2020 between different population sub-groups in India into ratio and product components

Age	Difference in the gain in life expectancy at birth (years) between											
	Rural female-rural male			Urban female-urban male			Rural male-urban male			Rural female-urban female		
	Ratio	Product	Total	Ratio	Product	Total	Ratio	Product	Total	Ratio	Product	Total
<1	-0.07	-0.66	-0.74	-0.01	0.01	-0.01	0.01	0.09	0.10	0.03	0.11	0.14
1-4	-4.24	-11.02	-15.26	0.19	0.05	0.24	0.08	0.43	0.51	-0.02	0.60	0.58
5-9	-3.36	-10.81	-14.17	0.06	0.08	0.14	0.27	0.52	0.79	0.31	0.64	0.95
10-14	0.13	-1.95	-1.81	0.14	0.01	0.15	0.15	0.47	0.63	-0.05	0.59	0.55
15-19	-10.75	-10.30	-21.05	0.28	0.05	0.33	-0.05	0.33	0.28	-0.03	0.47	0.44
20-24	-18.54	-6.34	-24.88	0.56	0.01	0.57	0.09	0.31	0.40	0.01	0.45	0.46
25-29	-23.26	-6.14	-29.40	0.52	-0.04	0.49	-0.02	0.29	0.27	0.13	0.53	0.66
30-34	-16.40	9.42	-6.98	0.39	-0.12	0.27	-0.09	0.27	0.17	-0.02	0.44	0.42
35-39	-14.85	18.31	3.46	0.41	-0.17	0.24	0.03	0.25	0.28	0.02	0.37	0.39
40-44	-7.50	24.62	17.11	0.18	-0.22	-0.04	-0.13	0.22	0.09	-0.10	0.34	0.24
45-49	-5.72	26.52	20.80	0.04	-0.21	-0.17	-0.19	0.14	-0.06	-0.03	0.18	0.15
50-54	2.22	18.64	20.86	0.01	-0.19	-0.18	-0.11	0.13	0.01	-0.20	0.25	0.05
55-59	-2.14	22.07	19.94	-0.02	-0.13	-0.14	-0.21	0.21	0.00	-0.10	0.18	0.08
60-64	-2.47	17.64	15.17	0.00	-0.13	-0.13	-0.06	0.16	0.11	0.04	0.19	0.24
65-69	-2.60	14.05	11.46	-0.03	-0.11	-0.13	-0.03	0.13	0.10	0.10	0.17	0.27
70-74	-3.58	10.93	7.34	-0.03	-0.09	-0.12	-0.15	0.17	0.02	0.04	0.22	0.26
75-79	-4.19	7.50	3.31	-0.06	-0.07	-0.13	-0.09	0.14	0.05	0.15	0.20	0.35
80-84	-3.69	3.35	-0.34	-0.04	-0.06	-0.10	-0.18	0.16	-0.02	0.02	0.27	0.29
85+	-0.56	-0.17	-0.73	-0.01	-0.01	-0.01	-0.04	0.03	-0.01	-0.01	0.05	0.04
All ages			4.09			1.26			3.73			6.56

SOURCE: AUTHOR

Among the sixty mutually exclusive population groups, the gain in LEB during the period 1976–2020 has been the slowest in urban males in Punjab (6.8 years) but the highest in rural females in Uttar Pradesh (24.6 years), a difference of around 17.8 years. Table 6 decomposes the difference in gain in LEB between rural females in Uttar Pradesh and urban males in Punjab. Almost two-thirds of the difference in the gain in LEB between rural females in Uttar Pradesh and urban males in Punjab is attributed to the difference in the ratio component while the product component accounts for around one-third of the difference. Mortality improved in all ages in rural females in Uttar Pradesh during the period 1976–2020, but this has not been the case for urban males in Punjab where mortality increased, instead decreased, in the age groups 35–49 years, 65–74 years, and eighty years and above. The table also shows that the product component of the difference in the gain in LEB between the two population groups contributed to increase the difference in the gain in LEB for all age groups. However, the ratio component of the difference in the gain in LEB contributed to the decrease the difference in the gain in LEB between the two population groups in the age groups 0–1 year; 10–19 years; 25–29 years; and 50–59 years. In other age groups, the ratio component contributed to increase the difference in LEB gain between the two population groups. As the result, the net contribution of the ratio component or the difference in improvement in age-specific mortality rate to the difference in LEB gain between rural females in Uttar Pradesh and urban males in Punjab has been smaller than the net contribution of the product component or the difference in improvement in average mortality in the two population groups.

Discussion and Conclusions

This article has highlighted the unevenness in LEB gain within India, across sixty mutually exclusive population groups. The gain in LEB has varied widely across these mutually exclusive groups, ranging from more than 24 years in rural females in Uttar Pradesh to less than seven years in urban males in Punjab. Reasons for this very marked variation in LEB gain within India are not known at present. A part of the observed unevenness in LEB gain may be attributed to the ceiling effect as LEB varied from around 41 years in rural females in Uttar Pradesh to more than 69 years in Punjab in 1976–1980. If the unevenness in LEB gain attributed to the ceiling effect is controlled, substantial inequality in LEB gain within the country still remains, as is revealed through comparing the observed LEB gain trajectory

in different population groups with the medium model mortality improvement trajectory of the United Nations. This comparison suggests that the difference between the actual gain and the expected gain in LEB has been different in different population groups and, in about two thirds of the population groups, gain in LEB has been slower than expected.

Table 6. Decomposition of the difference between LEB gain in rural females in Uttar Pradesh and urban males in Punjab, 1976–2020 (years)

Age	Difference between LEB gain in rural males in Uttar Pradesh and urban males in Punjab	Components of the difference in LEB gain	
		Ratio component	Product component
<1	0.061	-0.096	0.156
1-4	1.971	1.224	0.747
5-9	1.948	1.226	0.722
10-14	0.045	-0.541	0.586
15-19	0.381	-0.318	0.699
20-24	1.202	0.812	0.390
25-29	0.496	-0.111	0.607
30-34	1.479	1.224	0.256
35-39	1.358	1.133	0.226
40-44	1.603	1.478	0.125
45-49	0.973	0.939	0.035
50-54	-0.254	-0.351	0.098
55-59	-0.012	-0.064	0.051
60-64	0.559	0.523	0.036
65-69	1.019	0.818	0.201
70-74	1.337	0.996	0.340
75-79	1.668	1.186	0.482
80-84	1.671	0.990	0.681
85+	0.283	0.129	0.155
All ages	17.788	11.195	6.593

SOURCE: AUTHOR

Reasons for observed heterogeneity in LEB gain within India are not known at present. A part of this heterogeneity may be due to the variation in LEB gain across states which is common to all population sub-groups within a state. Another part of the observed heterogeneity may be due to variation in the gain across population sub-groups which is common to all states. Finally, heterogeneity in LEB gain may also be due to factors that are specific to specific population groups. The present analysis suggests that around 77 per cent of the variation in LEB gain across sixty population groups may be explained, almost equally, by heterogeneity in gain across states which is common to all population sub-groups within the state and heterogeneity in gain across population sub-groups which is common to all states. Heterogeneity in gain attributed to factors specific to specific population groups accounts for about 23 per cent of the total heterogeneity in LEB gain across sixty population groups. This heterogeneity in LEB gain is not explained by the variation in the gain across states and across population sub-groups.

The variation in LEB gains across states, after accounting for differences across population sub-groups and the residual component, may be attributed to state-level factors that potentially influence life expectancy. A review of the extensive literature on the determinants of life expectancy has identified seven factors: 1) health care expenditures; 2) health financing policies; 3) elements of medical care; 4) health habits; 5) social determinants; 6) social spending; and 7) other external factors, that have a potential impact on LEB (Roffia et al., 2022). Variations in per capita health expenditure and the way health services are organised also contribute to the variation in LEB. Higher public health spending, coupled with efficient health services, is found to accelerate LEB gain whereas inadequate funding and inefficient health services hinder LEB gain. An increase of ten per cent in health spending per capita in real terms is found to be associated with an increase of 3.5 months in LEB gain in OECD countries (OECD, 2019). In Africa, increase in health spending, urbanisation and improved water access are found to be associated with LEB gain (Salami et al., 2019). The impact of increasing per capita public health expenditure on LEB gain is found to be greater than increase in private health expenditure (Raeesi et al., 2018; Novignon et al., 2012). However, these factors do not account for the variation in LEB gains among rural males, rural females, urban males and urban females after controlling for state-level and residual components common to all states. They also fail to explain variation in LEB gains specific to population groups beyond what is attributable to state and sub-group effects.

The gain in LEB summarises mortality improvement in different ages. In general, mortality improved in all ages in the sixty population groups but there are notable exceptions. In Punjab, mortality increased, instead of improving, in ages forty years and above and this increase appears to be the reason behind very slow gain in LEB in the state since 1976–1980. In Odisha, mortality increased in ages seventy years and above in the urban areas but not in the rural areas, which appears to be a factor behind the slow gain in LEB in the urban areas of the state relative to its rural areas. The relatively slow gain in LEB in urban females in Assam and Karnataka, and in urban males in Gujarat and Himachal Pradesh, also appears to be due to the increase in mortality in older ages. There is a need to explore reasons behind the increase in mortality in older population in these population groups. Had mortality not increased in these population groups, the gain in LEB would have been larger and the inequality in LEB gain would have been smaller. In most of the population groups, the gain in LEB has primarily been due to mortality improvement in younger ages, less than fifteen years.

