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Policy briefs from the

UNESCO SCIENCE REPORT

The race against time for smarter development

Science for the Sustainable Development Goals

SDG 3 : **Good health and well-being**

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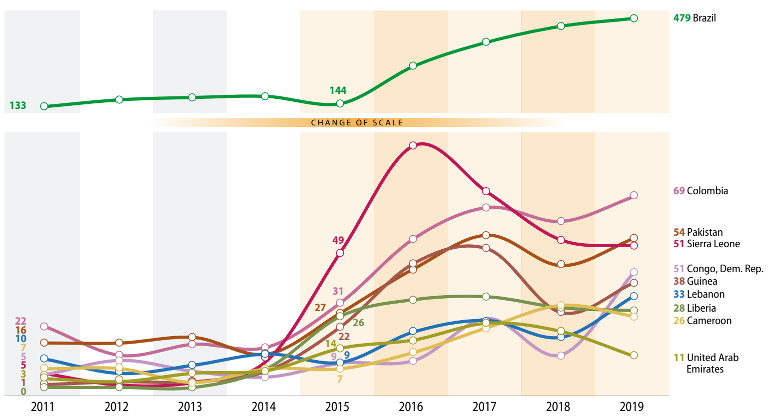
Trends in scientific publishing

- Health research accounted for 33.9% of global scientific publications in 2019.
- In 2020, UNESCO analysed scientific publishing trends for a sample of 56 research topics of particular relevance to eight of the 17 Sustainable Development Goals (SDGs). Data were analysed for 193 countries covering the period 2011–2019. The growth rate was determined by dividing data for 2016–2019 by data for 2012–2015.
- With regard to good health and wellbeing (SDG3), UNESCO analysed research trends for the nine following topics: *reproductive health and neonatology*, *tropical communicable diseases*, *human resistance to antibiotics*, *regenerative medicine*, *impact on health of soil, freshwater and air pollution*, *medicines and vaccines for tuberculosis*, *human immunodeficiency virus (HIV) research*, *new or re-emerging viruses that can infect humans* and *Type 2 diabetes*.
- Reproductive health and neonatology enjoyed the **largest volume** of output among the nine health-related topics under study, with 303 873 publications over 2012–2019 (1.52% of global publications).

Top 10 countries for growth in scientific publishing on new or re-emerging viruses, 2011–2019
For countries with at least 100 publications



- Studies on the impact of soil, freshwater and air pollution on human health enjoyed the **fastest global growth rate**.
- At the other end of the scale, HIV research had the **lowest growth rate** of all 56 topics under study, even though HIV infection rates remain high. HIV research actually declined as a share of global output between 2012–2015 and 2016–2019 (Figure 2.4 in the report).
- Health remains a strong suit for African researchers, with tropical communicable diseases and HIV research among the top five topics for the majority of sub-Saharan countries. However, output on these topics is not growing, which may be a sign that research investment is waning or that other subjects are competing for precedence in Africa's research pathway (see Figure 2.10 in the report).
- Type 2 diabetes (adult-onset diabetes) is becoming more prevalent. Africa, the Arab States, Asia and Europe are leading growth in related research. Treatment of diabetes has benefited from advances in precision medicine, notably in the USA (see chapter 5).
- All of the top countries for the growth rate in research on new or re-emerging viruses that can infect humans have been affected by a viral outbreak in the past decade (see Box 2.1 in the report and figure left). With the discovery of the SARS-CoV-2 virus and its global impact in the Covid-19 pandemic, output on this topic is likely to surge.

To appreciate the urgency of taking an integrated approach to development, one need only consider the ravages of the Covid-19 pandemic, a prime example of the interconnectedness between ecology, human health and economic prosperity.

3 GOOD HEALTH AND WELL-BEING

Research trends by income group

For an interactive version of these data, please visit the online data visualization. Publication data by country and selected regions are freely available from the *UNESCO Science Report* web portal.

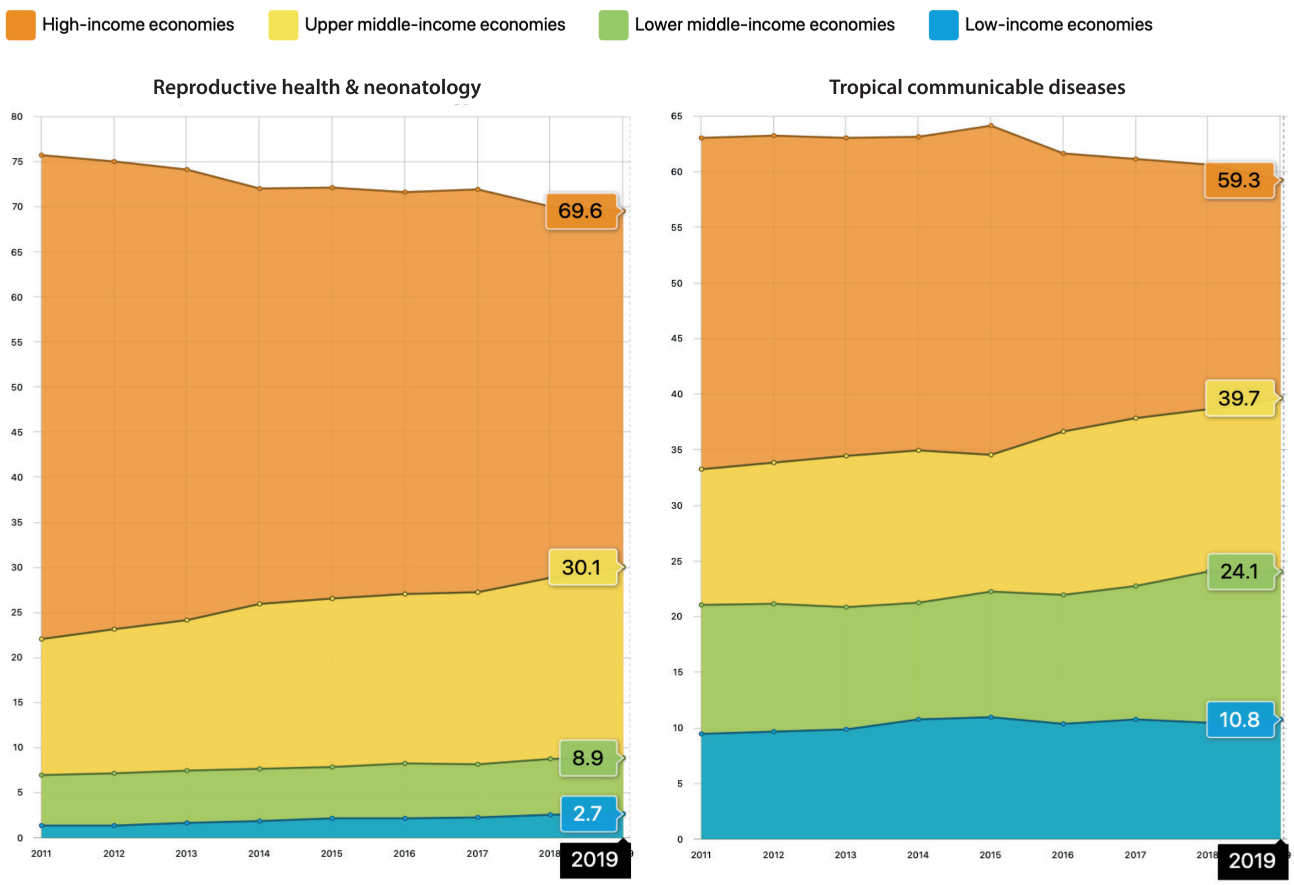
Topic: *Reproductive health & neonatology*

- Scientists produced 303 873 publications on reproductive health and neonatology between 2012 and 2019, equivalent to 1.52% of global scientific output.
- Global scientific output on this topic rose from 32 148 (2011) to 45 153 (2019) publications. This translates into 140 722 (2012–2015) and 163 151 (2016–2019) publications.
- The USA published the most on this topic over 2016–2019 (43 272), followed by China (19 745), UK (12 657), Australia (7 900), Canada (7 564), Italy (7 528), Germany (6 875) and India (6691).
- Among countries with at least 100 publications on this topic over 2012–2019, there has been a surge in the Democratic Republic of Congo (61/139), Ecuador (64/192), Iraq (83/497), Malawi (107/253) and Russian Fed (792/3 754).

Topic: *Tropical communicable diseases*

- Scientists produced 100 553 publications on tropical communicable diseases between 2012 and 2019, equivalent to 0.50% of global scientific output.
- Global scientific output on this topic rose from 10 785 (2011) to 13 712 (2019) publications. This translates into 53 534 (2012–2015) and 47 019 (2016–2019) publications.
- The USA published the most on this topic over 2016–2019 (13 375), followed by Brazil (6 398), UK (6 233) and India (5211), China (4 335) and France (3 104).
- Among countries with at least 20 publications on this topic over 2012–2019, Iraq showed the fastest growth rate with 25 (2012–2015) and 178 (2016–2019) publications.
- Equatorial Guinea published 110 times the global average intensity on this topic, producing 20 (2012–2015) and 30 (2016–2019) publications.

