From Research to Policy: JSS AHER's Integral Role in Advancing SDG-Governance Frameworks

Preamble & Introduction

JSS Academy of Higher Education & Research (JSS AHER) plays an instrumental role in shaping Sustainable Development Goal (SDG) policy development at the national and regional levels. The institution's contributions span a wide range of domains including public health research, epidemiological modelling, precision medicine, disease surveillance, and health systems strengthening. Through partnerships with entities such as the Indian Council of Medical Research (ICMR), the Ministry of Health and Family Welfare (MoHFW), State Health Departments, and major global research consortia such as the Global Burden of Disease (GBD) Study coordinated by IHME, JSS AHER ensures that high-quality evidence directly informs policies, programs, and interventions.

This document compiles key initiatives demonstrating how JSS AHER contributes to SDG-aligned policy development—identifying challenges, generating data, modelling future scenarios, shaping strategic interventions, and supporting monitoring and evaluation. The sections that follow provide a detailed account of research-to-policy pathways driven by the institution across multiple public health priority areas.

1. "From Evidence to Policy: Transforming Sickle Cell Disease Care and Stigma Elimination in Tribal India"

The institution's pioneering work in **Sickle Cell Disease (SCD)** research and implementation exemplifies JSS Academy of Higher Education & Research's (JSS AHER) direct and sustained contribution to **national-level policy development, evidence generation, and adaptive management** for India's most vulnerable tribal and rural populations.

Recognizing that SCD disproportionately affects India's indigenous communities—often marginalized by geography, poverty, and limited access to healthcare—JSS AHER, through JSS Medical College, Mysuru, undertook a landmark multi-centric initiative titled *"Transforming Sickle Cell Disease Care: Community-Led Implementation Research Across Tribal India."* This initiative was implemented in partnership with the **Indian Council of Medical Research (ICMR)**, the **Centre for Training, Research, and Innovation in Tribal Health (CTRITH)**, and various **State Health Departments**, making it one of the largest collaborative efforts in tribal health research in the country.

Through extensive fieldwork involving **over 50,000 tribal individuals** across multiple states, the study systematically identified **critical challenges in screening, early**

diagnosis, treatment adherence, and community-level awareness. Employing the **WHO Service Availability and Readiness Assessment (SARA)** framework, the research mapped existing health system capacities, identified gaps in infrastructure, human resources, and essential drug availability, and **modelled intervention outcomes** to forecast the likely impact of government action or inaction. These findings were directly translated into **state- and national-level policy planning**, helping shape the **National Sickle Cell Anaemia Elimination Mission (NSCAEM 2023–2047)** — a flagship initiative of the Government of India that now serves as the central framework for SCD control and management nationwide.

One of the most transformative outcomes of this initiative was the development of **India's first scientifically validated psychosocial tool for SCD**, which addressed a previously neglected yet pervasive challenge — *stigma*. Under this initiative, JSS Medical College researchers designed the **Sickle Cell Disease Stigma Scale** and a **Self-Management Education Package** that together empowered individuals and families to navigate the disease with dignity and resilience. These community-led tools were used to train frontline health workers — including ASHAs, ANMs, and Community Health Officers — to provide empathetic, informed care and counseling.

Building upon this foundation, a **breakthrough study co-authored by Dr. Deepa Bhat**, Professor of Anatomy and Certified Genetic Counsellor at JSS Medical College, was published in *The Lancet Regional Health – Southeast Asia*. This national milestone in genetic and public health research introduced the **ICMR-SCD Stigma Scale for India (ISSSI)** — the country's **first validated instrument** to measure multidimensional stigma associated with SCD among patients and caregivers.

Developed under the **ICMR National Task Force Project** (Socio-Behavioural Research Division), the ISSSI was a **multi-institutional collaboration** involving **JSS AHER**, **Central Tribal University (Vizianagaram)**, **Bodoland University (Assam)**, **Parul University (Vadodara)**, and **ICMR-RMRC (Bhubaneshwar)**. The study's inclusive, multilingual approach ensured that the tool was **culturally attuned and linguistically adaptable**, capable of capturing stigma across diverse tribal settings.

The ISSSI measures stigma across five domains—**familial, illness burden, interpersonal, healthcare interactions, and social disclosure**—providing policymakers, clinicians, and researchers with a nuanced understanding of the social determinants influencing SCD outcomes. This tool now serves as a **key policy instrument under the National Sickle Cell Anaemia Elimination Mission**, enabling **systematic monitoring**, **data-informed planning**, and **adaptive management** across states. It is currently being deployed in both **clinical and community settings**, guiding interventions that promote empathy-driven and equitable care.

Together, these efforts illustrate how **JSS AHER's research ecosystem bridges academia, policy, and community action.** By combining genomic science, social research, and implementation science, the university has established itself as a **trusted national partner in evidence-based health governance**. Its sustained collaborations with ICMR, the Ministry of Health and Family Welfare, and multiple state health departments have resulted in tangible policy outcomes — including **increased hydroxyurea access**, **better health-seeking behavior**, **reduction in pain crises**, and **improved school attendance** among children with SCD in tribal areas.

Through these integrated research-to-policy pathways, JSS AHER demonstrates how universities can function as **policy accelerators**, not only identifying public health challenges but actively co-creating strategies, **modelling policy futures**, and enabling **real-time monitoring and adaptation**. More importantly, these initiatives reaffirm that public health innovation must be both **data-driven and dignity-driven**, ensuring that the goals of **equity, inclusion, and justice** remain central to India's journey towards achieving the Sustainable Development Goals.

Transforming Sickle Cell Disease Care in India

Professor of Anatomy | Genetic Counselor | National Sickle Cell Technical Expert

Dr. Deepa Bhat stands at the intersection of genetics, public health, and medical education, leading India's movement toward equitable, evidence-driven care for Sickle Cell Disease (SCD). Based at JSS Medical College, Mysuru, she has spearheaded some of the country's largest and most influential SCD implementation studies, shaping national strategy and health system capacity.

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Pioneering Large-Scale SCD Initiatives

- ICMR–National Task Force (2019–2022): Designed and tested interventions to strengthen community and health system capacity for SCD screening and management among tribal populations (₹67 L).
- Wellcome Trust / India Alliance CTRITH Centre (₹1.2 Cr): Established a Centre for Training, Research, and Innovation in Tribal Health — developing scalable models for rare and genetic disease care.
- ICMR–NTF (2022–2025): Unveiling the psychosocial and economic toll of SCD in tribal Mysuru (₹75 L).
- ICMR Ad-hoc Research: Addressing neurocognitive challenges in SCD children, linking hydroxyurea therapy and educational support (₹20 L).
- NHRP Flagship Implementation Model (₹2.62 Cr): Designing India's first comprehensive SCD screening, diagnosis, treatment, and care model under the National Sickle Cell Anaemia Elimination Mission (NSCAEM).

SCD experts brainstorming meeting

State Team at ICMR

SCD Pregnant women care

ASHA Training on SCD Screening

Kerala Health System Capacity Building

Shaping National Policy & Programs

- **Technical Expert:** Blood Cell Program & NSCAEM, Government of Karnataka.
- **Master Trainer:** trained health cadres across 7 districts in Karnataka & Kerala, covering medical officers, nurses, ASHA, ANM, CHOs, lab technicians.
- **Advisor:** Centres of Competence (CoC) under NSCAEM for integration of genetic counselling & advanced diagnostics into public health.
- Supported Karnataka to achieve **screening targets,** embedding tribal community as research assistants and creating sustainable local capacity. (3.48 lakh screened, 577 SCD and 4667 SCT)

Key Community Leaders and PwSCD awareness

35 patients with sickle cell disease get disability certificates

The Hindu Bureau
MYSURU

A total of 35 patients with sickle cell disease were given disability certificates at a health camp jointly organised by the Centre for Training, Research, and Innovation in Tribal Health (CTRITH) and the Department of Health and Family Welfare at Kollegal taluk hospital on Friday.

Sickle cell disease has been identified as a genetic disorder in which red blood cells contort into a sickle shape, causing them to block blood flow and reduce oxygen delivery. Predominantly affecting tribal communities in India, sickle cell disease may cause chronic anaemia, pain, fatigue, acute chest syndrome, stroke, and a host of other health complications.

According to a statement issued by the CTRITH, a total of 45 patients, along with 55 caregivers, participated in the free health camp, where they underwent a routine health check and medical consultation.

The persons with sickle cell disease were successfully registered and certified under the Unique Disability ID (UDID) system, enabling them to access the government's disability benefits.

"This was not just another health camp. It marked a significant milestone by bringing together all diagnosed sickle cell disease patients from across the district under one roof and facilitating their disability certification," the statement noted.

The health camp was inaugurated by the Chamarajanagar district health officer, M. Chidambara, who said sickle cell disease was a genetic disease that not only required medical attention, but also strong community and family support for its prevention, early detection, and effective management.

"Today, our district has become the first in the State to issue disability certificates for people with sickle cell disease through a camp-based approach. This is a proud moment for us. This reflects our commitment to the National Sickle Cell Anaemia Elimination Mission and highlights the value of collaboration with organisations working in the field," he said.