LEB is a universally recognised as the indicator of population health. The inequality in LEB gain, across population groups, therefore, indicates that improvement in population health has been uneven in different population groups. At the policy level, however, there has rarely been any acknowledgement of the inequalities in the improvement in population health as revealed through the inequality in the gain in LEB. The latest health policy of India aims at achieving LEB of seventy years by the year 2025 but is silent about the unevenness in the improvement in population health across different population groups and how to address this inequality (Government of India, 2017). Although the goal set out in the National Health Policy 2017 appears to have been achieved, the present analysis reveals that significant challenges persist due to uneven improvements in population health across the country. Addressing these disparities among population groups is essential for accelerating overall health progress in India.

The health care delivery system in India is a mix of public and private services. A comprehensive review of India's health care delivery system has been carried out elsewhere (Selvaraj et al., 2022). The private health care system is heavily concentrated in big cities and large towns and primarily provides institution-based curative health care at a cost. In contrast, the public health care system provides services either free of cost or at an affordable cost and mainly focuses on health

promotion and preventive treatment, particularly in rural areas. Its presence in urban areas is limited primarily to the delivery of hospital-based curative services. Historically, the public health system in India has been preoccupied with the delivery of maternal and child health care services, as demonstrated by various national level programmes launched from time to time. These programmes appear to have produced substantial improvements in mortality in younger ages, and reduction in female reproductive mortality. However, meeting the health needs of the older population appears to have received only residual attention. The focus on the rural areas in the organisation of public health services is reflected in above average gain in LEB in the rural areas, especially rural females, whereas LEB gain in urban areas has lagged. India launched the National Urban Health Mission in 2013 to address urban health concerns (Government of India, 2013) which has now become a part of the National Health Mission (Government of India, 2016). In 2018, the Ayushman Bharat scheme has been launched to improve health of the population and drastically reduce or eliminate health care-related impoverishment through universal health coverage. The Ayushman Bharat is a publicly financed health insurance scheme for the socioeconomically deprived rural population and selected occupational categories of the urban population (Keshri and Gupta, 2020).

The analysis presented in this article highlights two critical imperatives for India as regards improvement in the health of the people of the country. The first imperative is to explore further the factors, both exogenous and endogenous to the health care delivery system, that are responsible for the inequality in the gain in LEB across mutually exclusive population groups. An understanding of these factors is important since reducing this inequality may contribute to accelerating in the countrywide gain in LEB. Reasons for these disparities are not yet fully understood. In Karnataka, Kerala and Punjab, the gain in LEB has been less than expected in all of the four mutually exclusive population sub-groups, whereas the gain in LEB in Tamil Nadu has been more than that expected. In other states of the country, the gain in LEB has been more than that expected in some population groups but less than expected in others.

The second imperative of the present analysis is that health policy and planning for meeting the health needs of the people of India must adopt a more nuanced and integrated approach than the existing highly centralised approach. The

present analysis highlights the need for moving towards a decentralised approach to health policy and planning that is sensitive to the marked inequality or disparity in population health that appears to be quite pervasive in India. Setting up separate population health goals for different population groups may be a step in this direction. These goals may be defined in terms of either the gain LEB or in terms of some other appropriate indicator of population health. Estimates of age-specific mortality rates and resulting LEB are currently available for 88 mutually exclusive population groups, cross-classified by 22 states and four mutually exclusive population sub-groups in each state through the official sample registration system. These estimates may serve as the basis for setting up group-specific population health goals. Such an approach may lead to reducing within-country disparities in population health. A reduction in the disparities in population health is an operationally feasible and optimal strategy towards accelerated improvement in population health in India which remains low by international standards.

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RESEARCH ARTICLE

Community pressure drives population pressure: evidence of social influence on Israeli fertility

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Abstract

Israel presents an anomalous fertility case: the non-Jewish sectors demonstrate dramatic fertility decline whereas the Jewish sectors maintain perplexingly high fertility rates. Traditional explanations of demographic trends focusing on economic development, educational level, women's empowerment or contraceptive availability fall short in explaining the current situation. A national online survey (n=602) conducted in April – May 2020 explored a wide range of drivers of fertility behaviour trends. Descriptive analysis supported by further multivariate linear regression analysis identified congruence with social influence as central factor contributing to high fertility rates and the homogeneity within Israel's disparate Jewish communities. Strong statistical correlation was found between answers to questions relating to desired family size, ideal family size, perceptions of average family size in one's community and actual fertility. Additionally, the number of siblings and the number of children currently in a family affect fertility, whereas other demographic factors, including education and income levels, were not statistically significant. Increased understanding of these social factors can contribute to more effective population policies in Israel and other high-fertility countries.

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Keywords: Israel, social influence, population dynamics, fertility, ideal family size, desired family size

Introduction

The role of social influences to explain fertility behaviours and subsequent transitions has been discussed for nearly fifty years (Berrington, 2021; Coale, 1973; Greenhalgh, 1996; Casterline, 2001; Szreter, 1993). Both personal economic factors (e.g., career trajectory or economic stability) and social factors (e.g., support networks or community resources) may inform one's decision to have a child (Dasgupta and Dasgupta, 2017; Lois and Becker, 2014), suggesting that, in economically developed countries, social influences may prove more salient than economic factors.

Extended family, friends and the larger social community all provide incentives, pressures or motivations to have children. These social forces may be overt, like one's parents pressuring for grandchildren, or they may be covert, such as the admiration and praise for social cohort members successfully managing families with multiple children (Bernardi and Klärner, 2014). A more recent social force is concern over environmental impacts and the associated uncertainties about the future. The environmental consequences of having children or what kind of future they might have, in light of climate change and other emerging environmental challenges, have also appeared as topics for consideration prior to conception (Helm et al., 2021; Murtaugh and Schlax, 2009; Stern and Wolske, 2017; Wynes and Nicholas, 2017).

Developed countries which are member states of the Organization for Economic Cooperation and Development (OECD) have experienced almost uniformly low total fertility rates below replacement levels (D'Addio and D'Ercole, 2005; OECD, 2024). Israel [2] historically has been a demographic outlier, the only OECD country with both an expanding gross domestic product (GDP) and a consistently high total fertility rate (TFR), above replacement fertility levels, particularly in the Jewish sector of society (DellaPergola et al., 2014; Weinreb, 2023). In 2024 the Israeli TFR was 2.9 versus a TFR average across the OECD countries of 1.5

2 In discussing Israel and its population trends, this paper is not referencing population growth trends that include Palestinians living under the authority of the Palestinian Authority (PA) in the West Bank or in the Gaza Strip under the authority of Hamas.

(Reuters and TOI Staff, 2024). The negative correlation apparent between the economic development of OECD countries and their low fertility rates reinforces the perspective, Israel notwithstanding, that economic development is the key to reducing fertility rates. Concerns over increasing population sizes in developing countries continue to be addressed by policies anchored in economic terms and frameworks (Adam, 2021; Madsen et al., 2018), even as research shows that economic incentives appear to have limited influence on fertility rates (D'Addio and D'Ercole, 2005; Gauthier and Hatzius, 1997).

This article re-assesses the anomaly of Israeli population growth and considers why Israel's birth rate continues to be high despite a convergence of factors that would otherwise lead to declines in birth rates as seen in comparison to that of other developed countries. Based on the results of a national survey, the present study provides a broad selection of variables from which it may be possible to identify more specifically the drivers underlying social norms in Israel. This is the first peer-reviewed study we are aware of that considers the individual's social perception variables such as ideal, desired and perceptions of community family sizes together with a full set of demographic variables.

This paper first reviews influences that lead to changes in fertility rates and behaviours. Then Israel is presented as a case study. In the subsequent section the data collection for a national study and the analytical methods used to evaluate the data are outlined. Next comes a discussion of the survey results in light of the observed fertility behaviours in Israel. Finally, the article draws conclusions about the forces influencing Israeli fertility trends.

Changing fertility rates and behaviours

The literature analysing these socio-economic forces influencing fertility behaviours is robust and includes evaluation of economic incentives, access to education, empowerment of women and interpersonal factors that exist within a society (Berrington, 2021; McAllister et al., 2016; Montgomery and Casterline, 1996). Some of these forces are applied deliberately, with expected results, while other forces are applied more subtly or even unintentionally, influencing fertility behaviour imperceptibly, unbeknownst to most members of the society.

Economic incentives and drivers

Economic demographic theories and policy recommendations began with a focus on the negative relationship between fertility and income (individual or GDP) (Becker, 1960, 1991). Fertility rates decline as either countries or individuals improve their economic wellbeing (Madsen et al., 2018). The dominant perspective argues that, if parents place an emphasis on the rational assessment of the opportunity cost of additional children, parents are expected to have fewer children and invest more in the development of the children they do have (Easterlin, 1975; Ermisch, 1988; Willis, 1973).

The economic demographic thinking has evolved since the 1960s (Pampel and Peters, 1995; Robinson, 1997), recognising other economic influences on fertility decision-making. Gender parity in employment opportunities (McAllister et al., 2016), reduced social inequality (Macias, 2015), avoidance of traditional gender roles (D'Addio and D'Ercole, 2005) and state transfer payments (Cohen et al., 2013) have all been connected to changes in fertility behaviours. In high income countries, as women's participation in the labour force increases, fertility rates decline; in lower income countries fertility declines have been observed in connection with indirect economic development efforts (Adam, 2021).