Contribution by income group to global publishing on selected research topics related to Sustainable Development Goal 3: Good health and wellbeing, 2011–2019 (%)



Source: Scopus data treated by Science-Metrix and visualized by Values Associates

3 GOOD HEALTH AND WELL-BEING

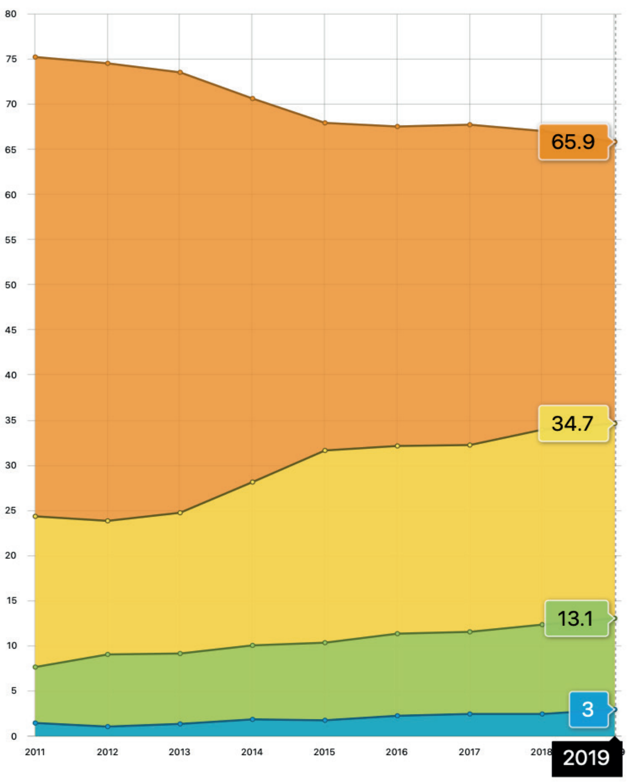
Topic: *Human resistance to antibiotics*

- Scientists produced 39 983 publications on human resistance to antibiotics between 2012 and 2019, equivalent to 0.20% of global scientific output.
- Global scientific output on this topic rose from 3 149 (2011) to 7 212 (2019) publications. This translates into 16 203 (2012–2015) and 23 780 (2016–2019) publications.
- The USA produced the most publications on this topic over 2016–2019 (5 189), followed by China (3 342), UK (1 761), India (1 431), Germany (1 196), France (1 180), Iran (1 045), Spain (1 024), Italy (962), Australia (865), Japan (849) and Rep. Korea (724).
- Among countries with at least 20 publications on this topic over 2012–2019, Myanmar showed the fastest growth in output (1/20). There was also a surge in St Kitts & Nevis (5/26), Trinidad & Tobago (3/17), Georgia (5/21) and Ghana (17/61).
- Among countries with at least 100 publications on this topic over 2012–2019, Iraq showed the fastest growth (18/153). There was also a surge in Nepal (37/93), the Russian Federation (82/281) and South Africa (122/358). Nepal showed the strongest specialization for this category.
- Low-income economies' contribution to this topic doubled from 1.5% in 2011 to 3.0% in 2019.

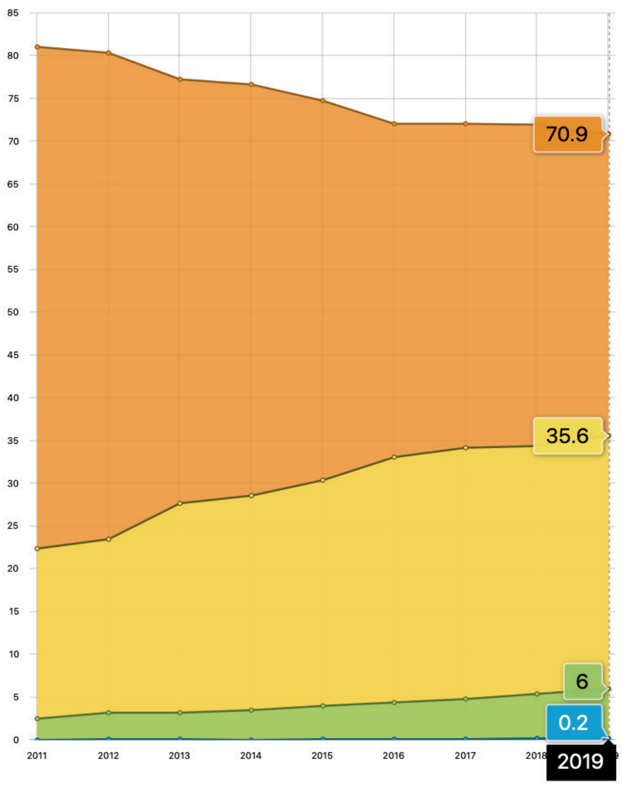
Topic: *Regenerative medicine*

- Scientists produced 206 882 publications on regenerative medicine between 2012 and 2019, equivalent to 1.04% of global scientific output.
- Global scientific output on this topic rose from 20 267 (2011) to 29 572 (2019) publications. This translates into 95 314 (2012–2015) and 111 568 (2016–2019) publications.
- The USA published the most on this topic over 2016–2019 (32 731), followed by China (26 982), Germany (8 178), the UK (7 619), Japan (7 510), Italy (6 076), Rep. Korea (5 086), France (4 274), Canada (3 595), Spain (3 577), Australia (3 081), Netherlands (2 796), Brazil (2 173), Russian Federation (1 988), Sweden (1 794), Poland (1 689), Turkey (1 508) and Belgium (1 468).
- Indonesia ranked first for growth rate with 65 (2012–2015) and 417 (2016–2019) publications, followed by Iraq (20/113). Strong growth was also recorded by Sri Lanka (6/24), Bangladesh (21/60), Viet Nam (47/166) and the United Arab Emirates (48/131).
- Researchers in Singapore published at 70% more than the global average intensity on regenerative medicine, producing 1 372 (2012–2015) and 1 329 (2016–2019) publications, the highest specialization in the world.

Human resistance to antibiotics



Regenerative medicine



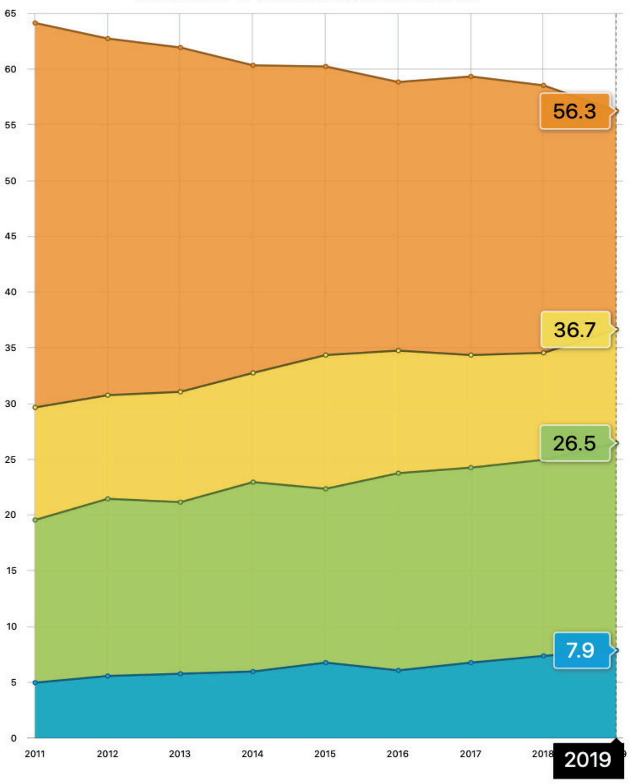
Topic: *Medicines and vaccines for tuberculosis*

- Scientists produced 51 796 publications on medicines and vaccines for tuberculosis between 2012 and 2019, equivalent to 0.26% of global scientific output.
- Global scientific output on this topic increased from 5 608 (2011) to 7 097 (2019) publications. This translates into 24 616 (2012–2015) and 27 180 (2016–2019) publications.
- The USA published the most on this topic over 2016–2019 (5 832), followed by India (4 324), China (3 295), UK (2 609), South Africa (2 015), France (1 213) and Brazil (1 178).
- Among countries with at least 20 publications on this topic over 2012–2019, Myanmar showed the fastest growth: 12 (2012–2015) to 64 (2016–2019) publications.
- Among countries with at least 100 publications on this topic over 2012–2019, Indonesia ranked first for growth rate (122/496). There was also a surge in Ghana (64/133) and the Russian Federation (401/999).
- Haiti joins nine sub-Saharan African countries (Guinea-Bissau, Gambia, Djibouti, Eswatini, Lesotho, Mozambique, Zambia, Uganda and Malawi) in the top ten for specialization on tuberculosis research.
- Low-income economies' contribution to this topic rose from 5.0% to 7.9% over 2011–2019.