Dr. Chidambara also emphasised the importance of genetic counselling and awareness among carriers to help prevent the birth of children with the disease.

Genetic counsellor from JSS Medical College, Mysuru, Deepa Bhat, who is also the head of the sickle cell disease programme at CTRITH, acknowledged the leadership shown by Dr. Chidambara and nodal officer for the National Sickle Cell Anaemia Programme in Chamarajanagar district, Ravikumar.

Dr. Bhat said Chamarajanagar was possibly the only district where regular and systematic sickle cell disease camps were being conducted. The health camp not only provided the patients with routine care, but also facilitated their disability certification, which is an essential step towards accessing government support, she added.

Chamarajanagar district tuberculosis eradication officer Ravikumar, Kollegal taluk administrative medical officer Rajashekar, and the medical staff of Vivekananda Girijana Kalyana Kendra Hospital, B.R. Hills, also participated in the programme.

District Health Officer Chidambara addressing the participants of a health camp, organised for sickle cell disease patients at Kollegal on Friday. SPECIAL ARRANGEMENT

Assistance towards Social Welfare Benefits

Capacity Building & Social Impact

- **Workforce creation:** recruited and trained 10 research assistants, 5 scientists, 1 senior resident, 1 lab technician, and multiple data operators — many from tribal and underserved communities.
- **Community transformation:** awareness campaigns among tribal sanghas, panchayat leaders, women's collectives, and traditional healers; culturally contextual health education.
- **Genetic counselling services:** delivered to hundreds of families and pregnant women in remote SCD clusters, reducing preventable morbidity.

Academic & Scientific Contributions

- 50+ publications in Lancet Regional Health–Southeast Asia, BMJ Global Health, British Journal of Haematology, Journal of Community Genetics, Wellcome Open Research, among others.
- First ICMR–SCD Stigma Scale for India (ISSSI): cultural and linguistic adaptation to measure psychosocial impact nationwide.
- Indian SCD Registry: converting fragmented, hospital-centric data into population-level surveillance and decision support.
- Novel work with traditional healers and tribal leaders improving cultural acceptance of SCD screening and care.
- Working with Key National Expert Team

MoHFW Expert Stakeholders Meeting

Trainign at Bhopal with state team


TCD Screening for stroke prevention

Strategic Collaborations

- Partner with Novartis, MoHFW, MoTA, Institute of Public Health Bengaluru, Stroke Foundation of India, ORDI and international rare disease networks.
- Active mentor for PhD scholars, medical students, and public health researchers; frequent faculty for national-level capacity-building workshops.


Training and awareness at several levels

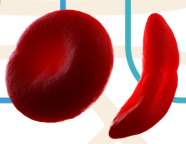
Medical Officers Training on SCD management

Vision: To bridge advanced genomics with culturally rooted public health models — ensuring that SCD care in India becomes inclusive, stigma-free, and community-powered.

Impact

- Directly influenced national SCD elimination roadmap; evidence from her trials fed into the NSCAEM (2023–2047).
- Enabled >10,000 tribal individuals to be screened, creating India's first Population based hemoglobinopathy registry.
- Shifted policy conversations from episodic care to long-term prevention & psychosocial support.
- Established a sustainable genetic counseling network in low-resource, tribal areas, embedding new public health roles for local women.

Way Forward



Scale & Integrate: Take proven SCD screening and stigma-reduction models nationwide.

Precision Genomics: Embed advanced molecular testing for early, tailored care.

Global Partnerships: Align India's SCD care with international best practices.

Education & Mentorship: Train future physician-scientists and genetic counselors.

2. Informing National Health Priorities: JSS AHER's Role in GBD 2021 Highlighting Pandemic Reversals and Changing DALY Trends

JSS Academy of Higher Education & Research (JSS AHER), Mysuru, plays a significant role in national and global health policy formulation through its participation in the **Global Burden of Disease (GBD) Study 2021**, a multicentric international collaboration coordinated by the **Institute for Health Metrics and Evaluation (IHME)** and supported by the **Bill & Melinda Gates Foundation**.

The **GBD Study** provides one of the most comprehensive and systematic analyses of global health trends, estimating **incidence, prevalence, years lived with disability (YLDs), years of life lost (YLLs), disability-adjusted life-years (DALYs),** and **healthy life expectancy (HALE)** for **371 diseases and injuries across 204 countries and 811 subnational locations** from 1990–2021.

By contributing to this major global initiative, **JSS AHER directly supports evidence-based policy development and strategic planning** for achieving the **Sustainable Development Goals (SDGs)**, particularly **SDG 3 – Good Health and Well-being**. The data and analytical models generated through this study enable national and regional health authorities to:

Identify emerging **public health challenges** and disease trends;

Model future health scenarios with and without policy interventions;
Formulate and monitor national health strategies and priorities;
Assess the progress of interventions towards SDG health targets; and
Enable **adaptive management** in response to shifting disease burdens, including the impact of the COVID-19 pandemic.

The **GBD 2021 study**, which presented for the first time estimates of health loss due to COVID-19, highlighted the pandemic's reversal of global progress in reducing disease burden, while also identifying significant reductions in age-standardised DALY rates for communicable diseases such as HIV/AIDS and diarrhoeal diseases. These findings inform **national policy frameworks** on pandemic preparedness, non-communicable disease prevention, and maternal and child health improvement.

Through this collaborative engagement, **JSS AHER contributes valuable data and analytical expertise** that inform **national and multilateral health agencies**, including India's Ministry of Health and Family Welfare, WHO, and ICMR, reinforcing the institution's **direct role in evidence generation, policy development, monitoring, and evaluation** aligned with the SDGs.

1. Advanced Demographic and Mortality Estimation for Policy Development: Insights from the Global Burden of Disease Study 2021Project Overview:

The **Global Burden of Disease (GBD) Study 2021** represents one of the most comprehensive global efforts to quantify trends in mortality, life expectancy, and population dynamics across **204 countries and territories and 811 subnational locations** between 1950 and 2021. The project provides timely and detailed estimates to inform national and international policies, particularly in the context of the **COVID-19 pandemic** and its impact on global health and demographic trends.

Using over **22,000 data sources**—including vital registration systems, censuses, health surveys, and disease registries—the study assessed all-cause mortality, life expectancy, and population growth through advanced statistical models such as **Spatiotemporal Gaussian Process Regression (ST-GPR)** and **Bayesian hierarchical cohort component modelling**.

Relevance to National Policy and SDG Development:

This multicentric study provides critical evidence that supports **data-driven decision-making** in health systems and demographic planning. The findings directly inform **national and regional SDG policy frameworks** by:

- **Identifying public health challenges** related to demographic transitions, excess mortality during the COVID-19 pandemic, and the growing burden of non-communicable diseases.
- **Developing and guiding policy strategies** to address mortality and morbidity patterns, child survival, ageing populations, and healthcare system resilience.
- **Modelling future population and health scenarios** under various intervention conditions, enabling adaptive planning for sustainable health outcomes.
- **Monitoring and reporting progress** toward SDG targets such as reducing premature mortality (SDG 3.4) and improving life expectancy.
- **Supporting adaptive management** through continuous updates of population and mortality data, allowing for evidence-based adjustments to policy interventions.

Key Findings and Policy Implications:

- Global life expectancy increased from **49.0 years in 1950 to 71.7 years in 2021**, though it declined by 1.6 years during the COVID-19 pandemic, reflecting the pandemic's significant demographic impact.
- All-cause mortality decreased by **62.8%** between 1950 and 2019 but rose by **5.1%** during 2020–2021, revealing the reversal of long-term health gains.
- The ratio of the elderly population (≥65 years) to the child population (<15 years) increased in **92% of nations**, highlighting the urgent need for ageing-focused health policies.
- The study's insights are being used by **national governments, the World Health Organization (WHO)**, and other global agencies to design and refine **evidence-based health and population policies**.

Institutional Role:

Participation in this global initiative involves data sharing, analytical input, and contextual interpretation of results at the national and regional levels. The outputs are integrated into **India's health and demographic planning frameworks**, supporting the Government's **National Health Policy**, **Ayushman Bharat**, and the broader **SDG monitoring architecture**.

2. Global Fertility Trends and Forecasts (1950–2100): A Comprehensive Demographic Modelling Project under the Global Burden of Disease Study 2021 for Policy and SDG Planning

This project, conducted as part of the Global Burden of Disease (GBD) Study 2021, provides one of the most comprehensive demographic assessments of global fertility patterns from 1950 to 2021, with forecasts extending to 2100. The analysis spans 204 countries and territories and uses robust statistical and forecasting models to estimate historical fertility rates, assess demographic transitions, and project future trends.

Given the profound social, economic, and geopolitical impacts of fertility trends, these estimates are crucial for shaping long-term national and global policies related to population growth, education, gender equality, labour markets, healthcare needs, and sustainable development.