Education as a tool to reduce fertility

Access to education for girls and women consistently results in a decline in fertility rates (Bongaarts, 2003; Emil Vollset et al., 2020; Madsen et al., 2018; Meisenberg, 2008; Sheikh and Loney, 2018). Education contributes to female empowerment and transforming women's status within the family, community and/or society. Women have been observed to delay their decision to have their first child to enrol in a higher education degree programme (Aassve et al., 2012), or even until they have completed their degree (D'Addio and D'Ercole, 2005; Martin, 2000). Education contributes to equality in professional opportunities which empowers girls and women to delay marriage or first births (Basu, 2002). Improved professional opportunities increase women's earning potential and overall empowerment. In contrast, levels of education for men and for those in higher socioeconomic bands do not necessarily translate to preferences for smaller families (Weeden et al., 2006).

Education is also a tool to dispel myths about contraception and empower women to use family planning, resulting in lower family size preferences and fertility levels (Bongaarts and Hodgson, 2022a). Women with education have been observed to be better prepared for and more likely to survive childbirth. Their children also have improved child survival rates (Kim, 2016), leading ultimately to fewer pregnancies to ensure some children survive to adulthood. Parents may also prioritise a smaller family to enable greater access to education, in order to enhance future socio-economic conditions for their children (Axinn and Barber, 2001; Knodel et al., 1990).

Contraception and family planning

Contraception use has historically led to declining fertility rates and smaller families. Both the Millennium Development Goals and the Sustainable Development Goals call for access to reproductive health-care services including contraception (Bongaarts and Hardee, 2017). Obstacles to the use of contraception include lack of knowledge, availability, cost, quality of the contraception and the care provided to receive them, health concerns, side effects, objections from other family members to the use of contraception and general social acceptability (Bongaarts and Hodgson, 2022b). Recent research has focused on the question of demand for versus use of contraception (Bongaarts, 2024). It is not sufficient that contraception is available – women have to want to use it and be empowered to use it for it to be a successful family planning approach. This further requires public support for the use of contraception to remove any stigma associated with family planning. Fundamentally, the use of contraception allows women to control their fertility. While this is empowering for women it can be threatening to men or more broadly to a society if that clashes with the norms of the community.

Social norms and preferences

Family size preference is a core determinant of high (Bongaarts, 2011; Bongaarts and Hodgson, 2022a; O'Sullivan, 2018) and low (Cleland et al., 2020) fertility rates. Preferences are influenced by informal (e.g., neighbours and friends) and formal social structures (e.g., religious communities) (Bernardi et al., 2007; Lois and Becker, 2014; McAllister et al., 2016; Okun, 2017; Potts, 1997). Members of a cohort acquire a more positive perception of raising a family to align with the behaviour of their cohort (Lois and Becker, 2014) and to remain within their established social network (Fent et al., 2013); children become a requirement for maintaining one's

social capital. In societies with stronger expectations for compliance with social mores, uniformity of fertility behaviours is further enhanced, even without explicit enforcement (Dasgupta and Dasgupta, 2017; Gelfand, 2018; Gelfand et al., 2011). It is therefore not surprising that a correlation between religious observance and family size has consistently been observed (Götmark and Andersson, 2023; Landau, 2003; Turner and Götmark, 2023).

In an attempt to identify how social norms influence fertility behaviours Bernardi and Klärner (2014) name four possible mechanisms: social learning, social pressure, contagion and social support. These mechanisms can be observed in individuals learning through observing others or mimicking the behaviors of others around them. The desire or necessity to conform to the expectations of others as well as the impact of resources available in one's social network are also factors that might influence fertility behaviours of the individual. Even if one or more social norm is identified, establishing a family remains a deeply personal decision, confounding the ability to isolate the influence of external motivations (Cleland et al., 2020) and social cohort influence (Merli et al., 2020).

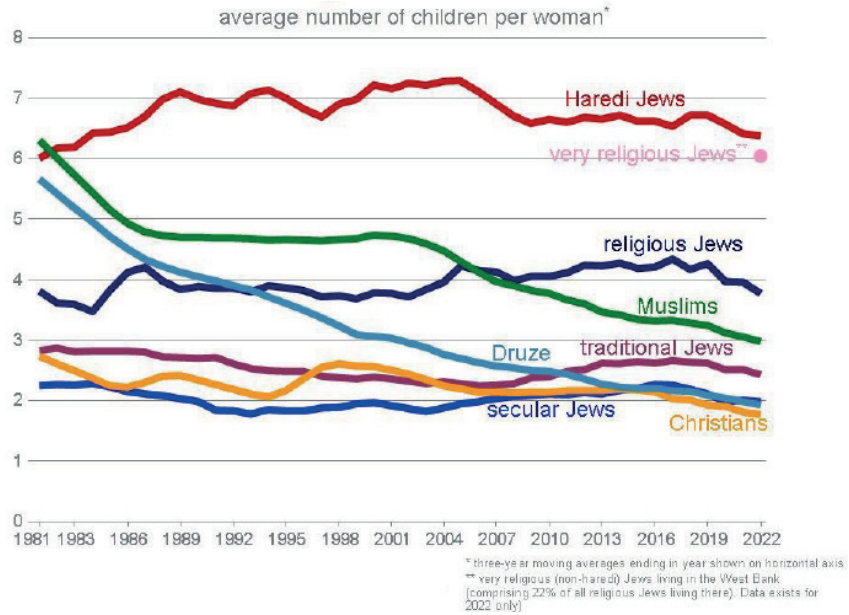
Israel as a case study

In just over 77 years, Israel has pursued and embraced economic and technological development to transform a country of post-war refugees into a bustling modern nation-state. Since joining the OECD in 2010, Israel's per capita GDP has been slightly above the OECD average (MacroTrends, n.d.b); its population size of just under 9.5 million people places it in the bottom quartile of OECD countries. In 2024, Israel had a TFR of 2.9, having been the only OECD country with an increasing fertility rate throughout the last decade (MacroTrends, n.d.a). Israel's demographic profile is commonly characterised based on religious affiliation and level of religiosity. The country is comprised of Jewish, Muslim, Christian and Druze populations (the latter three sometimes clustered as Arabic-speaking or 'non-Jewish'). Further, the Jewish population is often divided into secular, traditional, religious and ultra-Orthodox sectors with movement between the sectors.

High fertility rates (Figure 1) are prevalent throughout Israel's Jewish sectors, while birth rates in the non-Jewish communities (i.e., Muslim, Christian, Druze, atheist) have significantly declined throughout both the 1960s and 1970s, and again more recently in the 2010s (Staetsky, 2019). Given its small land area and

assuming a continued two per cent average annual population growth rate, Israel is projected to become one of the most densely populated countries on the planet by 2065, second only to Bangladesh (Ben-David, 2018).

Figure 1. Fertility rates in Israel



SOURCE: COURTESY OF THE SHORESH INSTITUTION FOR SOCIOECONOMIC RESEARCH.

Israel's founders perceived the country and the Jewish people under the constant threat of a 'continuity crisis', leading to the implementation of pro-natal policies (Kravel-Tovi, 2020: 6). Tensions between immigrant populations over differing birthrates informed population policies in the early years of statehood. Jewish communities with higher birth rates (i.e., Middle Eastern and North African immigrants) were encouraged to have smaller families under the banner of poverty alleviation, while communities with lower birth rates (i.e., European immigrants), who were seen as economically better-off, were encouraged to have larger families (Tal, 2016). The result was an asymmetrical, preferential and discriminatory fertility policy (Birenbaum-Carmeli and Carmeli, 2010; Hashash-Daniel, 2010).

Four main themes have been suggested to explain the ideological motivations to prefer large families. First, the magnitude of losses from the Holocaust cast a long shadow over the surviving generations and their children, sparking a desire to rebuild the Jewish people (Manski and Mayshar, 2003). Second, the potential reality of a Jewish minority in its first sovereign state compared to its Arab neighbours resulted in what some have considered a demographic war to increase the Jewish population in relation to the Arab population (Orenstein, 2004). Third, the ongoing wars and conflicts with Israel's Arab neighbours drove both a desire to ensure future generations of soldiers and as an 'insurance policy' for parents who must send their sons to battle and risk losing them (Kraft, 2018; Orenstein, 2004; Sperling, 2010; Yuval-Davis, 1996). Finally, the biblical commandment to 'be fruitful and multiply' was emphasised across the entire society, and especially within religious communities (Landau, 2003; Sperling, 2010; Tal, 2016).