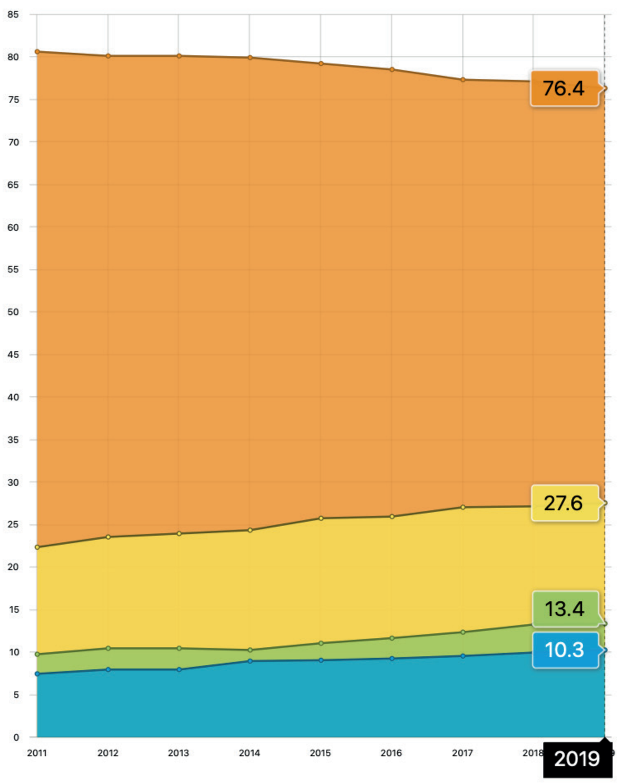
Topic: *Human immunodeficiency virus (HIV)*

- Scientists produced 125 512 publications on HIV between 2012 and 2019, equivalent to 0.63% of global scientific output.
- Global scientific output on this topic inched up from 14 883 (2011) to 16 851 (2019) publications. This translates into 61 999 (2012–2015) and 63 513 (2016–2019) publications.
- The USA published the most on this topic over 2016–2019 (28 340), followed by the UK (6 369), South Africa (5 359), China (4 693), India (3 686), Canada (3 590), France (3 020) Australia (2 564), Germany (2 464), Spain (2 364), Italy (2 276), Netherlands (1 847), Switzerland (1 748), Uganda (1 466), Kenya (1 359) and Japan (1 267).
- Among countries with at least 20 publications on this topic over 2012–2019, Sierra Leone showed the fastest growth from 8 (2012–2015) to 32 (2016–2019) publications. There was also a surge in Cyprus (32/65).
- Among countries with at least 100 publications on this topic over 2012–2019, Indonesia ranked first for growth rate (150/558). Kazakhstan (24/77) and Myanmar (25/78) also showed strong growth. Lesotho published at 44 times (45/58) and Malawi at over 40 times the global intensity on HIV (499/686).
- Low-income economies' contribution grew from 7.5% to 10.3% over 2011–2019.

Medicines and vaccines for tuberculosis



Human immunodeficiency virus (HIV)



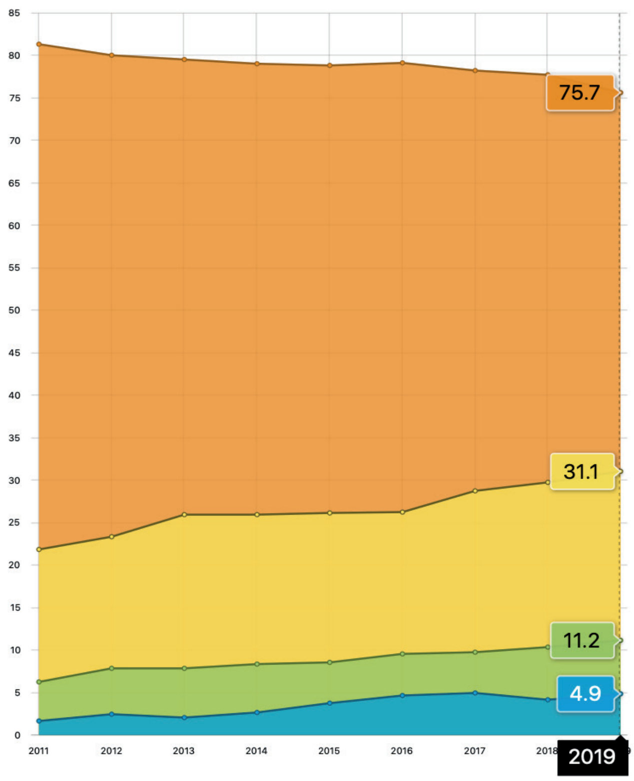
Topic: *New or re-emerging viruses that can infect humans*

- Scientists produced 53 392 publications on new or re-emerging viruses that can infect humans between 2012 and 2019, equivalent to 0.27% of global scientific output.
- Global scientific output on this topic rose from 6 257 (2011) to 7 471 (2019) publications. This translates into 24 251 (2012–2015) and 29 141 (2016–2019) publications.
- The USA published the most on this topic over 2016–2019 (10 459), followed by China (3 928), UK (2 460), Germany (1 909), France (1 906), Brazil (1 605), Japan (1 520), Canada (1 234), India (1 159), Australia (1 156), Rep. Korea (1 043).
- Among countries with at least 20 publications on this topic over 2012–2019, Iraq showed the fastest growth in output on this topic from 5 (2012–2015) to 45 (2016–2019) publications.
- Among countries with at least 100 publications on this topic over 2012–2019, Guinea ranked first for growth rate (32/160). There was also a surge in other countries affected by viral epidemics (see Box 2.1 in the report): Liberia (33/122), Sierra Leone (62/261), Brazil (643/1 605) and Lebanon (34/95).
- Low-income economies' contribution to this topic surged from 1.7% to 5.9% over 2011–2019.

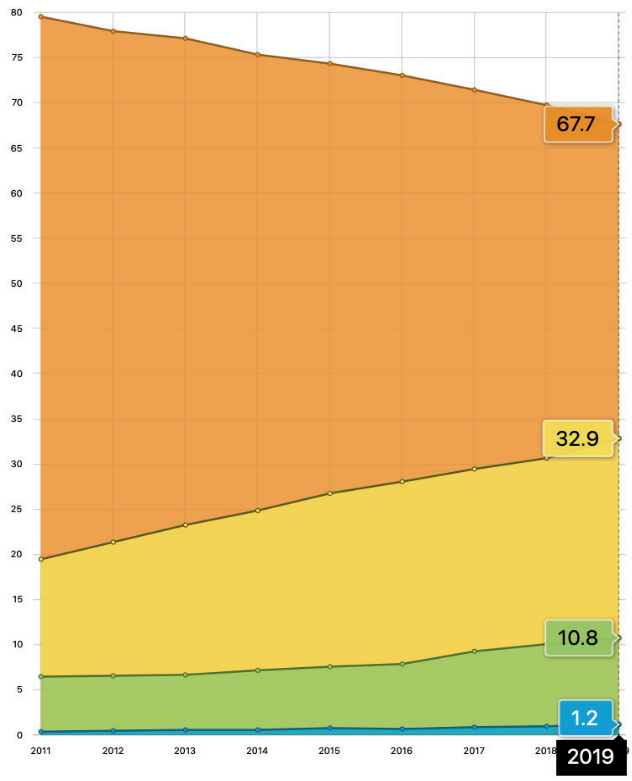
Topic: *Type 2 diabetes*

- Scientists produced 142 561 publications on Type 2 diabetes between 2012 and 2019, equivalent to 0.71% of global scientific output.
- Global scientific output on this topic increased from 13 486 (2011) to 21 344 (2019) publications. This translates into 64 792 (2012–2015) and 77 769 (2016–2019) publications.
- The USA published the most on this topic over 2016–2019 (20 414), followed by China (11 993), UK (6 075), Germany (3 808), Italy (3 637), Canada (3 284), Spain (2 727), France (2 395), Iran (2 333), Sweden (2 069), Netherlands (2 050), Denmark (2 097), Turkey (1 491), Poland (1 343), Switzerland (1 157) and Russian Fed. (1 125)
- Among countries with at least 20 publications on this topic over 2012–2019, Myanmar showed the fastest growth in output from 2 (2012–2015) to 26 (2016–2019) publications.
- Among countries with at least 100 publications on this topic over 2012–2019, Iraq ranked first for growth rate with 38 (2012–2015) and 296 (2016–2019) publications.
- Suriname published at seven times the global average intensity on Type 2 diabetes, with this research emerging from 0 (2012–2015) to 10 (2016–2019) publications.