Methodological Approach

The project synthesised an extensive body of demographic data, including:

- 8,709 country-years of vital and sample registration data
- 1,455 surveys and censuses
- 150 additional demographic and fertility data sources

To ensure methodological rigor, the study employed advanced modelling tools such as:

- **Mixed-effects regression models**
- **Spatiotemporal Gaussian Process Regression (ST-GPR)**
- **IHME's forecasting model based on Completed Cohort Fertility at age 50 (CCF50)**
- **Ensemble modelling with multiple sub-models using key covariates**
- **Meta-regression—Bayesian, regularised, trimmed (MR-BRT) framework**
- **First-order autoregressive time-series modelling**

Fertility indicators—including age-specific fertility rates (ASFRs), total fertility rate (TFR), and annual livebirths—were estimated for the period 1950–2021 and forecast to 2100 using both reference and policy-dependent alternative scenarios.

Relevance to National Policy and SDG Planning

The project provides critical evidence for strengthening national and global demographic policies. It informs:

- **Resource planning** for education, healthcare, and labour markets
- **Family planning and reproductive health programs**
- **Policy strategies addressing ageing populations and declining workforce sizes**
- **Progress monitoring for SDG 3 (Good Health and Well-being) and SDG 5 (Gender Equality)**
- **Long-term scenario planning** through SDG-linked forecasts for education and contraceptive access
- **Design of pro-natal, gender-sensitive, and family-supportive policies in low-fertility countries**

The forecasts generated under different SDG-aligned scenarios support governments in anticipating demographic shifts and designing adaptive, evidence-based policy interventions.

Key Findings

- **Global fertility rates have sharply declined**, with TFR falling from **4.84 (1950)** to **2.23 (2021)**.
- **Global livebirths peaked in 2016** at 142 million and subsequently declined to 129 million in 2021.
- **Fertility has declined in all countries** since 1950; in 2021, 94 countries remained above replacement-level fertility.
- **Sub-Saharan Africa is now the world's primary fertility centre**, contributing 29.2% of global livebirths in 2021.
- **Fertility rebound is rare**—47 countries experienced a rebound after hitting their lowest fertility levels, and only three returned above replacement.
- **Future projections** show continued decline:
    - **TFR of 1.83 in 2050**
    - **TFR of 1.59 in 2100**
- The number of countries with TFR above replacement is projected to fall to:
    - **49 countries in 2050**
    - **Only 6 countries by 2100**, mostly low-income countries in sub-Saharan Africa
- **Livebirth distribution will shift significantly**, with sub-Saharan Africa projected to account for **over half of all global births by 2100**.
- **Pro-natal policies have limited impact**—even under SDG and pro-natal combined scenarios, global TFR remains below replacement levels by 2100.
- The IHME forecasting model shows **positive skill metrics**, indicating superior predictive performance compared to baseline models.

Policy Implications

The findings highlight urgent global challenges:

- **Ageing populations** and shrinking workforces in high- and middle-income countries

- **Demographic pressure and youthful populations** in low-income regions, particularly sub-Saharan Africa
- **Need for evidence-based reforms** in healthcare, education, labour policy, and social welfare
- **Importance of gender equity, contraceptive access, and education** to moderate fertility trends
- **Limited effectiveness of pro-natal incentives alone**, necessitating structural policy reforms
- **Increasing global inequality**, with a growing share of births occurring in the poorest regions

These insights are critical for shaping policies aligned with SDG targets and long-term national planning.

Funding: This project was funded by the **Bill & Melinda Gates Foundation**.

3. Global Burden and Evidence Assessment of 88 Health Risk Factors (1990–2021): A Comprehensive Comparative Risk Analysis under the Global Burden of Disease Study 2021 for Policy and SDG Planning

Project Overview

This project, conducted as part of the Global Burden of Disease (GBD) Study 2021, provides the most comprehensive scientific assessment to date on the contribution of modifiable risk factors to global morbidity and mortality. The analysis evaluates **88 risk factors** across **204 countries and territories, along with 811 subnational locations**, spanning a 31-year assessment period from 1990 to 2021.

The project aims to equip global, national, and regional policymakers with reliable evidence on risk exposures, associated disease outcomes, and the attributable burden of disease. These findings directly support strategic public health planning, health system prioritisation, and Sustainable Development Goals (SDGs), particularly SDG 3—Good Health and Well-being.

Methodology

The project employed a rigorous comparative risk assessment framework built on:

- **54,561 distinct data sources**, including epidemiological surveys, clinical studies, and health registries.
- **631 risk–outcome pairs**, identified through data-driven causal determination.
- **Age-sex-location-year–specific estimates**, generated at global, regional, and national levels.

Key analytical components included:

- **Estimation of relative risks (RRs)** for each risk–outcome pair.
- **Computation of Summary Exposure Values (SEVs)** to quantify the weighted prevalence of risk exposure.

- **Determination of Theoretical Minimum Risk Exposure Levels (TMRELs)** to model optimal population health scenarios.
- **Calculation of Population Attributable Fractions (PAFs)** to estimate the proportion of disease burden preventable through risk reduction.
- **Burden of Proof Risk Function (BPRF)** analysis to provide conservative, consistency-based interpretations of risk–outcome associations, accounting for unexplained heterogeneity.
- **500-draw uncertainty modelling**, with 95% uncertainty intervals to ensure reliability and transparency of estimates.

Mediation adjustments were applied to account for indirect effects of multiple interacting risks, ensuring more accurate attribution of burden.

Key Findings

Leading Risk Factors (2021)

The analysis identified the top contributors to global disability-adjusted life years (DALYs):

1. **Particulate Matter Air Pollution** – 8.0% of global DALYs
2. **High Systolic Blood Pressure (SBP)** – 7.8%
3. **Smoking** – 5.7%
4. **Low Birthweight & Short Gestation** – 5.6%
5. **High Fasting Plasma Glucose (FPG)** – 5.4%

Risk Burden Across Age Groups

- **Children (0–14 years):** Low birthweight, short gestation, and unsafe water, sanitation, and handwashing (WaSH) were dominant contributors.
- **Adults and elderly:** Metabolic risks—high SBP, high BMI, high FPG, and high LDL cholesterol—were major drivers of disease burden.

Shifts in Global Risk Patterns (2000–2021)

- **Behavioural risks**: Attributable DALYs decreased by **20.7%**.
- **Environmental & occupational risks**: Decreased by **22.0%**.
- **Metabolic risks**: Increased by **49.4%**, reflecting global ageing and lifestyle transitions.
- Notably:
- High BMI and high FPG saw significant increases in exposure and attributable burden:
  - High BMI: **15.7% rise** in age-standardised DALYs
  - High FPG: **7.9% rise**
- Risk reductions were strongest for:
  - **Child growth failure** (–71.5%)
  - **Unsafe water sources** (–66.3%)

Trajectories of Risk Factors

The study categorised risks into three major groups:

1. **Declining burden due to falling exposure and reduced child populations**
    - Eg: Household air pollution, diet high in trans-fat, maternal and child malnutrition
2. **Moderately increasing burden despite declining exposure, due to ageing**
    - Eg: Smoking
3. **Rapidly increasing burden due to rising exposure and ageing**
    - Eg: Ambient particulate matter air pollution, high BMI, high FPG, high SBP

Interpretation & Policy Implications

The project underscores substantial global progress in reducing disease burden attributable to maternal and child health risks, WaSH deficiencies, and household air pollution—particularly in low SDI settings. However, metabolic and lifestyle-related risks represent a rapidly escalating public health crisis.

Policy imperatives emerging from the findings include:

- Continued investment in maternal and child health programmes
- Strengthening environmental and air-quality regulations
- Intensifying efforts to reduce metabolic risks through preventive healthcare
- Scaling interventions to reduce obesity, high blood pressure, and diabetes-related risks
- Prioritising low SDI regions for WaSH interventions and nutrition programmes

The success of tobacco control policies demonstrates the transformative impact of evidence-based policy action—highlighting the need for similarly aggressive strategies to address air pollution, metabolic diseases, and lifestyle-related health risks.

6. Global Burden of Bacterial Antimicrobial Resistance (1990–2021) with Forecasts to 2050: A Comprehensive Multinational Analysis to Inform Global Health Security and AMR Policy Frameworks

1. Project Overview

The project *"Global Burden of Bacterial Antimicrobial Resistance (1990–2021) with Forecasts to 2050"* represents the first comprehensive multinational effort to quantify historical trends and future projections of antimicrobial resistance (AMR) globally. Covering 204 countries and territories, the study evaluates the burden, distribution, and epidemiological evolution of AMR over 31 years, along with probabilistic forecasts up to 2050.

AMR remains one of the most critical public health threats of the 21st century. While earlier studies provided estimates for specific years or selected regions, this project delivers a consolidated global analysis integrating mortality, morbidity, pathogen–drug resistance patterns, and forecast modelling across multiple demographic groups.