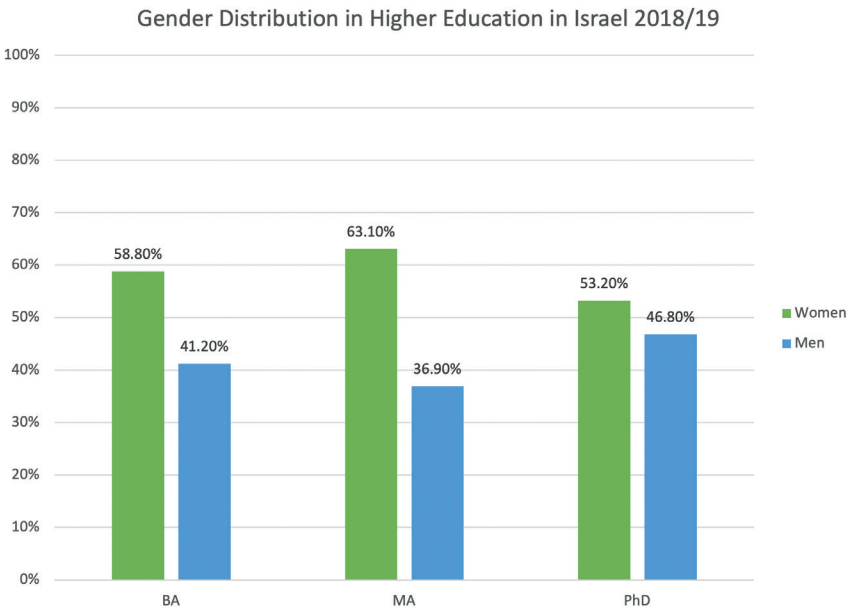
Israelis who choose not to have children face the risk of being deemed 'selfish' or 'barren', may find themselves excluded socially and may not be viewed as full adult members of society (Berkovitch, 1997; Birenbaum-Carmeli, 2016; Bystrov, 2016; Granek and Nakash, 2017). This may even be the case among couples with fewer than three children (Birenbaum-Carmeli, 2004; Granek et al., 2017; Kraft, 2018; Sperling and Simon, 2010). Choosing not to have children or regretting the ones you have are pervasive taboos in Israel across all religious sectors (Donath, 2015, 2017). Israeli culture is positively pro-natal and family oriented.

Policies in Israel that affect income levels show little to no influence on fertility behaviours (Cohen et al., 2013). The average family size remains consistent, regardless of income levels, in each of the Jewish sectors of Israeli society (Central Bureau of Statistics, 2021a). Anecdotally there are indications that those earning above middle-class income levels may in fact choose to have four or more children, presumably a function of their higher disposable income (Starkman, 2020); more research is warranted to fully understand this case. Amongst the poorest Israelis, where many of the largest families are found, the relationship between income level and family size is more complicated, given large numbers of ultra-Orthodox (i.e., the most religious sector) in this group. Establishing the poverty line based on income levels or the cost of basic goods may not accurately characterise the socio-economic conditions within the ultra-Orthodox Jewish communities, which often operate with strong sharing economies that do not necessitate high levels of income (Berman, 2000). A more nuanced understanding of internal socio-economic dynamics would

better represent the actual economic well-being of these communities (Zaken, 2018) and shed light on how economic policies influence family size decisions.

According to a 2021 OECD report, Israel has a well-educated population. Israel ranks above the OECD average for tertiary education for men and women up to age 34 (OECD, 2021a). A 2018 report to the Israeli parliament summarised the representation of female students in Israeli higher education (Lerer and Avgar, 2018). Israeli women represent a larger percentage of students in higher education than men at all degree levels and across all ethnic sectors of society (see Figure 2). Even in the Bedouin and ultra-Orthodox sectors, where high levels of poverty and fertility are prominent, women remain more likely to obtain higher education than men. In comparison globally, Israel is the only country with a TFR above 1.80 and an average of twelve or more years of schooling for girls and women (UN, World Population Prospects, 2024).

Figure 2. Gender Distribution in Higher Education in Israel for the Academic Year 2018-2019 Across Three Levels of Degrees Granted



SOURCE: CENTRAL BUREAU OF STATISTICS (ISRAEL) (HTTPS://WWW.CBS.GOV.IL/EN/PUBLICATIONS/PAGES/2019/STUDENTS-INSTITUTIONS-OF-HIGHER-EDUCATION-2007-2019.ASPX).

State support for families is front-loaded with pre-pregnancy, pre-natal and birth related benefits, resulting in a sense of government assistance for parents that encourages fertility. Israel's well-known and exceptionally generous provisioning of IVF treatment compared to all other developed nations contributes to a perception that the state is economically supportive of new parents (Birenbaum-Carmeli, 2004; Birenbaum-Carmeli, 2016; Sperling, 2010). Birth grants drop off precipitously after the second birth; payments for multiple births (e.g., twins) are considerably higher. Parents are eligible for maternity and paternity leave, day-care subsidies, income tax reductions, accommodations to care for sick dependents, along with monthly child welfare payments regardless of employment status, a national savings programme for each child and free education from age three.

This appears to be a magnanimous basket of social benefits for parents. In fact, compared to European nations, the social benefits provided to new parents in Israel are meagre. Depending on the mother's employment history prior to the birth of a child, Israeli mothers and fathers can share up to fifteen paid weeks of maternity/paternity leave. Only four other European countries in the OECD provide fewer weeks of paid parental leave (OECD, 2021b).[3] Additional unpaid leave time is available to Israeli women. Monthly cash transfers to families, while often in the news and on the government's agenda, also compare poorly to European countries (Matthews, 2016; OECD, 2019). Perhaps more important, the cost of living in Israel is higher than in most European countries[4] where the prodigious expense associated with raising a child is one reason why birth rates are low (Kalia, 2021). These economic, educational and 'social-safety-net' factors would suggest that Israel should already be near or below replacement level fertility, which is clearly not the case.

Social norms and community forces vary significantly between subgroups within Israeli society and influence differential fertility behaviours. As mentioned, Israel's Jewish population has clear societal divisions primarily predicated on religious

3 Parental leave is a combination of maternity or paternity leave immediately after the birth of a child together with parental or home care leave. In both cases these benefits may be paid or unpaid or some combination.

4 Only Switzerland, Sweden, and Norway are more expensive, based on data provided here https://www.numbeo.com/cost-of-living/rankings_by_country.jsp (last accessed 20 Aug. 2022).

observance that correlate with large differences in fertility, from 6.38 TFR among the ultra-Orthodox Jews to 1.98 TFR among secular Jews (Weinreb, 2023).

In 2023, the Jewish population in Israel was estimated at 11% ultra-Orthodox, 13% religious (understood as National Religious), 32% traditional and 44% secular (*Population Religiosity by Religion in Israel 2023*, 2025). The ultra-Orthodox Jewish sector contains numerous smaller sects that tend to be close-knit and cloistered and span a range from those who use technology to those who shun the internet and television and primarily speak Yiddish rather than Hebrew. The National Religious sector is a more modern and slightly more progressive, geographically integrated branch of Orthodox Judaism, with a strong sense of national identity as Israelis. A large percentage of the Jewish Israeli population identify as 'traditional', a broad and diverse swath of society that is neither observant/Orthodox nor secular. Many 'traditional' Jews are of Mizrahi origins from North Africa and the Middle East. Those who do not identify with any level of religious observance comprise the secular Jewish sector.

The National Religious and the ultra-Orthodox have been of particular interest in the literature on Israeli fertility behaviours; religious observance within a homogeneous community influences uniformity of fertility norms and ideals. In the National Religious sector engagement with community activities has been shown to relate to family size and the convergence of similar family sizes within those communities (Okun, 2017). Ultra-Orthodox communities have been compared to clubs with membership predicated on family size (Berman, 2000). Families that meet membership requirements (i.e., are sufficiently large) may access the benefits of the club including bulk purchasing schemes and charitable loans of goods or money. In a self-perpetuating loop, access to member-only economic resources is necessary to provide a desired (or, at least a minimum) quality of life for oneself and one's family within this sector. Alignment with community and societal norms around fertility behaviours play a significant role in the Jewish sector of Israeli society.

Methods

Choice of research method

This research is based on a national survey exploring individuals' general attitudes about fertility decisions and trends in Israel. It focuses solely on the population within Israel proper, not the West Bank or Gaza territories. Survey questions

focused on fertility decisions and behaviours; attitudes about having and raising children; concerns for the future; opinions of current and potential fertility policies; and perceptions of population growth, crowding and environmental impacts from population growth.

Of particular interest are several questions that probed attitudes about respondents' family size and the perceptions of others' family sizes, and of those who do not have children. Respondents were queried about their 'ideal' and 'desired' family sizes. 'Desired' references one's ideal of family size for him or herself. The use of the term 'desired family size' is less accurate when fertility is low (not the case in Israel) (Trent, 1980). It tends to be relatively uniform across social groups (Bacci, 2001), which, as we shall see, is not the case in Israel. 'Ideal' creates an opening for survey respondents to share their attitudes about family size without regard to their own personal plans. Questions pertaining to 'ideal family size' have value in measuring societal pro-natalism. This was confirmed by research in the 1960s and 1970s in America showing that the two child 'ideal' family emerged in parallel with media attention on overpopulation (Trent, 1980).

The survey was conducted by an internet research company, iPanel, which includes a panel of Arabic-speaking Israelis. Respondents were previously registered with this company and had expressed an interest in completing surveys for compensation, as is the industry practice. The sample reflected Israeli society demographically as closely as possible, based on previously collected demographic information held by the company. There was no obligation or coercion to complete the survey; compensation was provided by iPanel.

Internet survey tools such as iPanel, while not providing randomised and representative survey sampling, do offer a few noteworthy benefits. In seeking to reach a demographic in their years of fertility, online surveys are the most effective and efficient survey option, remunerated or not. Internet-based surveys may reduce recording errors, because individuals record their own responses (Groves et al., 2009). For sensitive subjects such as fertility, completing the survey in the privacy of one's home enhances anonymity for respondents (Hewson et al., 2015).

