Quantum Healthy Longevity for healthy people, planet, and growth

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It is widely thought that lifespans are increasing globally. However, life expectancy has begun to stagnate in the UK, and is falling in more than 50 countries including the USA. Lifespan stagnation or decrease is a consequence of socioeconomic inequalities, lifestyle factors, and the COVID-19 pandemic. In the UK, the National Health Service spends vast sums treating chronic diseases; by some estimates, 40% of its costs go to treating preventable conditions. UK citizens spend a fifth of their lives in poor health, and there is a 20-year difference in healthy life expectancy between the richest and the poorest, a difference that is widening, not narrowing. Together with unprecedented economic uncertainty, geopolitical strife, and post-pandemic recovery challenges, this burden of ill health is having a substantial impact on economic productivity and resilience.

Health-care systems based only on response to illness are no longer affordable, and economies need a more productive workforce. The current model, which focuses on reactive sick-care alone, must be shifted to a new one based on proactive prevention, with the ever-growing recognition that the wealth of nations is not possible without the health of populations.

In response to this reality, leaders are coming together for a Quantum Healthy Longevity Innovation Mission that aims to structurally leverage the value of existing assets, reduce duplication and waste in funding allocation, and prioritise effective coordination of key organisations[1] and resources worldwide (including longevity education and research). We need to radically reimagine short-term, medium-term, and long-term responses at a global, societal, and individual level and significantly invest in an interdependent ecosystem for science and innovation to accelerate healthy longevity at quantum scale and pace.

As we are seeing with research on the biology of ageing (geroscience[2]), age-related chronic diseases are not inevitable or untreatable; there are common pathways, defined by the hallmarks of ageing,[3] including cell senescence and systemic chronic inflammation, that lead to multiple morbidities. These pathways can now be manipulated with drugs and other interventions[4] early in the disease process, with promising data emerging from early human clinical trials.[5]

We need to take a multipronged whole-of-life approach to tackle all the different, but interacting, drivers of health and disease. These include lifestyle factors, such as diet and physical activity; socioeconomic determinants, such as discrimination, early and lifelong education, training and skills, financial status, and social support; and, increasingly, the characteristics of physical environments, such as green spaces and air quality, which need more attention.[6] Particularly, continuous interactions with and cumulative exposures to the surrounding physical and social environments throughout life have crucial roles in later-life outcomes.

The Quantum Healthy Longevity blueprint aims to harness such opportunities, address urgent needs, and fulfil aspirations of the UK Innovation Strategy to tackle big, real-world problems in climate and health, by harnessing developments that we are seeing in longevity science and data innovation to maximise access to healthier, longer lives for everyone.

Insights from genetics, biological, behavioural, social, environmental, and financial data are underutilised, and there are substantial opportunities to use artificial intelligence (AI) and multimodal learning to predict disease and incentivise healthier living through harnessing such life data.

At the heart of improved health and wellbeing is a deep, integrated understanding of people's needs and wants that contribute to maintaining health across the full life course. This notion embraces the emerging research in computational approaches to the psychology of ageing[7] that links with biological and biomedical ageing as well as the behavioural aspects for ageing well, including nurturing brain health and investing in brain capital.[8]

The core principles underpinning the Quantum Healthy Longevity Innovation Mission draw from a more comprehensive understanding of the environmental factors and their correlations influencing the ability of humans not only to survive, but to thrive in their real world (panel).

The Mission will harness unfolding opportunities of agile regulatory reform planned by the UK government.

Panel: The Quantum Healthy Longevity blueprint

Takes an exposome approach
The exposome is a concept explaining the complex exposures humans face that can lead to systemic chronic inflammation[9] and cumulatively affect lifelong health.[10] It includes the food we ingest, the air we breathe, the objects we touch, the psychological stresses we face, and the activities in which we engage.

Leverages technologies
To release breakthrough innovation using quantum computing, robotics, artificial intelligence, synthetic biology, and blockchain and other key emerging technologies.

Mobilises brain capital
An investment category placing a premium on approaches to protect brain health across the lifecourse, encompassing technology and health-care innovations that nurture brain health and skills such as resilience and self-esteem.

Focuses on intergenerational engagement
To mobilise people of all ages across the lifecourse, ensuring that there is effective dialogue and meaningful involvement of citizens of all ages, in all communities.

Optimises digital engagement
Engagement through skills development, citizen-driven co-design, and equitable access to new tools and enabling technologies such as 5G.

Is rooted in democratisation of access
Access to the benefits of a longevity dividend to all people, taking equality, diversity, and inclusion into daily life as a prerequisite.

Ensures that compassion is the running thread
Making looking after one another, especially in times of need, a core societal value.

It adopts the concept of Trusted Research Environments (TREs) in a federated network through a concierge model in which accredited organisations and networks check in to an AI-enabled Ageing Intelligence platform (National Innovation Centre for Ageing; Newcastle upon Tyne, UK), adhering to agreed standards in ethics, data operability, and governance.

The AI platform will evolve into a world-first testbed taking science and innovation out of the laboratory and directly into peoples' homes, with healthy longevity-as-a-service products and services designed and developed for unmet needs that make a real and measurable difference to people's lives and to planetary health too.