New or re-emerging viruses that can infect humans



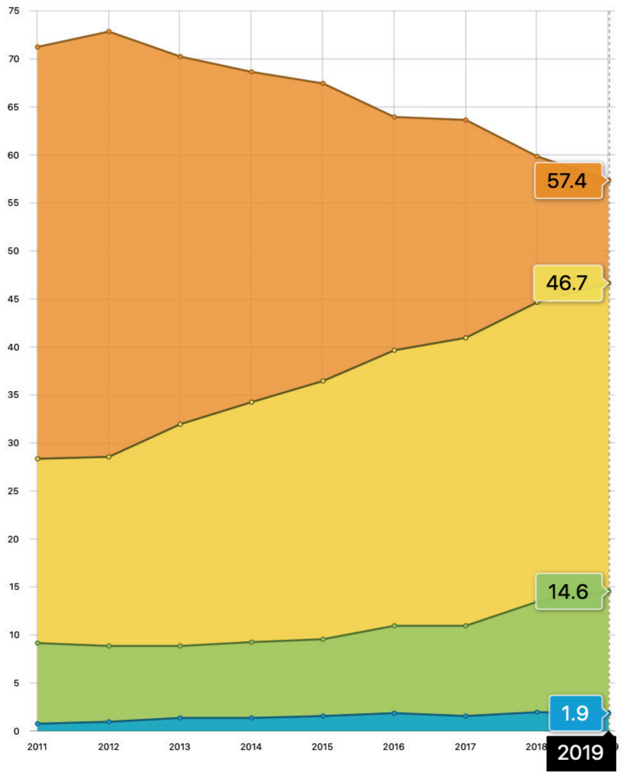
Type 2 diabetes



Topic: *Impact on health of soil, freshwater and air pollution*

- Scientists produced 48 288 publications on the impact on health of soil, freshwater and air pollution between 2012 and 2019, equivalent to 0.24% of global scientific output.
- Global scientific output on this topic more than doubled from 3 884 (2011) to 9 770 (2019) publications. This translates into 17 924 (2012–2015) and 30 364 (2016–2019) publications.
- China published most on this topic over 2016–2019: 8 254, up from 3 105 (2012–2015), followed by the USA (6 933).
- Among countries with at least 100 publications on this topic over 2012–2019, Indonesia ranked first for growth rate (70/371), with a notable surge also in Kazakhstan (8/50) and the Russian Federation (157/609). The Russian government plans to lower air pollution levels by 22% by 2024, as part of its national research projects endeavour (see chapter 13).
- Sub-Saharan Africa's output doubled from 523 (2012–2015) to 1 085 (2016–2019) publications, comparable to the pattern observed in the Arab States and Asia.
- India's output doubled from 893 (2012–2015) to 1 895 (2016–2019) publications. In November 2019, record air pollution levels in Delhi prompted the Supreme Court to warn that state governments failing to provide citizens with clean air and water would be obliged to pay them compensation (see chapter 22).

Impact on health of soil, freshwater and air pollution



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Strategies for good health and well-being

The growing number of national policies and strategies in support of environmental health also benefit human health. Here, we focus on those policies with a specific focus on sustainable human health and wellbeing.

Regional and supranational strategies

- Horizon Europe, the European Union's seven-year framework programme for research and innovation for 2021–2027, introduces five concrete missions, each accompanied by specific targets, including one on cancer and another on soil, health and food. The others are: adaptation to climate change, including societal transformation; climate-neutral and smart cities; and healthy oceans, seas, coastal and inland waters (see chapter 9).

- Wellbeing and the prevention and control of diseases was endorsed as one of six priority areas for the **African Scientific Research and Innovation Council** (est. 2016) at its second congress in 2019.

- One focus of the revised *African Health Strategy 2016–2030* (2016) is to mobilize research and innovation to address Africa's health challenges. The adoption of a treaty by ministers of health in May 2018 for the establishment of the **African Medicines Agency** represents a giant step towards harmonizing the continent's regulatory framework for drugs (see Box 20.2 in the report).

- In 2015, **Economic Community of Central African States** (ECCAS) governments and heads of state approved the creation of the Central African Health Organization with a watermark Community Health Fund for Central Africa. This initiative complements the common pharmaceutical policy adopted by ECCAS in 2014 to improve access to health services by making safe, effective and low-cost pharmaceutical products available to the entire population.

- A programme established in 2014 to control human African trypanosomiasis (or sleeping sickness) has since trained health workers to diagnose the disease in all six countries of the **Central African Economic and Monetary Community** (CEMAC), plus Angola and the Democratic Republic of the Congo.

- The *Industrialization Strategy and Roadmap 2015–2063* (2015) of the **Southern African Development Community** (SADC) prioritizes the development of three sectors with potential to integrate global value chains: agro-processing, mineral beneficiation and pharmaceuticals (see chapter 20).

- Adopted in November 2020, the Comprehensive Recovery Framework adopted by the **Association for Southeast Asian Nations** (ASEAN) in November 2020 has been touted as a consolidated exit strategy from the Covid-19 crisis that is aligned with regional priorities. The implementation plan makes no reference to any funding mechanism. According to this framework, a *Regional Strategic Action Plan for ASEAN Vaccine Security and Self-Reliance* is to be implemented, with an initial focus on ensuring timely and equitable access to affordable and quality-assured Covid-19 vaccines. For example, the Covid-19 ASEAN Response Fund may be used to procure test kits, personal protective equipment and medical supplies. This fund was announced in June 2020. By the end of that year, at least US$ 15 million had been pledged, including by countries situated beyond the bloc such as China and Germany (see chapter 26).

  – Over 2014–2018, a series of workshops were held in Thailand on building vaccine security and self-reliance in the region. These workshops were recalled in the *ASEAN Leaders' Declaration on ASEAN Vaccine Security and Self-Reliance* of November 2019. The workshops endeavoured to strengthen co-operation among ASEAN members, particularly through information-sharing, training and other forms of capacity-building. A communication and co-ordination plan entitled *ASEAN Vaccine Security and Self-reliance Initiatives* (2016) affirmed the long-term goal of seeing ASEAN countries adopt a comprehensive financial management plan for the purchase and/or manufacture of common vaccines, as well as innovative ones for emerging infectious diseases.

National strategies

- The adoption of the Sustainable Development Goals (SDGs) has led more countries to stretch measures of wellbeing beyond the mainstream focus on income and GDP.

  – The *Living Standards Framework* adopted by the **New Zealand** Treasury in 2015 provides a novel means of assessing wellbeing, inspired by the *How's Life* document published by the Organisation for Economic Co-operation and Development (OECD). This New Zealand framework elevates 'sustainable intergenerational wellbeing' to the status of key objective of policy-making and natural resource management (see chapter 26).

  – **Ecuador's** *National Development Plan 2017–2021: Toda una Vida (An Entire Life)* provides a roadmap for 'humaniz[ing] indicators and chang[ing] the face of vulnerable groups, as a state policy.' All eight objectives are aligned with the SDGs but 60% of total investment is devoted to 'guarantee[ing] a decent life with equal opportunities for all' (see chapter 7).

- The 13 mission-oriented national research projects adopted by the **Russian Federation** align with *The 2030 Agenda for Sustainable Development*. The fifth-biggest budget (1.73 trillion rubles, about PPP$ 70 billion) has been attributed to the National Project for Health (see Figure 13.2 in the report). Key measures include the development of domestic medical research centres; the introduction of innovative technologies, such as an early diagnosis system and remote patient monitoring; a lifelong medical training system, including e-learning; and a prevention programme for heart disease and cancer. A key target is to lower the mortality rate in the working-age population from 437 to 350 per 100 000 inhabitants.

  – The National Project for Science (636 billion rubles, about PPP$ 26 billion) plans to set up 15 world-class research and education centres in selected regions. Of the five that had been selected by 2019, that planned for the Nizhny Novgorod Region will specialize in supercomputer modelling, geophysics, genetics and personalized medicine.

- **Bhutan's** 1729 legal code states that 'the purpose of the government is to provide happiness to its people.' Bhutan has had no difficulty in adapting its policies to the SDGs, since its Gross National Happiness philosophy is built on four pillars that mirror this agenda: sustainable and equitable socio-economic development; preservation and promotion of culture; conservation, sustainable use and management of the environment; and the promotion of good governance. In the government's *Twelfth Five-Year Plan* (2018–2023), these four pillars have translated into 16 national key result areas which are highly correlated with *The 2030 Agenda* (see chapter 21).

- **Jordan's** *Reach2025* (2016) action plan, in support of the *Jordan 2025* framework strategy (2015), identifies six key sectors with the potential to drive Jordan's digital economy: health; education; energy and clean tech; the financial sector; transportation; and communication and security (see chapter 17).

- *New **Kuwait** 2035* (2017) aims to transform the country into a 'financial and trade hub regionally and internationally'. High-quality health care is one of seven goals guiding its 164 strategic programmes.

- **Saudi Arabia's** *National Industrial Strategy to 2030* identifies pharmaceuticals and medical supplies as two of its seven priority sectors, along with machinery and equipment; renewable energy generation; the automotive industry; chemicals; and the food industry (see chapter 17).

- There are several points of convergence between **Sudan's** *Science, Technology and Innovation Policy* (2017) and the *Arab Strategy for Science, Technology and Innovation*, endorsed by 22 Arab States in 2014. Both identify water resources management and the use of nanotechnology in health, the food industry and for the environment as priority areas for collaboration (see chapter 17).

- In 2017, **Syria's** Higher Commission for Scientific Research (est. 2005) published its first comprehensive report on *Science, Technology and Innovation in the Syrian Arab Republic*. It outlines priority research areas across 15 sectors, including health. Over 2018–2020, 42 research projects were conducted across these 15 sectors, based on needs assessments conducted in collaboration with relevant ministries (see chapter 17).

- The **United Arab Emirates** launched the *UAE Strategy for the Fourth Industrial Revolution* in 2017. It outlines a vision of integrating Industry 4.0 technologies in key areas that include education, health, food security, urban planning and defence. In health, the strategy highlights personalized medicine, robotic health care and wearable and implantable technologies (see chapter 17).

- Health research is one of seven research programmes defined in the *Action Plan for the National Scientific Research and Technological Development Policy* (2014) of **Côte d'Ivoire.**

- ***Kenya** Vision 2030* (2008), the country's blueprint for developing a knowledge economy, is being implemented through five-year plans. The third of these, covering the 2018–2022 period, is being driven by the president's Big Four Agenda, namely food security, affordable housing, manufacturing and affordable health care for all. The *National Research Priorities 2018–2022* align with the Big Four Agenda. These priorities are: food and nutrition security; manufacturing; universal health coverage; academic R&D and affordable housing.