This method could introduce an element of bias, as only those with both access to the internet and the free time to answer surveys for remuneration become

the sample population. Specifically in Israel, there could be difficulty in reaching the ultra-Orthodox and nomadic Bedouin populations with this survey method and affluent Israelis may be underrepresented. Reaching these communities will require in person relationship building to allow for interviews or focus groups to collect similar data. The internet survey method for this study provides an effective, albeit imperfect, trade-off between sample size, subgroup representation and ease of participation, administration and subsequent analysis and interpretation (Hewson et al., 2015; Tourangeau et al., 2013).

Sample composition

The survey was available online from mid-April until mid-May 2020. The survey company provided a nationally representative sample of 602 respondents (n = 602), sufficient to ensure a 95% confidence level with a 5% margin of error, given the population in Israel at the time of 9 million people.[5] Under-sampling was expected for several hard-to-reach sectors of Israeli society, specifically the Haredi and Negev Bedouin communities, due to limited internet access (Groves et al., 2009). To mirror the demographic reality in Israel, 20% of respondents self-identified as non-Jewish and 80% identified as Jewish.

The first question of the survey prompted respondents to select a language, either Hebrew or Arabic. Respondents were then asked to self-identify as Jewish, Muslim, Christian, Druze, no religion or other, with a space to be specific. The second question clarified the level of religiosity with categories for Jews and non-Jews that were different based on commonly used terminology. From the next question, the survey began to address issues of family size, asking respondents the number of children they had. Those who answered none skipped a series of questions specific to their children (e.g., ages) and to parenting. At the end of the survey, additional demographic questions were asked about education, income levels, country of origin and current geographic location of residence, age, gender, marital status and voting preferences.

Given this research focus on fertility, the age distribution of the sample was intentionally skewed in favour of those under the age of fifty; the sample

5 This was calculated using the sample size calculation tool found here: https://www.qualtrics.com/blog/calculating-sample-size/ a sample size of 385 is sufficient for 95% confidence and a 5% margin of error.

population does not reflect the age distribution of the broader Israeli population. The distributions based on religion (i.e., Jewish, Muslim, all other) and voting pattern for the most recent election during the survey launch period (i.e., twenty-third Knesset) were consistent with the nationally reported figures. For the demographic factors of district of residence, religiosity, marital status, age at first marriage, country of birth, education level and household income, attention was given to ensure representative sampling.

The survey data required significant cleaning and standardising to combine the datasets from the Jewish and non-Jewish respondents. All responses were translated from Hebrew and Arabic to English for the analysis. Due to nuances in the divisions by religiosity, different options were given to these two groups which were then aligned. Age brackets were created for the analysis phase and original ages given were preserved in the dataset as well. Given the small number of responses indicating eight or more for questions related to family size, these were placed in a new category of 8+; the original answers were preserved.

Table 1 summarises key elements of the demographic composition of the survey sample. The gender split of 51.5% female, 48.5% male is consistent with the national gender distribution of 50.3% female and 49.7% male. Even as the age distribution of the sample skewed toward the younger age brackets, as intended, it remained within a few percentage points of the national distribution. For example, in 2020 in the Israeli population 17.3% were between the ages of 18-24 and in the survey 18.4% of respondents were in this age bracket (see Appendix 1). In 2020, the Central Bureau of Statistics reported 74.1% of Israeli society being Jewish, the survey sample was 76.4% (Central Bureau of Statistics, 2021b). Other demographic characteristics (e.g., education level, geographic location, country of birth) represent a cross-section of Israeli society to ensure that all sectors were included.

This article focuses on a subset of questions from the larger survey and their relationship to each other. These questions included:

- How many siblings do you have?
- How many children do you have?
- What is the ideal number of children you want to have?

Table 1. Demographic Distribution of Survey Sample

Sample n=602											
Panel	**Religion**	**Gender**		**Religiosity**		**Education**		**Income Level**		**# of kids in family**	
Jewish		Female	236	Secular	199	Elementary or middle school	8	Unemployed	18	None	143
n=460		Male	224	Traditional	158	High School	41	Far below the average	57	1 to 4	282
				Religious	56	Bagrut certificate[7]	119	A bit below the average	75	5 or more	35
				Very Religious	47	Other non-academic certification	66	Similar to the average	102		
						BA	151	A bit above the average	118		
						MA	71	Well above the average	46		
						PhD	4	Don't want to answer	44		

SOURCE: AUTHOR

7 A Bagrut certificate is certification of completing the matriculation exams upon graduating from high school. It is in addition to a standard high school completion diploma.

Table 1. Continued

Sample n=602												
Panel	**Religion**		**Gender**		**Religiosity**		**Education**		**Income Level**		**# of kids in family**	
Non-Jewish n=142	Muslim	115	Female	74	Secular	24	BA	55	Unemployed	5	None	65
	Other (Christian, Atheist, Druze)	27	Male	68	Traditional	14	Bagrut certificate	50	Far below the average	51	1 to 4	64
					Religious	85	Elementary or middle school	4	A bit below the average	31	5 or more	13
					Very Religious	19	High School	13	Similar to the average	29		
							MA	14	A bit above the average	18		
							Other non-academic certification	5	Well above the average	3		
							PhD	1	Don't want to answer	5		

SOURCE: AUTHOR

Table 2. Descriptive Statistics of Key Variables

Desired Family Size				
Min	Max	Mean	Median	Standard Dev
0	20	3.84	3	2.46

Ideal Family Size				
Min	Max	Mean	Median	Standard Dev
0	15	3.84	3	1.85

Average Family Size in Community				
Min	Max	Mean	Median	Standard Dev
1	25	3.89	3	2.36

SOURCE: AUTHOR

- How many children on average do other people in your community have?
- What is the ideal number of children in a family?
- Do you feel that the State encourages you to have more children?

Multivariate linear regression analyses were conducted on each of these questions to identify the presence, or absence, of influencing demographic characteristics. Independent variables included gender, number of siblings, number of children and average family size in the respondent's community, with dummy variables for age group, district of residence, marital status, income group and religion. Dependent variables were ideal number of children in a family and desired number of children.

Findings

The initial statistical analysis revealed a strong correlation between desired family size, ideal family size and average community family size for all demographic factors (Tables 2, 3). Responses to these three questions have nearly identical mean values of 3.84 or 3.89 children. The calculated standard deviation value for these three questions demonstrated noteworthy similarity prompting further inquiry into the nature of the interactions between these three variables. Frequency distributions of all three variables demonstrate a concentration around a family size of three to

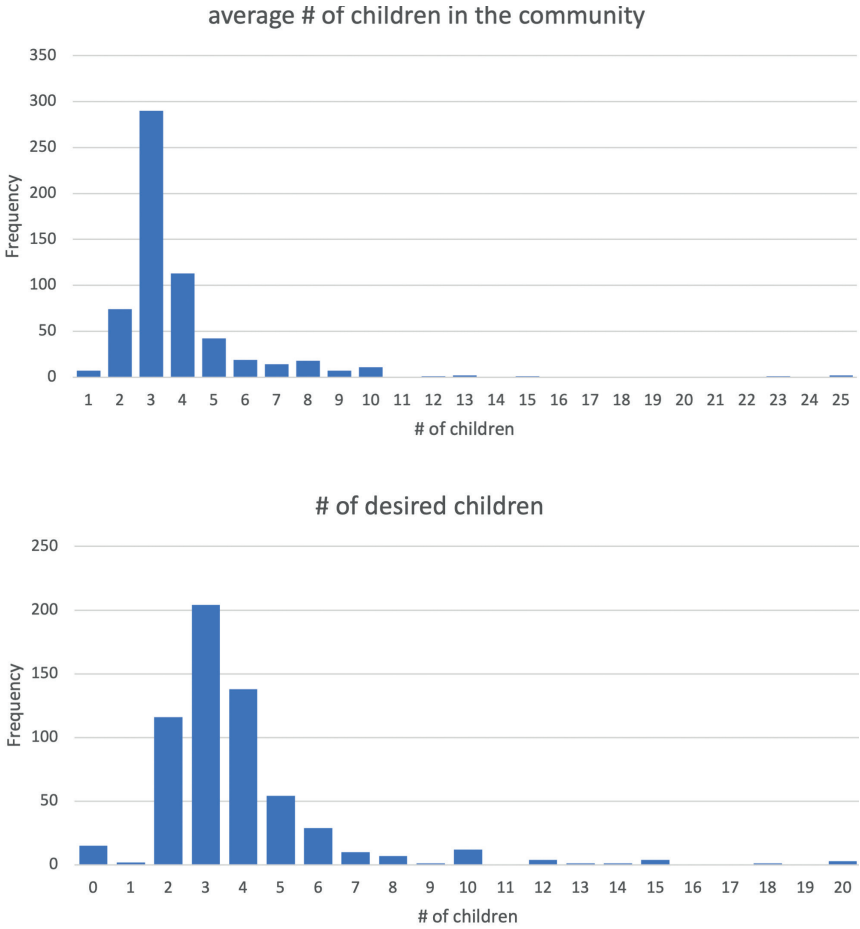
Table 3. Correlation Coefficients for Key Variables

