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The next national infrastructure: can Saudi Arabia become the world's first longevity nation?

Abstract

Modern healthcare systems have achieved extraordinary success in extending lifespan while remaining organised around the detection and treatment of established disease. Yet disease is a lagging indicator, the measurable end of biological processes that begin years or decades earlier. Advances in artificial intelligence, whole-body imaging, multi-omics, and longitudinal health data now make it feasible to detect biological decline before clinical disease emerges. The next frontier is not lifespan extension alone but the systematic preservation of physiological function. Saudi Arabia's Vision 2030, centralised healthcare architecture, MRI infrastructure, and growing longevity ecosystem create a structural opportunity to test a different model: healthspan as national infrastructure.

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The defining mistake of modern healthcare

Modern healthcare has become exceptionally good at treating disease. It has failed at preserving health. Global life expectancy has increased dramatically over the past century, yet people are living longer while spending an increasing proportion of life managing chronic disease, disability, and functional decline.[1,2] The World Health Organisation estimates that healthy life expectancy now lags behind total life expectancy by an average of 9.6 years globally, a gap that is widening as populations age.[3]

The defining mistake is that healthcare waits for disease. A patient is labelled pre-diabetic after insulin resistance has developed. Hypertensive after vascular dysfunction has emerged. Frail after muscle decline has become visible. Prevention, in practice, means intervening after disease has already begun. Non-communicable diseases now account for approximately 74% of global mortality. Biological ageing remains the single most consistent risk factor across cardiovascular disease, cancer, type 2 diabetes, and neurodegeneration.[4,5] We track the health of economies with precision while largely ignoring the biological trajectory of the people who sustain them.

Disease is a lagging indicator

Medicine has been organised around disease because disease was the only thing that could be reliably measured. Yet disease is not the beginning of decline, it is often its end result. Long before type 2 diabetes emerges, metabolic dysfunction and visceral adipose accumulation develop. Long before dementia is diagnosed, neurobiological decline has been underway for a decade or more.[6,7] Healthspan, defined as the preservation of physiological function, represents a more meaningful endpoint than disease incidence or mortality alone.

The question is no longer whether we can treat disease more effectively. The question is whether disease should remain the primary organising principle of healthcare at all.

Lessons from systems that changed population health

That health trajectories can be altered at population scale is not theoretical. Finland's North Karelia Project demonstrated that coordinated national interventions targeting cardiovascular risk factors could dramatically alter population outcomes over decades, through prevention, not treatment.[8] Singapore's Healthier SG initiative has embedded healthy ageing into national governance through preventive policy and longitudinal citizen engagement.[9] The world's longevity hotspots, Okinawa, Sardinia, Loma Linda, demonstrate that exceptional population longevity emerges from ecosystems of movement, nutrition, social connection, and purpose, not from healthcare systems managing established disease.[10] The common principle: healthspan is not created inside hospitals. It is created across systems.

The missing layer: measuring biological age

A convergence of artificial intelligence, advanced MRI, multi-omics, and longitudinal health data now enables a transition from detecting disease after it manifests to measuring biological decline before it does. Genomics provides insight into susceptibility but cannot reveal whether an individual currently possesses excessive visceral adiposity, declining muscle quality, or early metabolic dysfunction. Risk and current biological reality are not the same thing.

UK Biobank's 100,000-participant deep-phenotyping programme has demonstrated that whole-body MRI yields validated biomarkers of cardiovascular risk, hepatic fibrosis, sarcopenic trajectory, and early oncological change at a resolution that standard clinical reporting routinely ignores.[11] AI-derived organ phenotyping from routine MRI sequences achieves accuracy comparable to gold-standard measurements.[12] Epigenetic clocks, including DunedinPACE and GrimAge, demonstrate prospective associations with all-cause mortality that substantially outperform chronological age as a predictive variable.[13,14] Prospective population-scale MRI screening studies, including Project Hercules, are now evaluating whether integrated phenotyping predicts clinically significant diagnoses in asymptomatic individuals before symptoms emerge.[15] These developments point toward a future in which biological ageing itself is measurable, trackable, and modifiable before clinical disease appears.