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The Mission also aims to join often disparate and siloed policies and initiatives at the city level that impact infrastructure, including housing and urban planning that, if sensibly connected and coordinated, could much more effectively transform places and have a greater sustainable and tangible impact for people and the planet. The Mission sets out the concept of Longevity Cities that incorporate initiatives such as the Internet of Caring Things, in which connected objects and cognitive systems are designed or repurposed to actively care for people and enhance their biological, physical, mental, and emotional wellbeing, by understanding and measuring what they really value, what they care about, and what matters to them that can generate positive outcomes on their overall health.

This intelligence from connected systems can help deliver sustainable environments that make it easy for people to identify, learn, and repeat healthier behaviours and habits to follow healthier lifestyles well before old age, enabled by connected infrastructure, services, and policies that also influence the social determinants responsible for 80% of our health.

The platform will be underpinned by the Open Life Data Framework, which is geared to create the enabling conditions for public and private sectors to share data for the public benefit while ensuring public trust (thereby avoiding the backlash that Google's Sidewalk Labs faced when public outcry over privacy concerns halted the project). The framework's rationale was first set out in *The Lancet Healthy Longevity*,[11] taking learnings from the open banking system, which created an open standard to facilitate data sharing and portability between banks and which fuelled the development of a financial technology ecosystem that benefitted consumers.

Taking everything together, the Healthy Longevity Innovation Mission could achieve the ultimate prize in longevity research to create a bank of biomarker data and an atlas of geroprotective interventions based on larger and more diverse datasets than hitherto possible. The Mission would act as a TRE for life data accessible to trusted researchers and innovators in academic, non-profit, and commercial environments. It could link to other global initiatives such as Our Future Health, an ambitious research programme recruiting 5 million healthy volunteers to submit blood samples for physiological biomarker data collection at scale. This federated network of TREs enabled by AI could drive a world test bed for healthy longevity in which the community is motivated to evolve methods for new and improved biomarkers correlated with underlying measures of health span.

The desired outcomes of the Healthy Longevity Innovation Mission to increase healthy life expectancy and economic resilience are enshrined in the Business Framework for Health, a methodology and core metrics

(leading ultimately to an index) being developed by Business for Health with the Confederation of British Industry to measure the positive and negative health impacts of employers, businesses, and investors in three key areas: workforce health, consumer health, and community health. The index will learn from climate change approaches guiding investment to achieve carbon reduction and net zero targets, by adding Health as a core principle into Environmental, Social, and Governance (ESG) criteria to ensure greater investment in health, turning ESG into ESHG. An ESHG framework focused on equitable health outcomes as part of the Healthy Longevity Innovation Mission will help the business and investor community drive positive change through long-term strategic programmes that reduce the risk factors that can damage healthy longevity, incentivised and measured by their impact on positive health and wellbeing outcomes.

It is now time to be bold and accelerate the urgent system changes needed to achieve healthy people, planet, and growth.

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A list of references for further reading is available in the appendix.

See **Online** for appendix

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1 Cox LS, Faragher RGA. Linking interdisciplinary and multiscale approaches to improve healthspan—a new UK model for collaborative research networks in ageing biology and clinical translation. *Lancet Healthy Longev* 2022; **3:** e318–20.
2 Ferrucci L. Geroscience brings new focus on the life-course approach to health in humans. *Innov Aging* 2020; **4** (suppl 1)**:** 803.
3 López-Otín C, Blasco MA, Partridge L, Serrano M, Kroemer G. The hallmarks of aging. *Cell* 2013; **153:** 1194–217.
4 Le Couteur DG, Barzilai N. New horizons in life extension, healthspan extension and exceptional longevity. *Age Ageing* 2022; **51:** afac156.
5 Partridge L, Fuentealba M, Kennedy BK. The quest to slow ageing through drug discovery. *Nat Rev Drug Discov* 2020; **19:** 513–32.
6 Wang C, Sierra Huertas D, Rowe JW, et al. Rethinking the urban physical environment for century-long lives: from age-friendly to longevity-ready cities. *Nat Aging* 2021; **1:** 1088–95.
7 Mitina M, Young S, Zhavoronkov A. Psychological aging, depression, and well-being. *Aging* 2020; **12:** 18765–77.
8 Eyre H, Faulkenberg M, Das S, et al. Brain capital: an emerging investment opportunity. Psychiatric Times. 2022. https://www.psychiatrictimes.com/view/brain-capital-an-emerging-investment-opportunity (accessed Oct 22, 2022).
9 Furman D, Campisi J, Verdin E, et al. Chronic inflammation in the etiology of disease across the life span. *Nat Med* 2019; **25:** 1822–32.
10 Wild CP. Complementing the genome with an "exposome": the outstanding challenge of environmental exposure measurement in molecular epidemiology. *Cancer Epidemiol Biomarkers Prev* 2005; **14:** 1847–50.
11 Green D, O'Shaughnessy J, Starks G, et al. Open Life Data to support healthy longevity for all. *Lancet Healthy Longev* 2021; **2:** e238–39.