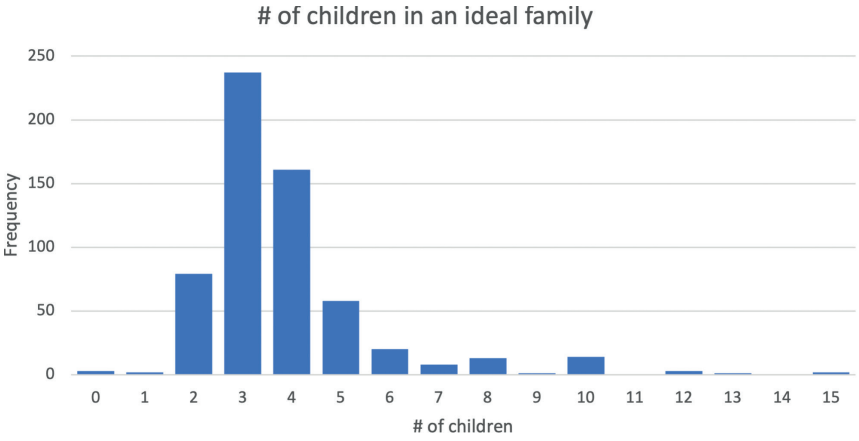
		Desired Family Size	Ideal Family Size	Average Family in one's Community	Religiosity	Current # of kid	Siblings
Family Size Realization	Desired Family Size	1					
	Ideal Family Size	**0.788**	1				
Community Norms	Average Family in one's Community	0.412	0.531	1			
	Religiosity	0.471	0.512	0.387	1		
Lived Experience	Current # of kids	0.327	0.367	0.106	0.197	1	
	Siblings	0.360	0.380	0.417	0.441	0.220	1

SOURCE: AUTHOR

four children (Figure 3). A closer examination of the difference between reported desired family size and ideal family size reveals that 59% of respondents reported the same number for both, while an additional 27% reported a difference of only one child. Accordingly, 86% of respondents reported a desired and ideal family size that differed by no more than one child (Figure 4).

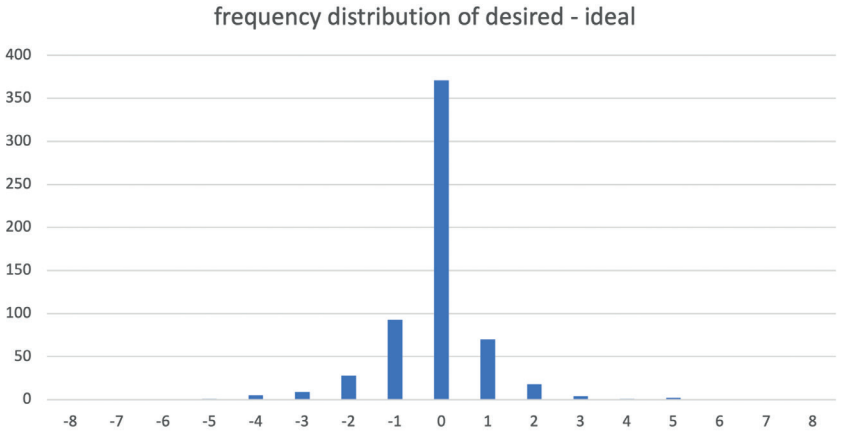
Figure 3 a, b, c. Distributions of Reported Desired Number of Children, Ideal Number of Children in a Family and Average Number of Children in Families in the Community (n=602)





SOURCE: AUTHOR

Figure 4. Frequency of Difference Between Desired and Ideal Family Size



SOURCE: AUTHOR, MITCHELL SMALL

Jewish respondents reported larger family size preferences compared to the non-Jewish respondents (Figure 5). Religiosity also influences family size preferences and impressions among the Jewish respondents. More religious respondents self-reported larger desired, ideal and perceived average community family sizes (Figure 6). Neither of these findings was unexpected, as they are consistent with official reports (Central Bureau of Statistics, 2021a). When asked about the average

family size in their community Muslim respondents reported larger average family sizes compared to the other religious groups. The one exception was for the 'very religious' respondents where Jewish respondents reported larger average family size in their communities compared to the non-Jewish 'very religious' respondents.

Figure 5. Average Number of Children by Religion

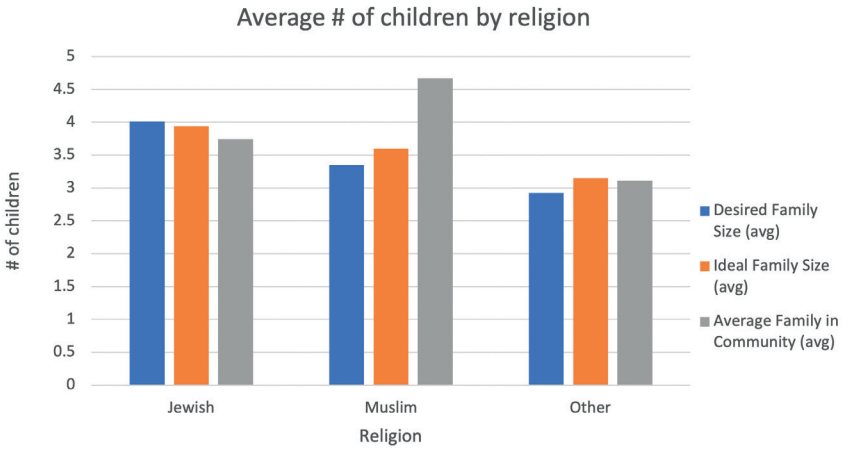
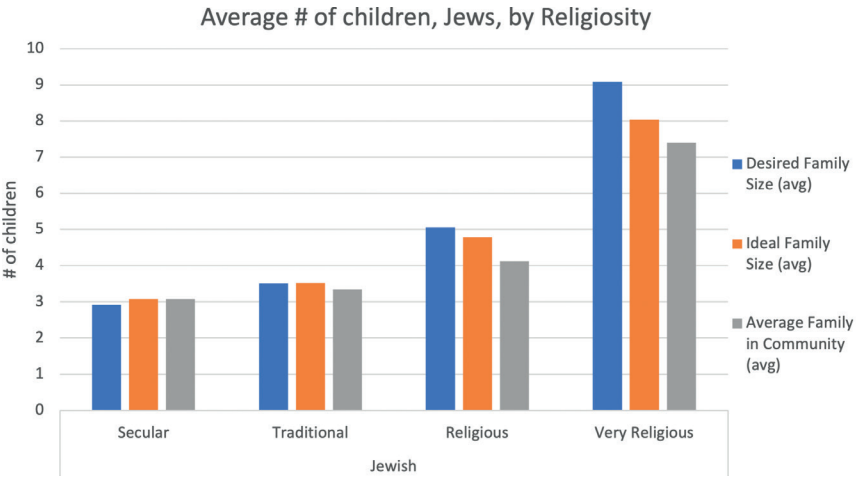


Figure 6. Average Number of Children, Jews, by Religiosity



SOURCE: AUTHOR

Results of a regression analysis revealed no statistically significant relationship between attitudes about desired, ideal or perceived average community family size and the other demographic factors of socio-economic status, gender, age and education. Influences that come from within the community or the larger society did demonstrate a statistically significant relationship. One influence was the size of respondents' origin family (i.e., number of siblings) where those reporting more siblings also reported larger desired and ideal family sizes. Each additional sibling reported resulted in a reported desire for 0.13–0.14 more children and 0.1–0.11 more children in an ideal family. Respondents from larger origin families also reported larger average family sizes in their communities.

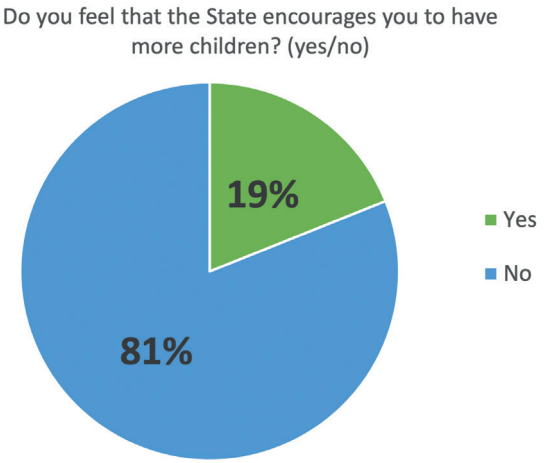
The other statistically significant explanatory variable indicating larger desired and ideal family size was the current number of children. The more children a respondent reported currently having, the larger their desired and ideal family sizes. Respondents desired between 0.23 and 0.25 more children per additional child already in their family. The same was true in relation to ideal family size, where we see an influence of 0.21 to 0.24 more children in an ideal family for each additional child a family already has. It is important to note that these respondents were on average older and so farther into the role of parenting and the establishment of families, compared to respondents indicating a preference for a smaller family. One possible explanation is that one's lived experience may influence family size preferences or aspirations. Cognitive dissonance may also play a role for the younger generation who may prefer a smaller family for economic or environmental reasons which clash with their origin family size, or their perceptions of what others are doing. Another possible explanation is that younger Jewish Israelis are shifting to a preference for smaller families. This is an important point for future investigation.

Concerning family sizes in the community, the larger the reported average family size in one's community, the larger the reported desired number of children. For each additional child reported as the community average, respondents indicated a desire for between 0.19–0.25 more children. The same trend exists when asked about ideal family size. For each additional child perceived in one's community, the ideal family size increased by 0.26–0.29 children.

Given the perception of broad, pro-natal government programmes as previously discussed, we expected that respondents would report strong state support for

and encouragement to have larger families. Instead, across all demographic factors, respondents answered that the state does not encourage one to have more children; 82 per cent of the entire sample answered this question in the negative (Figure 7). It is important to note that this question asked generically about the state encouraging the survey respondent to have more children. The survey did not enquire how respondents viewed specific pro-family or pro-natal policies provided by the state.