What could go wrong

The future described here is not inevitable, and intellectual honesty requires engaging with its risks. Earlier detection is not inherently beneficial. Screening programmes have repeatedly demonstrated that identifying abnormalities without effective intervention pathways increases anxiety, incidental findings, overdiagnosis, and costs without improving outcomes.[16] Detection alone is not success. Preserved function is success. A second risk is equity: at current commercial price points of USD 2,000 or more per assessment, comprehensive

preventive health phenotyping extends biological advantage to those who already carry the lowest chronic disease burden. Population-scale healthspan infrastructure must be designed as a public health function rather than a consumer product; otherwise it will reproduce the inequities of the reactive medicine it seeks to replace.

Why Saudi Arabia represents a structural opportunity

The argument for Saudi Arabia is structural rather than aspirational. Five conditions converge unusually. A centralised healthcare architecture enables national-scale implementation by policy mandate, removing the institutional fragmentation that has prevented Western decentralised systems from deploying population prevention at comparable speed. A median population age of 29.7 years places most citizens in the third and fourth decades of life, the period of maximum preventive benefit before metabolic accumulation becomes irreversible.[17] An MRI installation density of approximately 6.2 units per 100,000 population, substantially above the MENA regional average, means the imaging hardware required for whole-body phenotyping is already in place.[18] Vision 2030's Health Sector Transformation Program provides an institutional mandate of sufficient duration to outlast the political cycles that typically defeat prevention programmes.[19] Hevolution Foundation's commitment of over one billion dollars to longevity science positions Saudi Arabia as a global research investor, though the programme requires a clearer population delivery architecture to translate that investment into clinical practice.[20]

These advantages do not make implementation easy. Saudi Arabia carries a 73% NCD mortality burden, a 25% prevalence of undiagnosed fatty liver disease, and a primary care physician density of approximately 2.1 per 1,000 population, below the level required to absorb the clinical response that early detection at scale would generate.[17,21] These are arguments for careful sequencing: building detection capacity and clinical response capacity in parallel, validating AI models on Saudi population data before national deployment. Ethnicity is not a reliable shortcut here: MRI-based cohort data from the UK show that visceral and hepatic fat depots, the very biomarkers this model may depends on, less likely differ as consistently by ethnic background as once assumed, so imaging algorithms cannot simply be presumed transferable and must instead be checked directly against Saudi bodies.[22] The final pillar is designing data governance frameworks that earn public trust before data collection begins.

A Vision for 2035

In 2035, a 35-year-old Saudi citizen attends a routine primary care visit that includes a 22-minute whole-body MRI, a multi-biomarker blood panel, and an AI-generated biological age assessment. No symptoms are present. No diagnosis exists. Yet the assessment reveals that her liver is ageing seven years ahead of her chronological age, a finding that standard clinical encounters would not surface for another decade. She leaves with a structured intervention protocol and a six-month follow-up. The most effective window to alter her health trajectory has not yet closed. Success in this model is measured not by hospital admissions avoided, but by years of healthy function preserved.

Conclusion

The twentieth century built hospitals because disease was, by the time it became visible, largely inevitable. The twenty-first century may judge healthcare systems by a different standard: how long citizens remain biologically functional before disease appears. Finland demonstrated that population health trajectories can change. Singapore demonstrated that healthy ageing can be designed into governance. Advances in artificial intelligence, imaging, and multi-omics demonstrate that biological decline can be detected, and interrupted, before symptoms emerge. Saudi Arabia does not need to invent longevity science. Its opportunity is to integrate existing foundations at national scale within a structural architecture that makes population-wide implementation feasible. If successful, it will not simply have built a better healthcare system. It will have demonstrated a different purpose for healthcare altogether, the systematic preservation of human function before disease emerges. History may record this decade not as the age of artificial intelligence, but as the moment one nation decided to stop waiting for disease.

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Conflict of interest

The authors declare that they have no competing interests.

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