- The **Democratic Republic of Congo's** first science policy, in draft form as of 2021, counts reproductive, child and adolescent health among five priority areas. It fixes targets of achieving a research intensity of 0.80% of GDP by 2022 and 1% by 2030 (see chapter 20).

- **Eswatini** has the world's highest HIV prevalence rate, estimated by UNAIDS at around 27% of the population in 2018. The incidence of tuberculosis is also high, putting severe pressure on the country's public health budget. The *National Strategic Plan for Ending AIDS and Syphilis in Children 2018–2023* (2018) aims to eliminate the mother-to-child transmission of HIV and congenital syphilis by 2023. Scientists in Eswatini have doubled their output on HIV from 50 (2012–2015) to 110 (2016–2019) publications, according to the UNESCO study. This corresponds to 39 times the average global intensity on this research topic.

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- The ***Malawi*** *Growth and Development Strategy* identifies health and population among five key priority areas. Malawi invests less per capita (about US$ 39 in 2017) in the health sector than any other SADC country, well below the regional average of US$ 229. Measures set out in the *Malawi Growth and Development Strategy* include expanding primary and reproductive health care programmes, raising the national budget allocations for health and building upon partnerships with donor agencies (see chapter 20). Output on reproductive health and neonatology has surged from 107 (2012–2015) to 253 (2016–2019).

- **Namibia's** *Fifth National Development Plan* (2017) translates *Vision 2030* (2004) into concrete strategies and plans for the period 2017–2022. The plan has four strategic goals: inclusive, sustainable and equitable growth; healthy and capable human resources; a sustainable environment and enhanced resilience; and good governance through effective institutions. It sets a target of devoting 1% of GDP to R&D by 2022 (see chapter 20).

- The *National Malaria Elimination Strategic Plan 2017–2021* represents a significant policy shift for **Zambia**. Whereas the emphasis used to be on alleviating the burden of malaria, the ambition now is to eliminate malaria altogether by 2021, through improved health care and community engagement. The incidence of malaria declined from 346 to 319 cases per 100 000 population over 2015–2018 (see chapter 20).

- **Bangladesh** has developed a draft *National Strategy for Artificial Intelligence for 2019–2024*, with support from USAID and the United Nations Environment Programme. The strategy identifies health as one of seven national priority sectors for artificial intelligence (see chapter 21).

- Emerging biomedicine is one of ten cutting-edge sectors of manufacturing featured in the Made in China 2025 policy, with specific sector-by-sector goals for expanding the global market share of **Chinese** companies (see chapter 23). Biotech and health are one of six focal areas for China's megaprogrammes in science and engineering to 2030.

  – Brain research is not new to China but has assumed growing priority in recent years. In the new era of big data, it has become imperative to develop brain-inspired computing methods and systems, in order to improve AI systems and harness the ever-increasing amount of information. The *Medium and Long-Term Plan to 2020* included brain science and cognition as one of its eight scientific frontiers for basic research.

  – The *Thirteenth Five-Year Plan for the National Economy and Social Development* (2016–2020) and the accompanying *Thirteenth Five-Year Plan for the Development of Science, Technology and Innovation* have both launched a programme on brain science and brain-inspired intelligence known as the China Brain Project.

- Shortly after Professor Shinya Yamanaka of Kyoto University was awarded the Nobel Prize in Physiology or Medicine in 2012, **Japan** enacted three sweeping laws in quick succession. In 2013, the Regenerative Medicine Promotion Law was promulgated, followed by the Law on Ensuring the Safety of Regenerative Medicine (2013) and the Law on Securing the Quality, Efficacy and Safety of Products, including Pharmaceuticals and Medical Devices (2013). The second of these laws regulates clinical trials by medical institutions in regenerative medicine and provides for free medical care. The third law regulates the manufacture and sale of products that deal with regenerative medicine and cell therapy, among other things, by amending the Law on Pharmaceutical Affairs, which was subsequently enacted in 2014. The new law is unique, in that it establishes a 'conditional and time-limited approval system' for new therapies and medicines in regenerative medicine. This system ensures that a regenerative product is approved only once its innocuousness has been proven and that patient data are collected on the product's effects.

- **Indonesia's** *Master Plan of National Research 2017–2045* identified eight broad research priority areas: food; energy; health; transportation; engineering products; defence and security; maritime; and socio-humanity studies (see chapter 26).

- The **Philippines'** *National Integrated Basic Research Agenda* (2017) addresses water security, food and nutrition security, health sufficiency, clean energy, sustainable communities, and inclusive nation-building. It complements the *Harmonized R&D Agenda 2017–2022*, which defines four other priority areas for research, including health (see chapter 26).

- In 2017, **Thailand** approved the *National Strategy (2018–2037)*, the country's first long-term national strategy. It identifies sectors considered to be of future strategic importance. These include biology; integrated medicine; digital-, big data- and AI-driven industries; transport and logistics; and security (see chapter 26).

  – The Thailand 4.0 (2016) strategy targets ten strategic sectors for integrating high technology and developing human resources, including medical and wellness tourism.

3 GOOD HEALTH AND WELL-BEING

The Rwanda E-Waste Recycling Facility opened in 2017, the second-largest in Africa. It can process more than 7 000 tonnes of electrical and electronic waste each year. This facility should reduce the widespread practice of informal recycling and burning of e-waste, which pose a grave risk to health. Three million tonnes of e-waste were generated in Africa in 2019 but only 0.9% was collected and recycled. © Rwanda Green Fund, CC BY-ND 2.0

Box 1: **Circular economies: less waste, less pollution, better health**

Management of industrial waste, specific materials or waste production in general has benefits for human health by reducing pollution levels.

The circular economy reduces waste and re-uses and recycles industrial products. To modernize and decarbonize energy-intensive industries, the ***European Green* Deal** sets the objective of creating new markets for climate-neutral and circular products, such as steel, cement and basic chemicals. This tallies with the EU's revised industrial policy, which dates from March 2021 and rests on three pillars: the green transition; the digital transition; and global competitiveness (see Box 9.2 in the report).

Countries are taking a range of holistic or sector-based approaches to waste reduction and a circular economy. For instance, **Mongolia** has set a target of reducing solid waste in landfills by 40% by 2030 (see chapter 14).

Israel's Ministry of Environmental Protection is redirecting its waste management policy towards an integrated approach consisting of five levels: reduction at source, re-use, recycling, recovery and landfill. According to the *Strategic Plan for Waste Treatment to 2030*, 51% of all generated waste will be recycled by this date, 23% will be recovered for energy and the remainder will be landfilled (see chapter 16).

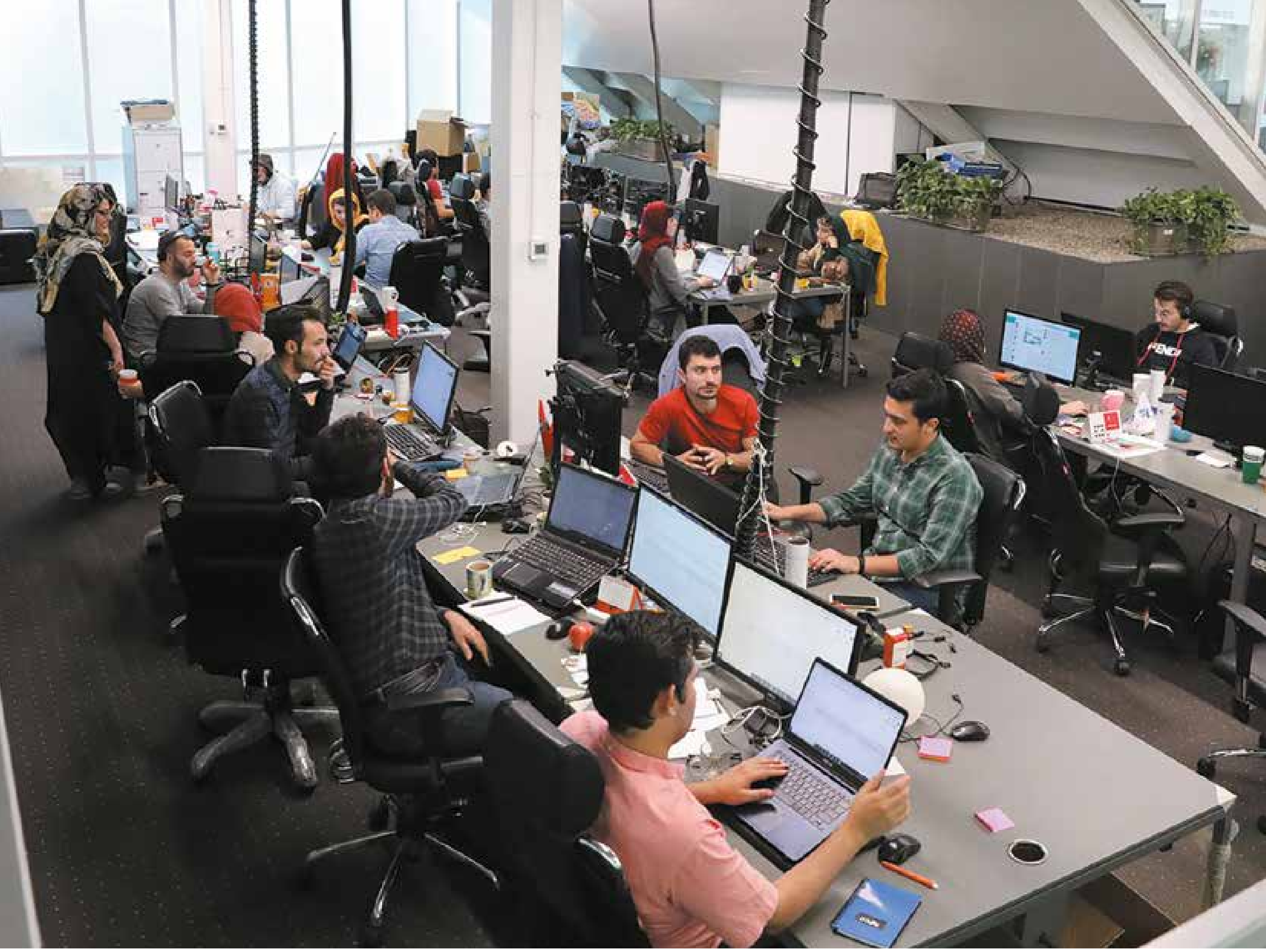
Transboundary pollution is a growing concern in the **Pacific Islands** region, which receives substantial waste via wind and ocean currents. As of 2020, 11 of the 14 Pacific Island countries had legislated bans or levies on single-use plastics. In 2018, Vanuatu became the first country in the world to ban plastic straws (see chapter 26). Among the 56 sustainability topics examined by UNESCO, that of floating plastic debris in the ocean showed the fastest growth, albeit from a low starting point (see Figure 2.3 in the report and the policy brief on SDG14).