2. Data Sources and Methodological Framework

The study utilised an unprecedented dataset of over **520 million individual records or isolates** and **19,513 study-location-years**, drawing from:

- Multiple cause-of-death records
- Hospital discharge datasets
- Microbiology laboratory databases
- National pharmaceutical sales data
- Antibiotic usage surveys
- Mortality surveillance systems
- Insurance claims (inpatient and outpatient)
- Previously published literature and AMR studies

Estimates were generated using advanced modelling approaches to capture five core components:

1. **Deaths involving sepsis**
2. **Proportion of infectious deaths attributable to specific syndromes**
3. **Proportion of syndrome-related deaths caused by each pathogen**
4. **Pathogen-level antibiotic resistance patterns**
5. **Excess mortality risk and infection duration linked to resistance**

AMR burden was calculated using two counterfactual scenarios:

- **Attributable burden:** resistant infections replaced with drug-susceptible infections
- **Associated burden:** resistant infections replaced with no infection

Forecasts to 2050 were produced under three scenarios:

- **Reference (baseline) scenario**
- **Gram-negative drug pipeline scenario**
- **Better care scenario** (improved access and quality of care)

3. Key Global Findings (1990–2021)

3.1 Current Burden

In 2021:

- **4.71 million deaths** were associated with bacterial AMR.
- **1.14 million deaths** were attributable directly to AMR.

3.2 Age-specific and Regional Trends

- AMR deaths **decreased by over 50%** among children under five.
- AMR deaths **increased by more than 80%** among adults aged 70+ years.
- All super-regions showed declining AMR mortality in young children but consistent increases in populations aged ≥5 years.

3.3 Pathogen–Drug Trends

- **MRSA (meticillin-resistant Staphylococcus aureus)** displayed the largest global increase in AMR deaths (1990–2021).
- Among Gram-negative bacteria, **carbapenem resistance** showed the steepest rise:
    - Associated deaths increased from **619,000** (1990) to **1.03 million** (2021).
    - Attributable deaths doubled between 1990 and 2021.

3.4 Impact of COVID-19 (2020–2021)

A significant decline in non-COVID infectious disease burden was observed due to global mitigation measures, while increased healthcare strain influenced AMR patterns.

4. Forecasts to 2050 and Policy Implications

4.1 Expected Burden by 2050

- **1.91 million deaths** attributable to AMR projected by 2050.
- **8.22 million deaths** associated with AMR annually by 2050.
- Highest mortality expected in:
    - **South Asia**
    - **Latin America and the Caribbean**

4.2 Ageing and AMR

By 2050, **65.9% of AMR-attributable deaths** will occur in adults aged 70+ years, highlighting the intersection of AMR and global population ageing.

4.3 DALY Patterns

While AMR-related deaths are projected to increase by **~70%**, DALYs will increase by only **~9%**, reflecting differing trends in mortality vs. long-term disability.

4.4 AMR Reduction Scenarios

- **Better care scenario:** up to **92 million deaths** could be averted from 2025–2050 through improved healthcare quality and access to appropriate antimicrobials.
- **Gram-negative drug scenario: 11.1 million deaths** could be averted via development and deployment of novel Gram-negative antibiotics.

5. Policy Relevance and Global Health Significance

The findings of this study directly support global and national policy planning by:

- Informing **AMR National Action Plans (NAPs)**
- Guiding **investment in new antibiotic development pipelines**
- Strengthening **health system resilience and infection prevention programs**
- Shaping **One Health strategies** to reduce inappropriate antimicrobial use in human health and agriculture
- Providing evidence for **SDG 3 (Good Health and Well-being)** monitoring, particularly SDG targets related to infectious disease reduction

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7.Global Burden of Neurological Disorders (1990–2021): Comprehensive Epidemiological Assessment and Disease Burden Modelling under the Global Burden of Disease Study 2021

Reframed Content as a Project Report

1. Project Overview

The project *"Global Burden of Neurological Disorders (1990–2021)"* presents the most comprehensive worldwide assessment of nervous system–related health loss to date. Conducted as part of the Global Burden of Disease (GBD) Study 2021, this analysis includes **37 neurological and neurologically-associated conditions**, covering

neurodevelopmental disorders, neurodegenerative diseases, neurological complications of systemic conditions, and newly emergent conditions such as post-COVID cognitive impairment.

Earlier GBD reports (2015 and 2016) assessed only 15 neurological disorders and excluded neurodevelopmental disabilities defined under ICD-11, as well as neurological sequelae of congenital, neonatal, infectious, and metabolic diseases. This project fills these critical gaps, offering an expanded and refined estimate of global neurological health needs across 204 countries and territories over a 32-year period.

2. Objectives of the Project

- To estimate the global, regional, and national burden of neurological disorders from 1990–2021.
- To quantify mortality, morbidity, and disability using standard GBD indicators: mortality, prevalence, YLDs, YLLs, and DALYs.
- To isolate and quantify nervous system–specific health loss even when neurological impairment occurs as a secondary outcome of other conditions.
- To enable evidence-based planning for neurological health services, rehabilitation, and long-term care.
- To support global and national policymakers in designing interventions aligned with SDG 3: Good Health and Well-being.

3. Methodological Framework

The study employed a sequela-level approach to precisely measure health loss caused directly by neurological damage. The analysis included:

3.1 Conditions Included

- **Primary neurological diseases:** stroke, epilepsy, dementias, Parkinson's disease, migraine, neurological cancers, etc.
- **Neurodevelopmental disorders (ICD-11):** autism spectrum disorder, intellectual disabilities, developmental delays.
- **Neurological sequelae of other conditions:**
    - Congenital anomalies
    - Neonatal conditions (e.g., jaundice, sepsis, prematurity)
    - Infectious diseases (COVID-19, malaria, Zika virus, syphilis, cystic echinococcosis)
    - Diabetic neuropathy

3.2 Measurement Indicators

For each condition and sequela, estimates were generated for:

- Mortality
- Prevalence
- Years lived with disability (YLDs)
- Years of life lost (YLLs)
- Disability-adjusted life-years (DALYs)
- Age-sex stratification across 204 countries

3.3 Comorbidity Correction

Models accounted for overlapping conditions to avoid double-counting total neurological prevalence and disability.

4. Key Findings (1990–2021)

4.1 Global Burden

- Neurological disorders were the **leading cause of global DALYs in 2021**, with **443 million DALYs (95% UI 378–521 million)**.
- These disorders affected **3.40 billion people** (43.1% of the global population).
- From 1990 to 2021, DALYs increased by **18.2%**, driven by population growth and ageing.

4.2 Age-Standardised Trends

- Age-standardised mortality decreased by **33.6%**.
- Age-standardised DALYs decreased by **27.0%**.
- Age-standardised prevalence remained largely stable (1.5% increase).

4.3 Leading Contributors to Neurological DALYs (2021)

1. Stroke
2. Neonatal encephalopathy
3. Migraine
4. Alzheimer’s disease and other dementias
5. Diabetic neuropathy
6. Meningitis

7. Epilepsy
8. Neurological complications of preterm birth
9. Autism spectrum disorder
10. Nervous system cancers

4.4 Interpretation of Trends

- Declining age-standardised rates indicate improvements in prevention and treatment.
- Rising absolute DALY counts reflect:
    - Increasing global population
    - Ageing demographics
    - Better identification of neurological sequelae

5. Policy and Health System Implications

As neurological disorders now constitute the **largest contributor to global disease burden**, the study highlights the need for:

- Strengthened neurological care pathways (acute, chronic, rehabilitation).
- Early childhood screening and intervention for developmental disorders.
- Expanded dementia and ageing-related care services.
- Integrated strategies addressing neurological sequelae of neonatal and infectious conditions.
- Enhanced neurology workforce, infrastructure, and long-term care systems.
- Policy integration aligned with SDG targets on non-communicable diseases, maternal and child health, and universal health coverage.

6. Conclusion

This project provides the most complete picture to date of the global burden of neurological disorders. By measuring health loss across 37 conditions and multiple associated risk factors, the findings provide a compelling case for investment in prevention, early intervention, treatment, and rehabilitation. These insights support national and global health authorities in shaping data-driven, evidence-based policies to reduce neurological disability and mortality worldwide.

8. Global Mortality Dynamics and Life Expectancy Decomposition (1990–2021): Comprehensive Cause-of-Death Modelling Across 288 Causes in 204 Countries under the Global Burden of Disease Study 2021

1. Project Overview

The project *"Global Mortality Dynamics and Life Expectancy Decomposition (1990–2021)"* forms a core component of the Global Burden of Disease (GBD) Study 2021, providing the world's most detailed and systematic estimates of mortality across **288 causes of death** in **204 countries and territories and 811 subnational locations**.

Regular and accurate reporting of cause-specific mortality is essential for designing public health policies, tracking epidemiological transitions, and preparing for health emergencies. This project offers comprehensive insights into mortality patterns over 32 years, capturing both long-term trends and the unprecedented impact of the COVID-19 pandemic on global life expectancy.

2. Objectives of the Project

- To estimate mortality and years of life lost (YLLs) for 288 causes of death from 1990–2021.
- To assess the impact of specific causes on global and regional life expectancy through decomposition analysis.
- To determine temporal shifts in leading causes of death, including the effect of the COVID-19 pandemic.
- To track geographic concentration of mortality causes to inform targeted public health interventions.
- To provide evidence that supports national and global policy planning aligned with SDG-3 (Good Health and Well-being).