Figure 7. Perception of State Influence on Fertility



Discussion

Across all sectors of Israeli society, families of three or more children are desired, idealised and perceived as the norm, with survey results demonstrating a statistically significant consistency and correlation between these variables.

The relationship between the number of siblings, the number of children currently in one's family, desired, and idealised family size all correlate with larger families. These results are unsurprising; one's lived experience certainly influences one's desires and behaviours (Bongaarts, 2011; Manski and Mayshar, 2003; Okun, 2013; O'Sullivan, 2018). As the learning curve of parenting shortens with each additional child, parents may develop confidence in managing larger families which translates into a desire or preference for more children. When other families in

one's community are also managing larger families, it can provide a subtle boost of confidence to parents of smaller families that they too can cope with larger ones (Dasgupta and Dasgupta, 2017).

As expected, the level of religiosity is a significant factor in encouraging larger family size expectations (Rotkirch, 2020). Those reporting greater levels of religious observance in the Jewish sector also reported desiring and idealizing larger families, which aligns with the current demographic reality of larger family norms in more religious communities. Religious respondents also believed that the families in their communities were larger compared to the less religious respondents.

Finally, in evaluating the influence of socio-economic status and education levels on desired, ideal and community family size, no statistically significant influences were identified. In fact, among the Jewish respondents, women holding a bachelor's degree or higher (e.g., an academic degree) reported larger desired and idealised family sizes compared to respondents without a degree. This runs contrary to what other research has found (Lutz et al., 2019), suggesting that access to higher education has limited, if any, influence on Jewish women desiring smaller families in Israel. Given the strong societal emphasis on women being mothers and having careers in Israel (Okun, 2016), this finding is not surprising, even as it is exceptional among developed nations.

Taken together, these findings point to the strong influence of social norms and behaviours in Israeli society, specifically in the Jewish sector. What others around you are doing, one's current family size (i.e., current number of children), or one's family origin size (i.e., number of siblings) constitute especially strong influences on fertility (Dasgupta and Dasgupta, 2017). Perhaps the most striking example of the effect of social forces can be seen in the responses of Jewish Israelis who were born in the Former Soviet Union (FSU). Just one generation previously, this immigrant population averaged families of only one child (Nahmias, 2004; Okun and Kagya, 2012; Tolts, 2015). These survey results show that, within one generation, even the population who self-identified as Jewish (predominantly secular), Israeli, but born in the FSU desired 2.72 children on average and idealised 3.21 children on average. This is a highly noteworthy finding, confirming the observed trend that migrants tend to adopt the fertility preferences of their new countries (Majelantle and Navaneetham, 2013).

The immigrant experience is important, albeit poorly understood, in evaluating fertility behaviours and the influence of social networks on these behaviours (Merli et al., 2020; Nahmias, 2004; Okun and Kagya, 2012). Israel's population remains heavily influenced by the immigrant experience. The national narrative relies heavily on Israel as both a homeland and a haven for the world's Jews. As such, unlike migrants seeking a better life or opportunities in another country, immigrants to Israel typically view themselves as returning from a diaspora back to a historic homeland. This dynamic is important and relevant, concerning the social integration of immigrants into their new society. As the results from FSU Israelis shows, there is a strong influence on newer immigrants to comply with societal fertility patterns. This was not a focus of this research effort; however, as Merli (2020) outlined, it is an area in need of further research and Israel may provide an interesting case study.

A consistent preference for larger than average[6] families would not be surprising if the state were in fact implementing generous pro-natal policies. As discussed, however, the benefits provided to parents before, during and after childbirth are in fact quite modest when compared to other OECD countries. Survey respondents confirmed this perception by rejecting the proposition that the state encourages them to have more children. Social and communal norms rather than formal policies seem to be more salient factors.

Understanding why Israel ostensibly serves as a prime candidate for low fertility and yet in fact exhibits high fertility requires a deeper understanding of the interplay between individuals (Grow and van Bavel, 2016). This reinforces previously mentioned research focusing on findings of consistency between community engagement and family size preferences (Berman, 2000; Manski and Mayshar, 2003; Okun, 2017).

Successful family planning policies that take into consideration the characteristics of the society in which they are implemented have proven more successful, in contrast to those that disregard social influences (Fent et al., 2013). The demographic forces at play throughout Israeli society, therefore, present an important case study for evaluating the actual power of social influence as a

6 Average family size in relation to OECD data and definitions as outlined here – https://www.oecd.org/els/family/SF_1_1_Family_size_and_composition.pdf (accessed 20 Sept. 2022).

fertility driver. In addition, this knowledge could provide a strong foundation for the development and implementation of societally appropriate population policies as a means to manage future fertility rates and ensure balance with available natural resources, should this ever become a priority in Israeli society.

Conclusion

Israel's continued high birth rate places the country on a population growth trajectory unlike that of any other OECD country. Some scholars have questioned the ecological viability of maintaining such population expansion and point to the negative social and environmental consequences of such unbridled growth for Israel (ben Tzvi, 2021; Kramer et al., 2022; Shorek, 2021; Starkman, 2020; Tal, 2016). Other immediate and existential threats (e.g., Iran's nuclear development, global security threats to Jewish communities, war with terrorist organisations) divert attention from population growth challenges in Israel, which rarely make it onto the public agenda.

The cumulative effect of Israel's historic policy efforts (Manski and Mayshar, 2003; Tal, 2016) to encourage higher fertility rates has brought Israel to a future population projection of 20 million people by 2065 and minimal political will to introduce population management policies (Central Bureau of Statistics, 2017; Maor, 2018). But, ultimately, limitless population growth is unsustainable. Understanding the forces behind individuals' fertility decision-making is a vital first step to crafting policies capable of stabilising Israel's population.

Policymakers seeking a balance with the available natural resources of the country or seeking to meet international climate change obligations, those concerned about crowding and biodiversity loss, or the ability of the state to maintain social services (e.g., schools, hospitals, and roads) must reckon with the imperative of ending demographic growth and eventually achieving a sustainable population level. Population-driven requirements for agricultural land and new settlements may also limit options for international peace initiatives that may otherwise be viewed as feasible and advantageous for Israel and its neighbours. Understanding the personal motivations of citizens is a necessary element to ensure that the design of population policies incorporates considerations of societal equity and equality for those affected by the policies.

This study seeks to develop a foundational understanding of the forces influencing population growth in Israel. Focusing first on individual intentions and decision-making around fertility is consistent with recent calls for understanding reproductive attitudes and fertility intentions amongst the younger generations in developed countries before attempting to implement policy measures (Helm et al., 2021).

The results of this research suggest that the population management discourse in Israel should focus on social influences together with educational or economic incentives. Results are consistent with previous findings (e.g. Bernardi and Klärner, 2014) that fertility is an individual decision that is primarily influenced by interactions with other members of society. The strong influence of social norms and the behaviour of others may in effect compromise individuals' reproductive autonomy, negating the 'calculus of conscious choice' (Coale, 1973: 65) that has become the ideal throughout much of the world. It also may impede population stabilisation or decline and, thus, the creation of more sustainable societies.

It is clear at the macro level that Israelis have some of the largest families in the developed world. As a country, Israel is a united and compliant society when faced with external threats. Even as fertility rates differ between subpopulations, uniformity within subpopulations reinforces the tightknit nature of the broader society. Far too often, policymakers disregard the influential power of 'peer group effects', even as research has shown that social networks are a key mechanism for explaining fertility (Fent et al., 2013: 964). This reveals a critical piece of the population management policy puzzle: how to best encourage smaller families in Israel based on the understanding of individuals or couples' fertility desires together with their perspective on the broader fertility behaviours of the rest of Israeli society? Further research is needed to identify the mechanisms that are most forcefully at play across Israel's diverse society so that policymakers can formulate a more effective portfolio of policies and incentives.

Acknowledgements

The author would like to express gratitude to the two anonymous reviewers who provided excellent feedback on and critiques of this manuscript. Alon Tal, Phil Cafaro, Jane O'Sullivan, Daniel Orenstein, Daphna Carmeli and Nurit Carmi all provided invaluable help, support and encouragement. Bruce Mann (the author's father) provided patient and unending engagement in support of this research and is sadly missed. Funding to support this research was provided in part by the Bernard Sher Endowment Doctoral Fellowship Fund at Tel Aviv University and the Richard and Rhoda Goldman Fellowship Fund for Better Government.

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BOOK REVIEW

The Ethics of the Climate Crisis
Robin Attfield
Cambridge: Polity Press, 2024.
ISBN: 978-150955909 1. 276 pp.

Environmental ethics and population growth in the work of Robin Attfield

David Samways

Those familiar with environmental ethics will need no introduction to Robin Attfield, a leading figure in the field for over four decades. Across his many books, Attfield has expertly surveyed the scientific and historical dimensions of humanity's impact on nature, as well as exploring the ethical foundations of that impact and of our responses to it.

Attfield's most recent book, *The Ethics of the Climate Crisis* (2024), applies much of his earlier thought to the specific, and perhaps most pressing, environmental problem facing humanity: climate change. As with previous works, Attfield's empirical exploration of the subject is detailed and once again concerned with the practical application of ethics. In particular, he is concerned with demonstrating the ethical case for climate action at all levels of society – from the state and global corporations down to the individual citizen.