Quality health care and the circular economy feature among the six thematic priorities for scientific research in **Tunisia's** *Strategic Plan for Scientific Research 2017–2022* (see chapter 17).

For its part, **Cabo Verde** is implementing a *Strategic Plan for Sustainable Development (2017–2021)* with a key objective of turning the country into a Circular Economy in the Mid-Atlantic, through connectivity and development of the blue economy, green growth, tourism and business, industry and financial services. The promotion of social inclusion and reduction in inequalities through health and social security, along with training, job creation and equality, is another key objective (see chapter 18).

Led by the National Advisory Council on Innovation, the South Africa Foresight Exercise for Science, Technology and Innovation 2030 published its findings in a *Synthesis Report* released in November 2019. Although the exercise found the circular economy to be poorly understood, it was seen as a 'powerful opportunity' for **South Africa** to advance its sustainable development agenda. The exercise recommended four thrusts: reducing, reusing and recycling waste; ensuring sustainable water, energy and food security; a low-carbon and climate-resilient economy; and smart connectivity and mobility in communities (see chapter 20).

In June 2019, the Cabinet approved **Japan's** *Long-term Strategy under the Paris Agreement*. By 2050, Japan is to have a 'circular and ecological economy' (see chapter 24).



Applying science and technology for better health

- Twenty years on from the first sequence of a human genome, and at huge expense, we now know that the vast majority of diseases do not depend on individual genes. Rather, everyone's genome is unique. This has led to precision medicine. The 21st Century Cures Act (2016) of the **USA** was a milestone, in that it allowed new clinical trials to factor in personalized parameters, such as biomarkers and genetics. The 21st Century Cures Act established four projects under the National Institutes of Health, namely, the Cancer Moonshot, the Brain Research through Advancing Innovative Neurotechnologies (BRAIN) Initiative, the Precision Medicine Initiative and Regenerative Medicine (see chapter 5).

  – Under the Precision Medicine Initiative, the All of Us Research Program began enrolling volunteers in May 2018 in a study which prioritizes populations traditionally underrepresented in biomedical research. The aim is to compile a vast database to inform research on a wide variety of health conditions. The data platform will be open to researchers worldwide. By September 2020, the programme had recruited 225 000 volunteers out of the 1 million it hopes to enrol in the programme.

- In **Mongolia**, Shastin Central Hospital in Ulaanbaatar, specializing in cardiology, was established in 2013 with support from the Millennium Challenge Account and World Health Organization. This was the only centre of excellence under the *Master Plan for Science and Technology 2007–2020* to reach completion by 2020 (see chapter 14).

- The **Iranian** government has been encouraging start-ups to diversify into various knowledge-based fields, with emphasis on developing local solutions and addressing the needs of industry (see photo). Since 2018, the Vice-Presidency for Science and Technology has published a series of books on global experiences in 20 tech-based fields, to alert entrepreneurs to opportunities for innovation. These fields span waste management, air pollution, sports and physical health, digital health and more (see chapter 15).

  – Iran's research strengths lie in biotechnology and nanotechnology. By 2018, there were 524 active biotech companies in Iran and sales of locally produced nanoproducts had increased twelve-fold in just three years (see Figure 15.2 in the report). Iran's output in terms of publications on health leapt by 64% between 2012 and 2018, according to the Scopus database.

Start-ups at the Azadi Innovation Factory in Tehran, established in 2017. Azadi covers an area of 18 500 m^2 and provides employment for 3 500 university graduates and young entrepreneurs. Start-ups cover a range of fields that include architecture and urban living, artificial intelligence, biotechnology, creative content, cybersecurity, fintech and insurance, nanopharmaceuticals and tourism. © Vice-Presidency for Science and Technology of Iran

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  – Local pharmaceutical production has climbed rapidly since 2015. The domestic market was worth US$ 4.5 billion in 2018, with 70% of pharmaceutical companies being locally owned. By 2019, Iran was able to produce 95% of medicines destined for the domestic market, including two-thirds of their active ingredients. Iran exported pharmaceuticals to 17 countries in 2019, a considerable portion of which went to the EU.

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- In 2018, **Israel** embarked on a five-year National Programme for Digital Health. The stated aims are to create a new national economic growth engine, advance Israel's clinical and academic research and create a local digital health care system that is among the best in the world. The programme is backed by an investment of NIS 898 million (ca US$ 256 million) and implemented by multiple governmental bodies, including the Ministry of Health, the Ministry for Social Equality (Digital Israel), the Ministry of the Economy and Industry, the Israeli Innovation Authority and the Council for Higher Education.

- The government-led **Qatar** Smart Programme, better known as TASMU, is targeting five priority sectors: health care, transport, environment, logistics and sport. Over 2017–2022, the programme is investing QAR 6 billion (ca US$ 1.6 billion) in related projects (see chapter 17).

- In March 2019, the **Democratic Republic of Congo** launched the National Agency of Clinical Information and Health Informatics Engineering, billed as the country's first digital health agency. Through social media accounts, this agency has provided regular updates on the status of Covid-19 in the country. The agency is also responsible for accelerating the use of telemedicine.

  – To mark the launch of this agency, a hackathon was held to explore digital solutions to the Ebola epidemic. A team of seven students won the competition with their Lokole app, designed to support the Ebola Response Coordination Team and community workers through real-time data exchange. The app did not require a smartphone or stable Internet connection. Their prize included three months of mentoring and coaching at the tech incubator Ingenious City in Kinshasa.

- The Active Pharmaceutical Ingredients Industrial Park at Munshiganj in **Bangladesh** is expected to be operational by 2023, according to the president of the Bangladesh Association of Pharmaceutical Industries. Once up and running, the park will enable companies to produce the main chemical components of pharmaceutical drugs. This should lower the cost of domestic drugs and boost their international competitiveness, since local firms currently import these raw materials from abroad, largely from China and India. The park intends to be environmentally friendly, with plans for a common effluent treatment plant (see chapter 21).

- A success story in terms of collaboration between industry and public institutions is the Sri Lanka Institute of Nanotechnology (SLINTEC, est. 2008). Between 2012 and 2018, SLINTEC developed seven new technologies with the private sector related to agriculture, apparel, health care and minerals (see chapter 21).

- Next-generation health care is one of five themes for joint industry–government committees in **Japan** under the umbrella of the Growth Strategy Council: Investing for the Future, composed of ministers, company chief executive officers and academicians (see Box 24.2 in the report).

- **Singapore's** Smart Nation Initiative (2014) has applied a high-tech focus to health, urban living, transport, digital government services, start-ups, more mature businesses and strategic national projects (see chapter 26).

- **Brazil**, **Russia**, **India**, **China** and **South Africa** decided in 2016 to develop the BRICS Networking Platform and Framework Programme for Multilateral STI Projects. The five countries use this platform to launch co-ordinated project tenders. Between 2016 and 2019, 13 projects were supported in biotechnology and biomedicine, including health care and neural science (see chapter 13).

- **Qatar's** Science and Technology Park (est. 2009) has been touted as the country's premier hub for business innovation. It incubates companies in health sciences, energy, environmental sciences and ICTs, among other areas. Twenty local firms have been incubated at the park's tech-focused Incubation Centre since 2016, including Meddy, which has since become Qatar's largest online platform for booking medical appointments (see chapter 17).

- Science parks in **Singapore** have experienced a rapid increase in biopharmaceutical incubators, with biopharma inching ahead of electronics in priority since 2015. The National University of Singapore and Nanyang University, in particular, have worked with incubators and firms in science parks to establish Singapore as a world-class research hub for biopharma. In 2018, a consortium agreement worth about US$ 24 million was signed establishing the Pharma Innovation Programme Singapore. The consortium consists of A*STAR, local universities and three leading pharmaceutical companies, GlaxoSmithKline, MSD International and Pfizer. The programme aims to raise the bar for pharmaceutical manufacturing, resulting in more sustainable processes and quicker production of active pharmaceutical ingredients (see chapter 26).