3. Methodological Framework

3.1 Data Sources

The analysis drew upon **56,604 data sources**, including:

- Vital registration systems
- Verbal autopsy studies
- Health surveys and censuses
- Disease surveillance systems
- Cancer registries

- Special pandemic-related mortality datasets

For this round, the study incorporated additional:

- 199 new country-years of vital registration data
- 5 country-years of surveillance data
- 21 country-years of verbal autopsy data
- 94 country-years of miscellaneous data sources

3.2 Mortality Estimation Tools

- The **Cause of Death Ensemble Model (CODEm)** was used as the primary modelling tool, selecting and combining models based on predictive validity.
- Alternative modelling strategies were applied where data were sparse, changing over time, or where causes had unique epidemiology.

3.3 YLL Calculation

YLLs were estimated by multiplying the number of deaths for each cause by the standard life expectancy for that age.

3.4 Life Expectancy Decomposition

Cause-specific contributions to life expectancy changes were assessed by region, year, and cause to better understand drivers of mortality improvement or decline.

3.5 Inclusion of Pandemic Mortality

GBD 2021 incorporates:

- COVID-19 deaths
- Excess mortality due to pandemic-related disruptions
  (excluding malaria, measles, pertussis, and lower respiratory infections, which were modelled separately)

3.6 Focus on Mortality Concentration

The analysis used metrics such as:

- Coefficient of variation
- Fraction of population accounting for 90% of deaths
  To identify whether specific causes are increasingly concentrated geographically.

4. Key Findings (1990–2021)

4.1 Trends in Leading Causes of Death

From 1990 to 2019, the top four global causes of age-standardised deaths remained unchanged:

1. Ischaemic heart disease
2. Stroke
3. Chronic obstructive pulmonary disease (COPD)
4. Lower respiratory infections

However, by **2021**, COVID-19 emerged as the **second-leading cause of age-standardised deaths**, replacing stroke.

4.2 COVID-19 Mortality Impact

- **Highest death rates** in 2021:
    - Sub-Saharan Africa: **271 per 100,000**
    - Latin America & Caribbean: **195 per 100,000**
- **Lowest death rates**:
    - High-income regions: **48 per 100,000**
    - Southeast Asia, East Asia & Oceania: **23 per 100,000**

4.3 Life Expectancy Trends

- Between 1990 and 2019, life expectancy increased globally for **18 of 22 major causes**.
- However, from 2019 to 2021, global life expectancy **declined by 1.6 years**, primarily due to COVID-19 and pandemic-related mortality.

4.4 Regional Variation

- **Greatest gain (1990–2021)**: Southeast Asia, East Asia & Oceania (+8.3 years).
- **Smallest reduction during COVID-19**: same region (–0.4 years).
- **Largest loss due to COVID-19**: Latin America & Caribbean (–3.6 years).

4.5 Geographic Concentration of Mortality

- As of 2021, **53 out of 288 causes** were highly concentrated geographically, affecting <50% of the global population.
- In 1990, only 44 causes showed similar concentration patterns.
- Most concentrated causes:

- Enteric infections
- Lower respiratory infections
- Tuberculosis
- Malaria
- HIV/AIDS
- Neonatal disorders
- Measles

This indicates persistent inequities in global mortality distribution.

5. Interpretation and Policy Implications

This project demonstrates that:

- Long-term progress in reducing mortality has been significantly disrupted by the COVID-19 pandemic.
- However, improvements in causes such as stroke, lower respiratory infections, and neonatal conditions continue to contribute positively to global life expectancy.
- Regional variations in mortality drivers highlight the need for **context-specific health strategies**.
- The increasing concentration of specific causes of death in particular geographies provides opportunities to replicate successful interventions from better-performing regions.
- These insights are critical for governments, international agencies, and health systems planning to strengthen resilience, align with SDG targets, and reduce mortality inequities.

6. Conclusion

This project offers the most exhaustive assessment to date of global mortality patterns across 288 causes, their impact on life expectancy, and the disruption caused by the COVID-19 pandemic. By integrating diverse data sources and advanced modelling frameworks, the study equips policymakers with evidence to design targeted interventions that improve survival and reduce mortality disparities worldwide.

9. Global, Regional, and National Trends in Stroke Burden and Attributable Risks (1990–2021): A Comprehensive Analytical Report Based on the Global Burden of Disease Study 2021

1. Introduction

Stroke continues to be one of the most significant contributors to mortality and long-term disability worldwide. Accurate, updated estimates of stroke burden and associated risk factors are essential for guiding evidence-based decision-making in clinical care, preventive strategies, and health-resource allocation. This project report presents a detailed analysis of global, regional, and national stroke burden from 1990 to 2021, drawing on the Global Burden of Disease (GBD) Study 2021.

2. Objectives

The primary objectives of this analytical project were to:

- Quantify mortality, incidence, prevalence, and disability-adjusted life years (DALYs) caused by stroke and stroke subtypes over a 31-year period.
- Evaluate disparities in stroke burden across 204 countries and territories.
- Assess the contribution of 23 risk factors and six risk clusters to stroke burden at global and regional levels.
- Identify temporal trends and changes in risk patterns to guide future public health strategies.

3. Methodology

3.1 Data Sources and Scope

The analysis utilised GBD 2021 data covering 204 countries and territories between 1990 and 2021. Metrics assessed include:

- Incidence and prevalence
- Mortality and YLLs
- DALYs and age-standardised rates

Stroke subtypes analysed:

- **Ischaemic stroke**
- **Intracerebral haemorrhage**
- **Subarachnoid haemorrhage**

3.2 Risk Factor Assessment

The burden of stroke attributable to **23 risk factors** grouped into **six clusters** was analysed:

1. Air pollution
2. Tobacco smoking
3. Behavioural risks
4. Dietary risks
5. Environmental risks
6. Metabolic risks

3.3 Statistical Modelling

Standard GBD methodologies were applied, including:

- Multistage estimation pipeline
- Propagation of 500 draws to calculate 95% uncertainty intervals (UIs)
- Evaluation of trends across the Socio-demographic Index (SDI) levels and 21 GBD regions

4. Key Findings

4.1 Global Stroke Burden (2021)

- **Stroke was the 3rd leading cause of death globally** with **7.3 million deaths** (95% UI 6.6–7.8).
- It ranked as the **4th leading cause of DALYs**, contributing **160.5 million DALYs**.
- A total of **93.8 million people** were living with stroke, with **11.9 million new cases** reported in 2021.

4.2 Distribution of Stroke Types

- **Ischaemic stroke:** 65.3% of incident strokes
- **Intracerebral haemorrhage:** 28.8%
- **Subarachnoid haemorrhage:** 5.8%

4.3 Regional and Socio-demographic Disparities

The burden of stroke varies significantly:

- Increased incidence and mortality observed in **southeast Asia, east Asia, Oceania**, and **low-SDI countries**.

- Rising burden particularly noted among **populations under 70 years**.

4.4 Trends, Patterns, and Emerging Challenges

- After years of gradual reduction, **global stroke incidence stagnated post-2015**.
- Some regions showed **increase in stroke incidence and DALYs**, signalling urgent need for intervention.

4.5 Risk Factor Attribution

Several risk factors showed substantial increases in attributable DALYs:

- **High BMI:** +88.2%
- **High ambient temperature:** +72.4%
- **High fasting plasma glucose:** +32.1%
- **Diet high in sugar-sweetened beverages:** +23.4%
- **Low physical activity:** +11.3%
- **High systolic blood pressure:** +6.7%
- **Lead exposure:** +6.5%
- **Diet low in omega-6 PUFA:** +5.3%

These trends underscore the growing impact of lifestyle, metabolic, and environmental factors on stroke burden globally.

5. Interpretation and Implications

The analysis reveals that:

- **Global stroke burden has increased significantly from 1990 to 2021**, driven by demographic expansion, population ageing, and rising metabolic risks.
- The worsening trends in younger age groups and lower-SDI countries highlight widening health inequalities.
- The rise in metabolic and behavioural risk factors indicates an urgent need for large-scale, multisectoral preventive strategies.
- Strengthening **surveillance systems**, **acute stroke care**, **rehabilitation services**, and **population-level risk reduction initiatives** is critical for reversing the upward trajectory.

6. Conclusion

This comprehensive 31-year analysis demonstrates that stroke remains a major global health challenge, with increasing incidence and an expanding contribution from modifiable risk factors. To mitigate rising burden, countries must prioritise:

- Accessible and effective stroke prevention programmes,
- Public health interventions targeting lifestyle and environmental factors,
- Enhanced acute care pathways, and
- Strengthened rehabilitation services.

Timely implementation of these strategies can significantly reduce stroke burden and improve population health outcomes worldwide.

10. Projecting the Impact of Future Smoking Prevalence Scenarios on Mortality, Years of Life Lost, and Life Expectancy (2022–2050): A Comprehensive Scenario Analysis Using GBD 2021 Data.

1. Introduction

Smoking remains the leading behavioural risk factor contributing to global mortality. Between 1990 and 2021, smoking was associated with more than **175 million deaths** and approximately **4.30 billion years of life lost (YLLs)**. Although global smoking prevalence has declined over the past decades, the rate of reduction has slowed in many regions. As countries consider policies aimed at achieving tobacco-free generations, projecting the future health impacts of various smoking prevalence trajectories is essential for informed policy design.