Attfield begins by presenting a concise but comprehensive account of the science of climate change, exploring both the causes and the effects as well as demonstrating the robustness of the evidence. Focusing on the notion of tipping points, he makes a strong case for the urgency of action. Although his focus in this work is on climate change, he clearly shows how the tripartite crises of biodiversity,

air pollution and climate change are related in the harm caused to humans and other species and in fact form a single and inseparable environmental emergency with interconnected tipping points.

Having outlined the scientific evidence for the scale of the climate crisis, Attfield turns to the ethical case for action. Underscoring the central role of agency to ethics, Attfield focuses on the capacity of individual and collective actors to reflect and choose, despite constraints, actions that mitigate harm to others. He extends the cosmopolitan, biocentric and consequentialist perspective developed in his earlier works, such as *The Ethics of Environmental Concern* (1983) and *The Ethics of the Global Environment* (2015). While acknowledging the inevitability of a human standpoint (perspectival anthropocentrism) he firmly rejects narrower anthropocentrism confining moral value solely to humans. At the same time, Attfield critiques ecocentrism for being overly holistic in its emphasis on ecosystems and argues for biocentric consequentialism as an alternative – a perspective that recognises the moral worth of all living beings, both present and future. This ethical stance is paired with a commitment to cosmopolitanism and the ideal of a universal human community, offering a framework for addressing environmental issues on both local and global scales.

Central to Attfield's argument in *The Ethics of the Climate Crisis* is the concept of need: 'Needs are either necessary conditions for well-being to remain intact, rather than being undermined, or indispensable components of well-being itself' (p. 55). Attfield's cosmopolitanism expands ethical responsibility across space and time to include the needs of all current and future human beings. His biocentrism, meanwhile, broadens this concern beyond human needs to encompass the well-being of all living entities. He argues that applying the precautionary principle is essential to safeguarding these needs against serious environmental risks, particularly the threat of crossing ecological tipping points. Although his primary orientation is consequentialist, Attfield demonstrates that his argument aligns with other moral frameworks, including Rawlsian contractarianism, rights-based ethics and deontological theories such as Kantianism.

Having established his ethical framework, Attfield turns to a more practical examination of climate justice. He focuses on the injustices climate change creates, particularly the rich world's responsibility for historic greenhouse gas

emissions and the developing world's heightened vulnerability to climate impacts. Effects such as drought, flooding, famine and extreme weather strain poor communities, forcing adaptation and, in severe cases, displacing people – sometimes permanently – through desertification or sea-level rise.

Attfield argues that, given the Global South's low per capita emissions, urgent development needs and disproportionate exposure to climate risks, affluent nations – who have historically benefited from emissions and continue to pollute the most per capita – bear a moral duty to assist. Consistent with his biocentric outlook, this duty extends to non-human life, grounded in both the intrinsic interests of individual organisms and their ecological roles supporting broader systems of life, including humanity.

Climate justice, assistance and recompense could take many forms, but all will involve the transfer of resources from wealthy to poorer countries – not only to support climate mitigation and adaptation but also to promote development and alleviate poverty. Attfield argues that an expanded UN Conference of the Parties (COP) Loss and Damage Fund could provide a method of compensating those affected by climate change and enable sustainable development including climate mitigation and adaptation. At the same time, developed countries should enhance their own mitigation and adaptation (embodied in the COP Nationally Determined Contributions or NDCs) measures to achieve the IPCC's target of 1.5° C above preindustrial levels. While Attfield views recent UN COP climate and biodiversity resolutions as disappointing for their insufficient scope and urgency, he argues these developments evidence that real progress toward climate justice is possible and notes a welcome growing shift in UN discourse toward a more biocentric, less anthropocentric perspective.

As a sociologist, I am sceptical of drawing sharp distinctions between anthropocentrism, ecocentrism and biocentrism (as defined by Attfield), and have argued instead for a continuum where others see binary oppositions (Samways, 2023, 2025). While moral philosophy aims to define principles of 'ought' and 'should', my focus is on how internalised values – ethics included – shape actual social practices. Agents' worldviews, or hermeneutic frames, are better understood as shifting coalitions of discourses and dispositions, allowing for conflicting values to emerge in different contexts. Since biocentric and ecocentric

ethics often coexist with more dominant anthropocentric values in routine decision-making, a discourse of 'ecologically enlightened anthropocentrism' (acknowledging that human interests are contingent on the sustained functioning of ecosystems) would appear to be both more evident and a more promising route to social change. Indeed, where Attfield sees a shift in UN rhetoric toward biocentrism, I interpret the UN's stance as one of ecologically enlightened anthropocentrism resulting in a narrative shift toward the softer end of the anthropocentric continuum (Samways, 2025).

Attfield's citation of Graham et al. (2017) showing that concern for abstract future generations is increased by when they are framed as family members (grandchildren etc.), supports the idea that people care about distant others. Yet public opinion remains inconsistent and often tracks economic conditions (Kahn and Kotchen, 2011; Scruggs and Benegal, 2012). People routinely ignore or deflect the suffering of distant others, including animals and future generations. Despite increased awareness of animal welfare, meat consumption remains high and factory farming dominant – 85 per cent of UK animal husbandry uses intensive methods, and the number of factory farms continues to rise (Ritchie et al., 2019; Compassion in World Farming, n.d.). Similarly, while climate concern has grown, many resist changing high-emission behaviours like flying or eating meat (Alcock et al., 2017; Fisher et al., 2018; Vieira et al., 2023; Colombo et al., 2023). Evidence suggests that only direct experience of climate impacts reliably alters both concern and behaviour (Spence et al., 2011; Broomell et al., 2015; Demski et al., 2017).

A more significant concern arises in Attfield's final chapter, where he turns to how society should respond to the climate emergency. While he rightly critiques apocalyptic fatalism and techno-optimism as obstacles to meaningful action, his dismissal of population growth as a relevant factor is problematic. In a brief paragraph (pp. 128–29), he downplays its role, arguing that technological and industrial factors are more important and citing Hans Rosling's (Rosling et al., 2019) sanguine developmental narrative.

This is a notable shift from Attfield's earlier works (Attfield, 1983, 2015), which offered more nuanced treatments of population. Previously Attfield acknowledged the complexity of the issue, warning against simplistic carrying capacity arguments,

recognising that population intersects with development, poverty and global justice, and concluding that policies aimed at an environmentally sustainable population should be pursued (1983).

Attfield is correct that consumption, particularly in affluent societies, has been the main driver of emissions. Between 1950 and 2020, global emissions increased sixfold while the population tripled – with the majority of the former taking place in the Global North and the latter in the Global South (Samways, 2022). Yet the aggregate impact of more people consuming, even modestly, cannot be ignored and, if the welfare of the poorest half of the global population is to improve, then their consumption must also grow. Population remains a multiplier of environmental impact, and as both the IPCC (2023) and IPBES (Brondízio et al., 2019) note, it is a significant indirect driver of environmental degradation. Indeed, population growth accounted for roughly a third of carbon emissions increase between 1990 and 2019, with its associated emissions outweighing the reductions achieved through technological advances (Chaurasia, 2020).

Addressing population growth poses unique challenges. Because of demographic momentum, even sharp declines in fertility today will not significantly reduce global population in the near term. However, over longer timescales, sustained fertility reduction can have substantial effects. The problem is that delayed action reduces these options. Had fertility rates fallen sooner, today's emissions and pressures on resources would be markedly lower (Bradshaw and Brook, 2014).

Attfield argues that population growth is slowing, and generally this is true. However, the concern is not whether rapid population growth will come to an end, but whether, without deliberate action, fertility decline is rapid enough to prevent ecological overshoot (Coole, 2018). For the last five decades the world population has grown by about 80 million annually (O'Sullivan, 2023) and is projected to peak at 10.3 billion in the 2080s (United Nations, 2024). Whether we can ensure a good life for all within planetary boundaries for the current, yet alone the projected peak, population remains doubtful (O'Neill et al., 2018).

Attfield's argument throughout *The Ethics of the Climate Crisis* is one of how our choices affect the welfare of other beings across time and space. The future size of the global population will depend upon individual and institutional choices

and the structural conditions which surround them. Fertility decline is associated with improvements in education, healthcare and the status of women, and, while cultural factors mediate these effects, the case of South Korea shows that rights-based family planning policies can accelerate transitions[1] (Samways, 2022). However, it is sobering to note that, if low-income nations emulate South Korea's developmental path and associated ecological footprint, global sustainability will be jeopardised. Reducing consumption in wealthy countries remains essential, but should be accompanied by ethical and effective efforts to bend the population curve.

In failing to address this, Attfield's latest work misses an opportunity for a frank discussion of demographic change within a justice-based environmental framework. His earlier, more thoughtful, engagement is largely absent, replaced by a brief endorsement of Rosling's optimistic developmentalism. This silence may reflect broader discomfort with discussing population ethics, but it is a conversation we cannot afford to avoid.

In sum, The Ethics of the Climate Crisis is a powerful and timely contribution to environmental ethics. Attfield presents a robust, pragmatic and deeply humane case for climate action. His cosmopolitan and biocentric consequentialism offer a thought-provoking alternative to conventional notions of ethical responsibility. Yet, by dismissing the population question, the book forgoes a critical dimension of the crisis it seeks to address. Given his lifelong commitment to ethical clarity and courageous thinking, one hopes future work will revisit this essential topic.

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1 Indeed, South Korea's fertility rate is now so low that the country faces the problems posed by an ageing population - something shared by many developed countries.

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The Journal of Population and Sustainability
is published by White Horse Press and
generously supported by Population Matters

ISSN 2398-5496