- At the continental level, one significant achievement has been the establishment of the **Africa Centres for Disease Control and Prevention** in Addis Ababa in 2016 (see Box 19.2 in the report). Five regional collaborating centres, one for each of central, eastern northern, southern and western Africa, co-ordinate regional public health initiatives taken by member states. They also serve as hubs for Africa CDC surveillance, preparedness and emergency response.

Innovative partnerships to tackle Covid-19

The Covid-19 pandemic has showcased the benefits of a culture of sharing scientific knowledge and expertise both within and beyond borders (see The time for open science is now, p. 12 of the report).

- The Covid-19 crisis has recalled the desirability of strong linkages between the public and private sectors for the production of equipment such as lung ventilators, masks, medication and vaccines. In early 2020, a team of biomedical engineers from the University of Antioquia in **Colombia** designed a low-cost lung ventilator in collaboration with the Hospital San Vicente de Paul, through a project supported by the Ruta N Medellin business development centre. This ventilator was approved in mid-2020 by the medical licensing institute, INVIMA, then manufactured by firms specializing in home appliances and automobiles which had repurposed their assembly lines. Since the developers used open-source techniques, other manufacturers have been able to download the same design (see chapter 7).

- Collaboration with universities, research centres, firms and hospitals has been vital. For instance, in **Uruguay**, the Pasteur Institute of Montevideo and the University of the Republic rapidly disseminated a virus detection test kit. This experience led them to establish the Centre for Innovation in Epidemiological Surveillance in June 2020 with private funding (see chapter 7).

- **Mexican** entrepreneurs banded together to create a platform called the Innovation and Action Network for Covid-19. This network groups firms specializing in fields such as medical equipment design and manufacturing, online medical services, artificial intelligence and analytics.

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The platform is being promoted by the Red Innova Mexico City network. Some early results include the binational design of a Mexican–Spanish ventilator, the founding of a national mathematical modelling group, an open access algorithm platform and a roadmap for studying the 'urban metabolism' within a system that would analyse wastewater to monitor the prevalence of Covid-19 and other diseases. Public research centres have collaborated with local companies and CONACYT to produce lung ventilators (see chapter 7).

- Many countries have accelerated their approval processes for research project proposals. For example, by early April 2020, the innovation agencies of **Argentina**, **Brazil** and **Uruguay** had all launched calls for research with an accelerated approval process. **Peru's** two innovation agencies shortened their own response time to two weeks (see chapter 7).

- **Brazil** was able to call upon 140 telemedicine and e-health centres during the Covid-19 pandemic to provide virtual consultations and remote monitoring of patients' health. The government adopted a law on telemedicine on 15 April 2020 which extended telemedicine services to rural areas and remote towns (see chapter 8). This builds on the digital transformation of the Brazilian health sector, which moved into high gear in 2017 with the publication of the *E-Health Strategy* by the Ministry of Health. The adoption of information technology is being encouraged to improve the Unified Health System (see Box 8.1 in the report).

- On 29 May 2020, **Costa Rica** and the World Health Organization launched a voluntary patent pool called Solidarity Call to Action. This repository should ensure that any vaccines, medicines or other tools developed to cope with Covid-19 in signatory countries can be manufactured widely. **Chile** was the first to rally the pool. By July 2020, it had been joined in the region by Argentina, Belize, Brazil, Dominican Republic, Ecuador, El Salvador, Honduras, Mexico, Panama, Paraguay, Peru and Uruguay.

- In March 2020, the government published ***Canada's** Plan to Mobilize Industry to fight Covid-19*, which requires the Innovation Superclusters (see Box 4.1 in the report), the Strategic Innovation Fund and the National Research Council to prioritize funding and support for goods and services that respond to the Covid-19 pandemic. Meanwhile, Canada's Industrial Research Assistance Program has provided financial support to help small and medium-sized enterprises refine their Covid-19-related product or process and get it to market (see chapter 4).

- As part of its rapid response arsenal for Covid-19, **Canada's** federal government has earmarked Can$ 1 billion for a national medical research strategy that includes vaccine development, the production of treatments and virus tracking. Of this amount, Can$ 192 million is being channelled through the Strategic Innovation Fund directly to institutions and companies developing vaccine candidates for the virus (see chapter 4).

- During the pandemic, the **USA** witnessed an unprecedented mobilization of the bioscience industry. By mid-2020, there were estimated to be more than 400 drug programmes in development aimed at eradicating the disease. These efforts were rooted in the White House's Operation Warp Speed, a public–private partnership that saw around US$ 9 billion allocated to developing and manufacturing candidate vaccines, including through advance purchase agreements (see chapter 5).

- Many governments have provided incentives for small and medium-sized enterprises to tackle the pandemic. In

Iran, the Corona Plus campaign offered start-ups financial incentives in 2020 to help them produce medical equipment such as protective gear and ventilators (see chapter 15).

- **India** has focused its response to the pandemic on producing low-cost solutions predominantly in three areas, including for export: vaccine research and manufacturing; the manufacture of generic versions of 'game-changer' drugs; and frugal engineering of medical devices in high demand, such as low-cost lung ventilators (see chapter 22).

- Pharmaceuticals were not a priority industry for **Sri Lanka's** National Export Strategy 2018–2022 until the Covid-19 crisis spurred demand. This led the government and private sector to invest US$ 30 million in a new pharmaceutical manufacturing plant in 2020 within the Koggala Export Processing Zone (see chapter 21).

- Following the Covid-19 outbreak in the city of Wuhan, the National People's Congress of **China** adopted measures in February 2020 restricting wildlife trade and banning consumption of bushmeat and market sales of farmed wild animals like civets.

- **The Maldives'** response to the pandemic has benefited from having a *Health Emergency Operations Plan* (2018), which has assigned specific roles and responsibilities to relevant agencies and operators.

- The **Republic of Korea** has an infectious disease surveillance system. The Infectious Disease Control and Prevention Act (2009), which was last amended in 2015, allows the government to withhold critical information and publish anonymous travel logs of infected cases. The government and municipal authorities are using emergency text messaging services to disseminate information on newly discovered cases of Covid-19 infection to the general public (see chapter 25).

- In October 2020, a public–private consortium led by the African Union Commission through the Africa Centres for Disease Prevention and Control launched the **Africa Pathogen Genomics Initiative**. This partnership is investing US$ 100 million over four years to expand access to next-generation genomic sequencing tools and expertise. Partners Illumina and Oxford Nanopore are providing machines and training, the Bill and Melinda Gates Foundation and the US Centers for Disease Control and Prevention are providing funding and technical assistance and Microsoft is providing technical assistance in designing the Africa Pathogen Genomics Initiative's digital architecture. The initiative will build a continent-wide disease surveillance and laboratory network to help identify and inform research and public health responses to Covid-19 and other epidemic threats, as well as endemic infectious diseases such as AIDS, tuberculosis, malaria and cholera (see box 19.2).

- In April 2020, the government tasked the **South African** Radio Astronomy Observatory with managing the national effort to design, produce and procure 20 000 lung ventilators. The observatory was chosen for its experience in designing sophisticated systems for the MeerKAT radio telescope in the Northern Cape. By December 2020, 18 000 units had been produced and 7 000 distributed (see chapter 20).

- In October 2020, the World Health Organization reported that **Africa** accounted for about 13% of 1 000 new or modified existing technologies developed worldwide in response to the pandemic, close to its share of the global population (14%). Of these, 58% involved digital solutions such as chatbots, self-diagnostic tools and contact-tracing apps. A further 25% of solutions were based on three-dimensional (3D) printing and 11% on robotics (see chapter 20 and photo, p. 2).

- A number of countries have deployed robots and drones to help curb the spread of Covid-19. For instance, in **Saudi Arabia**, drones have been used in markets to identify people with a high body temperature. **Rwanda** and **Ghana** have both utilized drone technology provided by the US firm Zipline to deliver blood samples recovered from remote health clinics to specialist institutes for testing.

- **Saudi Arabia** formed its Covid-19 Monitoring Committee in February 2020. By mid-April, the government had approved about 35 policies, classed as proactive, reactive and supportive. Among supportive policies, one could cite a government pledge to provide all residents infected with Covid-19 with free health care and the launch of an online service to enable expatriates to return home (see chapter 17).

- **Lebanon's** National Council for Scientific Research issued a Flash Call for Covid-19 Management as early as March 2020. This led to the acceptance of 29 research projects addressing topics such as vaccination policy, rapid test development and the use of AI to support early diagnosis of the disease and measure its impact on the mental health of frontline workers (see chapter 17).

- By May 2020, **Israel's** Ministry of Science and Technology was supporting more than 80 related research projects, including on vaccine development and the social implications of the pandemic. The government issued a compulsory license in 2020 for lopinavir/ritonavir, a drug that has proven effective in treating Covid-19 patients. In patent law, the compulsory license suspends the monopoly effect of a patent, allowing a generic producer to import the drug (see chapter 16).

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Research and training in health sciences

- The **Swiss** Innovation Park was formally opened In January 2016. It comprises five legally distinct sites, each with their own priority areas (see Figure 11.5 in the report). Two sites specialize in biomedicine and biotechnology and a third focuses on public health. The five sites are co-ordinated by the Switzerland Innovation Foundation and backed by a federal guarantee of CHF 350 million (ca US$ 360 million), which is used by the park as collateral for loans.