This project aims to forecast the impact of three future smoking prevalence scenarios on all-cause and cause-specific YLLs, as well as on global life expectancy, from 2022 to 2050.

2. Project Objectives

1. **To model future smoking prevalence trends** under three scenarios: continuation of past trends, immediate elimination beginning in 2023, and gradual elimination by 2050.
2. **To estimate the resulting burden of disease**, expressed through years of life lost (YLLs), for each scenario.

3. **To forecast changes in global life expectancy at birth** associated with each scenario.
4. **To provide evidence-based insights** for policymakers evaluating potential tobacco control strategies.

3. Methods

3.1 Data Source

The analysis uses data and modelling tools from the **Institute for Health Metrics and Evaluation (IHME) Future Health Scenarios platform** and the **Global Burden of Disease Study 2021 (GBD 2021)**.

3.2 Scenario Definitions

1. **Reference Scenario**
    - Assumes continuation of historical trends in smoking prevalence and other health risk factors.
2. **Elimination-2023 Scenario**
    - Models a hypothetical immediate reduction to **0% smoking prevalence starting in 2023**.
    - Represents the maximum achievable health benefits under total smoking elimination.
3. **Elimination-2050 Scenario**
    - Models a gradual reduction in smoking prevalence to **5% by the year 2050**.
    - Useful for countries considering progressive tobacco control strategies.

3.3 Analytical Approach

- YLLs were calculated using the **GBD 2021 reference life table**.
- Forecasts were generated for cause-specific mortality under each scenario.
- **95% uncertainty intervals (UIs)** were produced using 1,000 model iterations, capturing the 2.5th and 97.5th percentiles of the output distribution.

4. Key Findings

4.1 Smoking Prevalence (2022 Baseline)

- **Males**: 28.5% (95% UI 27.9–29.1)
- **Females**: 5.96% (95% UI 5.76–6.21)

4.2 Projected Prevalence Reductions (Reference Scenario, 2022–2050)

- **Males**: 25.9% decline
- **Females**: 30.0% decline

4.3 Projected Health Outcomes

Reference Scenario

- **Cumulative YLLs (2022–2050):**
    - Males: 29.3 billion
    - Females: 22.2 billion
- **Life expectancy at birth in 2050:**
    - 78.3 years (increase from 73.6 in 2022)

Elimination-2023 Scenario

- **Avoided YLLs by 2050:**
    - 2.04 billion fewer YLLs compared with the reference scenario
- **Life expectancy in 2050:**
    - Males: 77.6 years
    - Females: 81.0 years

Elimination-2050 Scenario

- **Avoided YLLs (2022–2050):**
    - Males: 735 million
    - Females: 141 million
- **Life expectancy in 2050:**
    - Males: 77.1 years
    - Females: 80.8 years

5. Discussion

The projections emphasize that **maintaining current tobacco control policies is crucial** for ensuring continued reductions in smoking prevalence. However, **accelerated policy interventions**, especially those aligned with rapid or phased elimination strategies—could yield substantial additional reductions in mortality and YLLs.

The Elimination-2023 scenario highlights the maximum potential health benefits from immediate action, while the Elimination-2050 scenario shows meaningful gains that remain achievable through gradual, sustained policy measures.

6. Conclusions and Recommendations

- Strengthening tobacco control efforts can significantly reduce the global burden of disease over the coming decades.
- Immediate or accelerated smoking elimination strategies have the potential to **avert millions to billions of years of life lost**.
- Countries should consider adopting comprehensive tobacco control frameworks, ensuring past gains in smoking reduction are not reversed.

11. Evaluating the Applications of Artificial Intelligence in Oral and Maxillofacial Pathology: A Systematic Review and Evidence Synthesis.

1. Introduction

Artificial intelligence (AI) is transforming numerous sectors of healthcare by enabling the rapid analysis of complex datasets, including medical records, imaging studies, and clinical indicators. In the field of **oral and maxillofacial pathology**, AI has emerged as a promising tool to assist clinicians and pathologists in diagnosing diseases, predicting clinical outcomes, and supporting treatment planning.

This project aims to systematically evaluate research trends and applications of AI within oral and maxillofacial pathology, with a focus on its diagnostic, predictive, and clinical decision-support capabilities.

2. Project Objectives

1. **To identify and review existing literature** examining the use of AI in oral and maxillofacial pathology.

2. **To evaluate AI applications** across diagnosis, treatment planning, image analysis, predictive modelling, and patient monitoring.
3. **To assess the accuracy, utility, and limitations** of AI tools reported in current studies.
4. **To highlight gaps and future directions** in the integration of AI into this specialty.

3. Methods

3.1 Definition of Key Terms

The project began by defining core concepts central to the research, including *machine learning*, *diagnostic support*, *predictive modelling*, *image analysis*, and *clinical decision support*.

3.2 Literature Search

A systematic search was conducted across multiple databases:

- **PubMed**
- **Scopus**
- **Web of Science**

Keywords and related synonyms were used, including:
"machine learning," "artificial intelligence," "oral pathology," "maxillofacial pathology," "image analysis," "diagnosis," "treatment planning," "predictive modelling," and "patient monitoring."

Additional sources were identified through **Google Scholar** to ensure comprehensive coverage.

3.3 Study Selection

Nine studies met the inclusion criteria based on relevance, methodological quality, and focus on AI applications within oral and maxillofacial pathology.

4. Results

4.1 Areas of AI Application

Most of the selected studies focused on the **diagnosis of malignant tumors of the oral cavity**. AI methods included:

- Deep learning-based image classification
- Predictive algorithms for disease progression
- Risk estimation models

4.2 Diagnostic Support

AI tools demonstrated significant potential in supporting pathologists by:

- Enhancing accuracy in distinguishing malignant from benign lesions
- Identifying high-risk patients
- Detecting recurrence likelihood following treatment

4.3 Predictive Modelling

AI-based predictive models were effective in forecasting:

- The potential development of oral cancer in at-risk individuals
- The probability of disease recurrence
- Patient-specific clinical outcomes

These capabilities show strong promise for improving early detection and personalized treatment strategies.

5. Discussion

The findings underscore AI's capacity to:

- Improve **diagnostic precision**
- Support **personalized treatment planning**
- Enhance monitoring and follow-up care
- Assist clinicians in making data-driven decisions

However, the integration of AI into oral and maxillofacial pathology requires careful consideration of:

- Ethical and legal implications
- Data privacy and security
- Regulatory approval pathways
- The need for robust clinical validation

Furthermore, since AI application in this field is still emerging, cautious and systematic adoption is essential.

6. Conclusions

AI has considerable potential to transform the field of oral and maxillofacial pathology by improving diagnostic accuracy, supporting clinical decision-making, and enhancing patient outcomes. Continued research, standardized validation procedures, and ethical oversight are critical to ensuring the safe and effective integration of AI technologies into clinical practice.

12. State-Level Trends in Disease Burden, Injuries, and Risk Factors in the United States (1990–2021): A Comprehensive Assessment Using GBD 2021 Data.

1. Introduction

Understanding the distribution and evolution of diseases, injuries, and risk factors across the United States is essential for informed public health planning and policy development. The **Global Burden of Disease Study (GBD) 2021** provides a detailed and standardized framework for evaluating health outcomes at global, national, and subnational levels.

This project analyzes the burden of diseases, injuries, and risk factors across U.S. states from **1990 to 2021**, highlighting inequalities in health status and identifying areas requiring urgent attention.

2. Project Objectives

The specific objectives of this project are to:

1. **Assess national and state-level trends** in mortality, morbidity, disability, and life expectancy in the USA over three decades.
2. **Quantify the burden** associated with 371 diseases and injuries and 88 risk factors using GBD metrics.
3. **Compare state performance with international benchmarks** to contextualize U.S. health outcome trends.
4. **Identify the leading causes of health loss** and the most influential risk factors across age groups and sexes.

5. **Provide evidence-based insights** to support public health decision-making, resource allocation, and health policy evaluation.

3. Methods

3.1 Data Source and Coverage

The analysis was conducted using data from **GBD 2021**, which evaluates:

- **371 diseases and injuries**
- **288 causes of death**
- **88 risk factors**
- **155 health outcomes and 631 risk–outcome pairs**

3.2 Metrics Used

Key GBD metrics included:

- **Years of Life Lost (YLLs)**
- **Years Lived with Disability (YLDs)**
- **Disability-Adjusted Life Years (DALYs)**
- **Life Expectancy and Healthy Life Expectancy (HALE)**
- **Risk-attributable mortality and morbidity**
- **Population attributable fractions and summary exposure values**

3.3 Analytical Framework

- Estimates were disaggregated by **sex (male, female)**, **age (25 groups from birth to ≥95 years)**, and **year (1990–2021)**.
- GBD methods accounted for differences in data sources, measurement error, and bias.
- **Comparability across states** was ensured using a consistent computational framework.
- **Uncertainty intervals (95% UIs)** were produced using 500 model draws, with uncertainty propagated throughout analysis steps.

4. Results

4.1 National Health Trends and Global Standing

The USA experienced a **significant decline in global life expectancy and HALE rankings** from 1990 to 2021:

- Life expectancy ranking dropped from **35th to 46th** for males and **19th to 47th** for females.
- HALE ranking fell from **42nd to 69th** for males and **32nd to 76th** for females.

The COVID-19 pandemic (2020–2021) further accelerated these declines.

4.2 State-Level Variation in Life Expectancy and HALE

Substantial disparities were observed across states:

- **Best-performing state:** Hawaii (1990 & 2021)
    - However, Hawaii's global ranking fell from 6th to 28th for males and 4th to 22nd for females.
- **Worst-performing states (2021):**
    - Males: Mississippi (ranked 107th globally)
    - Females: West Virginia (ranked 99th globally)

Fourteen states experienced **net life expectancy losses**, with West Virginia showing the greatest decline (–2.7 years).

HALE disparities were even wider:

- Hawaii (best): dropped from global ranks 14th (males) and 5th (females) to 39th and 34th.
- West Virginia (worst): ranked 141st (males) and 137th (females) in 2021.

4.3 Mortality Trends Across States

Between 1990 and 2021:

- Significant declines occurred in mortality from:
    - **Ischemic heart disease** (–56.1%)
    - **Lung cancer** (–41.9%)
    - **Breast cancer** (–40.9%)

- Large increases occurred in mortality from:
    - **Drug use disorders** (+878%)
    - **Chronic kidney disease** (+158.3%)
    - **Falls** (+89.7%)

State disparities were notable:

- Lowest mortality rate (2021): **Hawaii (433.2 per 100,000)**
- Highest mortality rate (2021): **Mississippi (867.5 per 100,000)**
- Largest improvement: **Washington, DC** (–40.7% decline)

4.4 Disability Burden (YLDs)

The USA ranks among the worst globally for disability burden:

- Only six countries had higher age-standardized YLD rates in 2021.
- Eight U.S. states—including West Virginia, Kentucky, and Oklahoma—recorded **higher YLD rates than any country worldwide**.

Leading contributors:

- **Low back pain** remained the top cause in 1990 and 2021.
- Large increases in:
    - **Depressive disorders** (+56%)
    - **Drug use disorders** (+287.6%)

Females experienced particularly high rates of mental health–related disability.

4.5 Leading Risk Factors for Mortality

The top risk factors in 2021 were:

1. **High systolic blood pressure**
2. **High fasting plasma glucose**
3. **Tobacco use**

Trends since 1990:

- Mortality from high systolic blood pressure ↓ 47.8%

- Mortality from tobacco ↓ 5.1%
- Mortality from high fasting plasma glucose ↑ 9.3%

Risk factor patterns differed by age:

- **Ages 15–49:** drug use, alcohol use, dietary risks
- **Ages 50–69:** tobacco, dietary risks, high BMI

5. Discussion

This analysis reveals persistent and widening disparities in health outcomes across U.S. states. While notable progress has been made in reducing certain chronic disease mortality rates, the national health profile is increasingly shaped by:

- Mental health disorders
- Musculoskeletal disorders
- Substance use epidemics
- Metabolic risk factors

Declining international rankings underline structural challenges in the U.S. healthcare and social systems. The worsening burden among disadvantaged states highlights the need for targeted policy interventions that address:

- Socioeconomic inequalities
- Behavioral risk determinants
- Access to healthcare and preventive services
- Environmental and social stressors affecting minority populations

6. Conclusions and Recommendations

GBD 2021 findings provide a vital evidence base for:

- **Prioritizing health interventions** at national and state levels
- **Allocating resources strategically** to high-burden states
- **Evaluating the effectiveness of existing health policies**

To improve outcomes and reduce disparities, the United States must:

- Strengthen behavioral health and substance use prevention programs

- Expand access to chronic disease prevention and management
- Address social determinants such as poverty, education, and housing
- Target high-burden states with customized, data-driven solutions

By doing so, the nation can work toward ensuring that all residents have the opportunity to achieve longer, healthier lives.

13. Assessment of Global, Regional, and National Progress Toward 2030 Nutrition Targets with Forecasts to 2050: A Project Report Based on the Global Burden of Disease Study 2021.

1. Introduction

In 2012, the World Health Assembly identified six Global Nutrition Targets (GNTs) as essential indicators of maternal and child health. These targets focus on:

- Low birthweight
- Exclusive breastfeeding
- Child stunting
- Child Wasting
- Child overweight
- Anaemia among females of reproductive age

Despite their importance, a consolidated evaluation of progress for the period 2012–2021 had been lacking. This project aims to fill that gap by presenting a comprehensive assessment of global, regional, and national performance using data from the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2021.

2. Project Objectives

The project set out to:

1. **Estimate levels, trends, and burden** associated with each nutrition target from 2012 to 2021 across 204 countries and territories.
2. **Evaluate country-level performance** by comparing observed progress against expected progress based on the Socio-demographic Index (SDI).
3. **Project future trajectories** of target indicators from 2021 to 2050 using meta-regression-based forecasting.

4. **Identify gaps and future needs** for policy, investment, and interventions.

3. Methods

3.1 Data Source

This analysis used the GBD 2021 dataset, the most comprehensive global platform for estimating causes of death, disability, and risk factors. Estimates were generated for:

- Annual prevalence
- Attributable burden
- Age- and sex-specific patterns
- Country-level performance

3.2 Performance Assessment

A Bayesian meta-regression model was developed to compare observed prevalence to expected prevalence based on SDI. This enabled evaluation of whether countries were progressing faster or slower than socio-demographically expected.

3.3 Forecasting

Indicators were projected to 2050 by modelling past trends using key quantities derived from historical GBD data and extrapolating forward using established meta-regression techniques.

4. Findings

4.1 Status in 2021

By 2021:

- **Exclusive breastfeeding:** 5 countries met the target
- **Stunting:** 4 countries met the target
- **Wasting:** 96 countries met the target
- **Overweight:** 3 countries met the target
- **Low birthweight & anaemia:** No country achieved these targets

4.2 Trends (2012–2021)

- Child overweight prevalence increased in **201 countries**.
- Anaemia declined substantially in only **26 countries**.

- SDI showed strong associations with most indicators (correlations |r| = 0.46–0.86), except exclusive breastfeeding.
- Sub-Saharan African countries showed faster-than-expected declines in stunting and wasting.

4.3 Burden Reduction

For many low- and middle-income countries, the attributable burden of low birthweight, stunting, and wasting declined **faster** than prevalence itself—indicating progress in mitigating health consequences even when prevalence changes are slow.

5. Forecasts

5.1 Projections to 2030

By 2030:

- **94 countries** will meet **one** target.
- **21 countries** will meet **two** targets.
- **89 countries** will not meet **any** target.

Target-specific projections:

- **Exclusive breastfeeding:** 7 countries
- **Stunting:** 28 countries
- **Wasting:** 101 countries
- **Low birthweight, overweight, anaemia:** No country expected to meet targets

5.2 Projections to 2050

Expected target achievement:

- **Exclusive breastfeeding:** +7 more countries
- **Low birthweight:** 5 countries
- **Stunting:** 96 countries
- **Wasting:** 9 countries
- **Overweight:** 1 country
- **Anaemia:** No countries projected to meet the target

6. Interpretation and Implications

The analysis suggests that, under current trajectories, **few GNTs will be reached by 2030**. Despite reductions in the burden associated with several child nutrition indicators, stagnation in anaemia and rising overweight rates indicate major systemic challenges.

Key takeaways include:

- **Childhood illness prevention and treatment remain vital** to sustain progress.
- **Long-term, multisectoral efforts** are urgently needed to address determinants of malnutrition.
- **Policy successes** in exclusive breastfeeding and anthropometric improvements should be recognised but must be expanded.
- The persistence of anaemia and rising overweight prevalence underscore a **tenuous global nutrition landscape**.

14. Advancements in Precision Medicine for Cystic Fibrosis: A Project Report on Genetic Pathways and Targeted Therapeutic Innovations

1. Introduction

Cystic fibrosis (CF) is a life-limiting genetic disorder driven primarily by mutations in the cystic fibrosis transmembrane conductance regulator (CFTR) gene. Traditional treatments have focused on managing symptoms rather than addressing underlying genetic causes. Recent advancements in personalized medicine now enable tailored therapeutic strategies based on individual genetic profiles.
This project report investigates genetic pathways involved in CF, reviews precision-based therapeutic developments, and evaluates future directions in targeted therapy.

2. Project Objectives

This project aims to:

1. Examine the genetic architecture of CF, with emphasis on CFTR mutations.
2. Assess current precision-medicine therapies, including CFTR modulators.
3. Explore the role of genetic modifiers and environmental factors in shaping disease expression.
4. Evaluate the emerging use of biomarkers and omics technologies in CF management.
5. Review applications of pharmacogenomics in optimizing treatment responses.
6. Highlight future innovations such as gene therapy and CRISPR-based approaches.

7. Identify ethical, regulatory, and accessibility considerations relevant to precision CF care.

3. Background and Rationale

CF arises from more than 2,000 known mutations in the CFTR gene, each affecting protein function differently. Variability in disease severity among patients with similar mutations demonstrates the influence of genetic modifiers and environmental factors. The shift toward precision medicine has accelerated the development of CFTR modulators and advanced genetic therapies, making it essential to understand the underlying biological mechanisms and implications for clinical practice.