- The European Centre of Nuclear Medicine opened its doors in November 2019, the first such facility in **Armenia**. It has been fitted with state-of-the-art equipment to provide radioactive iodine therapy for thyroid cancer, which is prevalent in Armenia and the wider region (see chapter 12).

- Nazarbayev University is **Kazakhstan's** first international research university. It could serve as a model for a network of like institutions. In line with the *Kazakhstan 2050 Strategy* (2012), Nazarbayev University has consolidated its mandate since 2015. The Medical School launched in 2015 hosts clinics and four universities attached to the University Medical Centre, as well as a Life Sciences Centre and School of Medicine. The University Medical Centre groups four hospitals (see chapter 14).

- The Centre of Technologies at the Academy of Sciences was inaugurated in Ashgabat, **Turkmenistan**, in June 2014. This modern centre has a range of laboratories specializing in drug development and other subjects (see chapter 14). The focus of these laboratories largely mirrors the decree on Priority Areas of Science and Technology (2016), where production technology for medical and pharmaceutical products features among the priorities.

- Launched in 2016, PersisGen in **Iran** is a biopharmaceutical company which designs, develops and produces biosimilars, vaccines and plasmaderived products. It also specializes in regenerative medicine through the use of stem cells. PersisGen has an accelerator department which is the first of its kind in medical biotechnology in Iran (see Box 15.1 in the report).

- Since 2014, the **World Bank** has supported the Africa Higher Education Centers of Excellence programme, including centres examining the genomics of infectious diseases (such as malaria, Lassa and Ebola) at Redeemer's University, phytomedicine research and development at the University of Jos and neglected tropical diseases and forensic biotechnology at Ahmadu Bello University in **Nigeria**, as well as a centre for reproductive health and population studies at the University of Benin (see chapter 18).

- The World Bank has extended its Centres of Excellence Programme to East Africa. Since 2017, there has been a centre specializing in innovative drug development and therapeutic trials for Africa at Addis Ababa University in **Ethiopia** and a centre for pharm-biotechnology and traditional medicine at Mbarara University of Science and Technology in **Uganda**, for instance (see chapter 19).

- Medical researchers published 91% of total publications from **The Gambia** between 2016 and 2018. This is to be expected, since the London School of Hygiene and Tropical Medicine has a Medical Research Council Unit in The Gambia with excellent laboratory facilities and staff. Its large portfolio ranges from basic research to evaluating the control of priority diseases for public health in sub-Saharan Africa, such as malaria and hepatitis B. The challenge for The Gambia will be to expand research capacity beyond the Medical Research Council Unit to the agriculture, industrial and energy sectors (see chapter 18).

- The Royal Science and Technology Park Act (2012) creating the eponymous park in **Eswatini** was revised in 2019. In addition to promoting research and innovation, the Royal Science and Technology Park serves as a special economic zone; enterprises operating in the park must adhere to a quota by employing a minimum of two-thirds Eswatini citizens. The complex hosts a Biotechnology Park consisting of a research centre and incubation facility. Medical biotechnology is one focus area (see chapter 20).

China opened its first national gene bank in 2016. © Aleksander Plaveski

- In order to channel students in **Afghanistan** towards degree programmes that will prepare them for the labour market, the Ministry of Higher Education has identified priority disciplines, including health studies with a focus on pharmacy, general medicine, stomatology and nursing (see chapter 21).

- The best illustration of the status accorded the **China** Brain Project is the founding of two specialized institutions in 2018, in collaboration with Chinese academies and universities: the Chinese Institute for Brain Research, Beijing and the Shanghai Research Centre for Brain Science and Brain-inspired Intelligence (see chapter 24).

- In 2015, the Japan Agency for Medical Research and Development (AMED) was established to address the decline in medical research in **Japan**. AMED's mission spans basic research and practical applications (see chapter 24).

- Smart health care is the focus of a national innovation cluster in Gangwon, **Republic of Korea**, as defined in the *National Innovation Cluster* plan of 2018 (see Figure 25.3 in the report). Meanwhile, Daegu City specializes in medical convergence.

- **Australia's** 2019 research budget was consistent with earlier years, boosting funding for medical research but providing little or no increase for most other research fields. New funding has been directed towards the Medical Research Future Fund (MRFF, est. 2015), which is being used to implement major initiatives identified in the National Health and Medical Industry Growth Plan (2018). In July 2020, the MRFF achieved its AU$ 20 billion target for reaching maturity. Unlike most research funding schemes, the government decides on the MRFF's funding allocations on the basis of advice from the Australian Medical Research Advisory Board and the priorities of the *Australian Medical Research and Innovation Strategy 2016–2021*, as well as the *Australian Medical Research and Innovation Priorities 2018–2020* (see chapter 26).

- The *National Technical Education and Skills Development Authority Plan 2018–2022* of the **Philippines** focuses on developing requisite skills for occupations in seven sectors, one of which is health, wellness and social services.

Source: UNESCO (2021) *UNESCO Science Report: the Race Against Time for Smarter Development*. S. Schneegans, T. Straza and J. Lewis (eds). UNESCO Publishing: Paris.

Publication data: Scopus (Elsevier), including Arts, Humanities & Social sciences; data treatment by Science-Metrix; data visualization by Values Associates unesco

3 GOOD HEALTH AND WELL-BEING

Ties to relevant UNESCO programmes

UNESCO's response to the Covid-19 global emergency

On 30 March 2020, as Covid-19 was turning into a global public health emergency, UNESCO convened a virtual dialogue for ministers of science and technology, to promote recourse to international scientific cooperation and open science to address both the pandemic and other global threats. The meeting was attended by 77 ministers, as well as regional bodies and a high-ranking representative of the World Health Organization (WHO).

On 6 April 2020, UNESCO's International Bioethics Committee (IBC) and World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) issued a joint *Statement on Covid-19: Ethical Considerations from a Global Perspective*. It recalled the need to coordinate international efforts and to formulate a common understanding of ethical review processes. 'It is important that research under these circumstances not be carried out purely for financial gain', it stated. 'Transparency, sharing of data and sharing of benefits of research for all humans need to be recognized as central values. The rapid spread of the disease has led to barriers being raised across borders between countries, communities and individuals in an attempt to prevent transmission. Such extreme measures should not impair international collaboration in the fight against the pandemic, nor instigate or perpetuate xenophobia and discrimination. It is an ethical duty to build solidarity and cooperation rather than find refuge in exclusivity and isolation'.

The pandemic has taught us that no-one will be safe from Covid-19 until everyone is safe, since the virus will continue to mutate until herd immunity is reached. The health crisis has heightened awareness of the importance of open science to ensure the timely sharing of research findings and data that can save countless lives. This awareness created a dynamic which led to the *Recommendation on Open Science* being adopted by UNESCO's 193 member states at the Organization's General Conference in November 2021, less than two years after the broad online consultations were launched with different stakeholder groups.

UNESCO networks in health research

UNESCO's networks include university chairs, which may collaborate with one another via twinning arrangements (UNITWIN), and international research centres which operate under the auspices of UNESCO. One such centre is the Regional Centre for Biotechnology in India. Since its inception in 2006, it has been instrumental in developing a number of specialized schools. One of the most recent is the Bio-imaging School for Protein Production and Purification and DNA Sequencing Technology and Droplet Digital PCR. The most recent UNESCO Chairs in Biotechnology date from 2020 (Turkey) and 2021 (Colombia).

These networks have been contributing their expertise to the global response against Covid-19. For instance, the International Institute of Molecular and Cell Biology in Poland has led a consortium of 12 universities and institutes in the development of Covid-19 drugs. Since its inception in 2018, the UNITWIN Interregional Network on PhD Education and Research in Biophysics, Biotechnology and Environmental Health has collaborated with UNESCO in organizing seven webinars on the science of Covid-19.

UNESCO prizes in health research

The UNESCO–Equatorial Guinea International Prize for Research in the Life Sciences dates from 2012. In 2020, it was awarded to scientists who developed an antimalarial treatment (artemisinin); solar water disinfection technology to combat waterborne diseases in places without access to safe drinking water; and regenerative engineering applied to the development of biomaterials for clinical use and stem cell science.

The UNESCO–Russia Mendeleev International Prize in the Basic Sciences is the youngest of UNESCO's international science prizes. This biennial prize covers the disciplines of biology, chemistry, mathematics and physics and was awarded for the first time in November 2021.

The UNESCO–Carlos Finlay Prize for Microbiology is sponsored by the Government of Cuba. This biennial prize dates from 1980.

The L'Oréal–UNESCO Awards for Women in Science were established by UNESCO and the L'Oréal Foundation in 1998. Each year, an exceptional scientist from each of the five regions receives a prize of €100 000, with the research focus alternating between the physical and life sciences. In addition, 15 mid-career women from around the world are designated international rising talents and awarded a research fellowship in life sciences each year.

Dr Nazek El-Atab in her laboratory in Saudi Arabia. Dr El-Atab's research focuses on the fabrication of 3D nanotube-based nano-electronics for implantation in the brain. Brain implants could enable the deaf to hear, the blind to see and the paralyzed to control robotic arms and legs. Her work is tackling the major problem of maintaining sufficient data memory in tiny electronic devices. In 2017, Dr EL-Atab won the L'Oréal-UNESCO For Women in Science International Rising Talent award.
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