4. Genetic Basis of Cystic Fibrosis

4.1 CFTR Gene Mutations

CF results from defective or absent CFTR protein, which impairs chloride transport across epithelial membranes. Key mutation classes affect CFTR protein synthesis, folding, trafficking, gating, and conductance.

4.2 Genetic Modifiers

Beyond primary mutations, additional genes influence:

- Disease onset
- Lung function decline
- Inflammatory responses
- Treatment outcomes

Examples include genes involved in immune regulation, mucociliary clearance, and epithelial integrity.

4.3 Environmental Contributors

Factors such as infection exposure, air quality, nutrition, and healthcare access can intensify or mitigate disease severity.

5. Current Precision Therapies

5.1 CFTR Modulators

Personalized treatments designed to restore CFTR function include:

- **Ivacaftor** – enhances CFTR channel gating
- **Lumacaftor** – improves CFTR folding and trafficking
- **Tezacaftor** – increases protein stability and processing

These therapies are prescribed based on specific CFTR mutation profiles established through genetic testing.

5.2 Gene Replacement and Editing Strategies

Modern interventions under investigation include:

- **Gene replacement therapy**
- **Lentiviral vector–based delivery systems**
- **Non-viral gene therapy formulations**
- **CRISPR-Cas9–mediated mutation correction**

These approaches aim to address the root cause of CF by restoring functional CFTR expression.

6. Biomarkers and Omics-Driven Insights

6.1 Emerging Biomarkers

Promising indicators for early diagnosis and disease monitoring include:

- Inflammatory markers
- Pulmonary function metrics
- Metabolic and proteomic signatures

6.2 Omics Technologies

Genomics, proteomics, metabolomics, and transcriptomics are uncovering:

- Novel disease pathways
- Predictive biomarkers
- Targets for personalized intervention

These technologies enhance precision in disease classification and treatment response assessment.

7. Pharmacogenomics in CF Care

Pharmacogenomic profiling helps optimize therapeutic regimens by identifying genetic variants that influence:

- Drug metabolism
- Antibiotic responsiveness
- Anti-inflammatory drug efficacy

- Risk of adverse reactions

Integrating pharmacogenomics into clinical workflows supports safer and more effective CF management.

8. Future Directions in Precision Medicine

Next-generation CF therapies are focused on:

- Expanding CFTR modulator coverage
- Enhancing gene therapy delivery efficiency
- Applying CRISPR-based mutation correction clinically
- Developing personalized anti-inflammatory and antimicrobial therapies

These innovations hold potential to minimize complications and substantially improve long-term patient outcomes.

9. Ethical and Regulatory Considerations

Key challenges include:

- Ensuring equitable access to high-cost precision therapies
- Validating long-term safety of gene-editing technologies
- Protecting patient genetic data and privacy
- Addressing regulatory barriers for novel gene-based treatments

A responsible framework is essential for the safe integration of personalized therapies into CF care.

10. Conclusion

Precision medicine has revolutionized the treatment landscape for cystic fibrosis by leveraging genetic insights to create highly targeted therapies. Advancements in CFTR modulators, gene therapy technologies, biomarkers, and pharmacogenomics demonstrate substantial promise for improving individualized care. Continued research, ethical oversight, and equitable implementation will be critical to realizing the full potential of these innovations.

15. Age-Specific Global, Regional, and National Progress Toward the 2020 WHO End TB Strategy Milestones: A Project Report Based on the Global Burden of Disease Study 2021.

1. Introduction

Tuberculosis (TB) remains one of the leading infectious disease burdens worldwide. In 2015, the WHO End TB Strategy established interim 2020 milestones, aiming for a **35% reduction in TB mortality** and a **20% reduction in TB incidence** relative to 2015 levels. However, global assessments have largely overlooked age-specific progress, despite known variations in TB risk and outcomes across age groups.

This project evaluates age-specific progress toward the 2020 milestones using data from the Global Burden of Diseases, Injuries, and Risk Factors Study 2021 (GBD 2021). The analysis spans 204 countries and territories from 1990 to 2021.

2. Project Objectives

The project aimed to:

1. Quantify TB mortality and incidence across five age groups globally, regionally, and nationally.
2. Assess age-specific progress toward the WHO End TB Strategy 2020 targets between 2015 and 2020.
3. Estimate TB mortality attributable to major risk factors—smoking, alcohol use, and diabetes.
4. Evaluate how the COVID-19 pandemic may have influenced TB mortality in 2020 and 2021.
5. Provide insights to guide countries in refining national TB control strategies toward 2035 goals.

3. Methods

3.1 Data Sources and Analytical Framework

The project applied the GBD 2021 framework to generate age-specific TB incidence and mortality estimates for 204 countries and territories.

Primary data inputs included:

- 22,603 site-years of vital registration
- 1,718 site-years of verbal autopsy
- 825 site-years of sample-based vital registration
- 680 site-years of mortality surveillance
- 9 site-years of minimally invasive tissue sampling (MITS)

These were incorporated into the **Cause of Death Ensemble Model** to derive TB mortality without HIV co-infection.

3.2 TB Incidence Modelling

Population-based TB data—prevalence surveys, case notifications, tuberculin surveys, mortality data—were analyzed using **DisMod-MR 2.1**, an established Bayesian meta-regression tool, to generate internally consistent estimates of incidence, prevalence, and mortality.

3.3 Risk Factor Attribution

The study estimated deaths attributable to smoking, alcohol use, and diabetes, both independently and in combination, to evaluate the contribution of modifiable risks.

3.4 Secondary COVID-19 Impact Analysis

For 41 countries (2020) and 20 countries (2021), expected TB deaths derived from pre-pandemic trends (2015–2019) were compared with observed deaths to assess disruptions caused by COVID-19.

4. Findings

4.1 Global TB Burden in 2021

- **Incidence:** 9.40 million cases
- **Deaths:** 1.35 million

4.2 Age-Specific Progress Toward the 2020 Incidence Milestone

Between 2015 and 2020:

Age Group	Global Incidence Reduction
<5 years	**16.5%**
5–14 years	**16.2%**
15–49 years	**6.29%**
50–69 years	**5.72%**
≥70 years	**8.48%**

Only **15 of 204 countries** achieved the 20% incidence reduction target, with western sub-Saharan Africa showing the most progress.

4.3 Age-Specific Progress Toward the 2020 Mortality Milestone

Globally, TB deaths decreased by **11.9%** between 2015 and 2020.

Age Group	Decline in TB Mortality
<5 years	**35.3%**
5–14 years	**29.5%**
15–49 years	**15.2%**
50–69 years	**7.97%**
≥70 years	**3.29%**

Only **17 countries** reached the 35% mortality reduction milestone, concentrated mainly in eastern and central Europe.

4.4 Burden Attributable to Risk Factors

Removing the combined effects of smoking, alcohol use, and diabetes would have reduced TB deaths in 2020 from:

- **1.39 million → 1.00 million**,
  a **36.5% decline** compared with 2015 levels.

4.5 Impact of the COVID-19 Pandemic

- **2020:** Expected deaths = 50,900; observed = 45,500 → **5,340 fewer deaths**
- **2021:** Expected = 39,600; observed = 39,000 → **657 fewer deaths**

Results varied by country but did not show widespread increases in TB mortality where data were available.

5. Interpretation

Despite notable progress since 1990, the world failed to meet the **2020 End TB Strategy milestones** for both mortality and incidence. Key observations include:

- **Progress was uneven across age groups**, with older adults (>50 years) experiencing **the slowest declines** in incidence and mortality.
- Children showed the most substantial mortality reductions, highlighting the effectiveness of pediatric TB control interventions.
- Risk factors such as smoking, alcohol use, and diabetes significantly amplify mortality, presenting major prevention opportunities.
- COVID-19 did not universally increase TB deaths in countries with available data but remains a potential threat to TB control efforts.

6. Recommendations

Countries aiming for the **2035 End TB Strategy targets** should:

1. **Adopt age-targeted TB interventions**, especially for adults over 50.
2. **Scale successful strategies** from countries that achieved 2020 milestones.
3. Address major modifiable risk factors through integrated health programs.
4. Strengthen surveillance, diagnosis, and treatment continuity, especially during global disruptions like pandemics.

Conclusion

Across all the initiatives detailed in this report—from transformative sickle cell disease research and stigma assessment tools, to contributions to global epidemiological modelling, demographic forecasting, antimicrobial resistance projections, stroke burden analyses, and advancements in AI and precision medicine—JSS AHER demonstrates unequivocal leadership in informing and shaping policy at national, regional, and global levels. The institution's work enables policymakers to anticipate future health trajectories, design targeted interventions, and monitor progress toward SDG targets using high-quality evidence. Importantly, these efforts highlight the university's commitment to translating research into action, strengthening health systems, empowering communities, and ensuring that scientific insights directly contribute to equitable, sustainable, and impactful policy outcomes. JSS AHER continues to serve as a model for how academic institutions can accelerate progress toward the Sustainable Development Goals through rigorous research, multisectoral collaborations, and evidence-driven policy engagement.