



Iran in transition

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Being the second-largest country in the Middle East, Iran has a long history of civilisation during which several dynasties have been overthrown and established and health-related structures have been reorganised. Iran has had the replacement of traditional practices with modern medical treatments, emergence of multiple pioneer scientists and physicians with great contributions to the advancement of science, environmental and ecological changes in addition to large-scale natural disasters, epidemics of multiple communicable diseases, and the shift towards non-communicable diseases in recent decades. Given the lessons learnt from political instabilities in the past centuries and the approaches undertaken to overcome health challenges at the time, Iran has emerged as it is today. Iran is now a country with a population exceeding 80 million, mainly inhabiting urban regions, and has an increasing burden of non-communicable diseases, including cardiovascular diseases, hypertension, diabetes, malignancies, mental disorders, substance abuse, and road injuries.

Introduction

Iran is a Middle Eastern country that has been governed as an Islamic republic since 1979. However, based on archaeological findings, the history of civilisation in the Iranian plateau is more than 5000 years old,¹ and the establishment of a sovereign state in Iran has a history of approximately 3000 years. During this lengthy past, similar to many other ancient civilisations, many great scientists and physicians have emerged from Iran who have contributed substantially in expanding medical knowledge, which was inextricably intertwined with mathematics, philosophy, and theology in the old ages. Some of these physician-philosophers had a major role in keeping the scientific torch alive during the Dark Ages until it was handed over to the Renaissance era pioneers.^{2,3} The unique expansion of science and medicine in Iran might be attributed to several factors, such as the importance of

learning and propagation of science in Iran (both before and after the Islamic conquest of the country in the 7th century AD) and its geographical proximity to ancient Greece, India, China, the Islamic empire, as well as being located on the Silk road, which was not only a route for economic trades but also led to cultural interactions between Iran and countries of east Asia and east Europe.

In this Review, we discuss the health system and the health status in Iran from ancient times and describe its challenges during those periods. We highlight the present challenges and hurdles of the Iranian health system, and conclude by outlining the actions and policies required to address these obstacles as well as present a framework of activities to engage the community, health authorities, and other sectors to maintain the sustainable development in health.

Iran in brief

Iran is one of the ancient civilisations, historically known as Persia, that has had a relatively continuous existence as a sovereign state over the millennia. According to Herodotus, an ancient Greek historian born in the Persian empire, Deioces established the first Iranian Government in Ecbatana (contemporary Hamadan and Biblical Acmeta) in the 7th century BCE through forging unity among different local tribes.⁴ Contemporary Iran has an area of 1648195 km² (636372 square miles), occupying most of the Iranian plateau in southwest Asia. Iran has a population of more than 80 million people (based on the 2016 census), which is mainly composed of the young, distributed across 31 provinces. Iran's population is predominantly urban. Between 1950 and 2010, the urban population increased from less than 30% to slightly more than 70% due to widespread rural-to-urban migration and the new classification of rural centres as towns. The capital, Tehran, now holds more than 8 million people in the city and more than 16 million in the wider metropolitan area, making it

Search strategy and selection criteria

We initially developed a preliminary conceptual framework based on the existing historical and well documented facts about Iranian history of medicine, followed by a systematic review of Persian and English literature to identify sentinel events or breakthroughs for inclusion in this paper. We then searched PubMed, Google Scholar, and Scientific Information Database (an Iranian database), without any time period limitation and using different combinations of the following search terms restricted to Iran: "Health", "Medicine", "Sciences", "Research", and "Education". Subsequently, we expanded our search to include all relevant papers, books, and historical reports, both in English and Persian. We sorted the extracted milestones and breakthroughs to depict a timeline. We also acquired feedback from renowned experts in the field of Iranian history of medicine at different stages and revised on the basis of their comments and guidance.

one of the world's largest megacities. Other major cities such as Mashhad, Karaj, and Isfahan have populations of more than 2 million.

Iran is an ethnically diverse country, and is categorised as a higher-middle-income country by the World Bank, with a gross domestic product (GDP) exceeding US\$454 billion in 2017, and a GDP per capita of approximately \$5593.⁵ Although Farsi (Persian) is the official and national language in the country, different ethnic groups speak different dialects (in addition to Farsi), such as Azeri, Kurdish, Gilaki, Arabic, and Balochi. Twelver Shia Islam is the official religion of Iran and more than 99% of the population are Muslims, while followers of other religions, including Zoroastrian, Jewish, and Christian, constitute the minority.⁶ In terms of geopolitics, the country is often categorised as part of the Middle East and is the second largest after Saudi Arabia, and the third most populous country after Pakistan and Egypt in the region. The political system in Iran is a constitutional Islamic republic and the Supreme Leader (elected by the Assembly of Experts) is the head of the state and supervises the executive, legislative, and judicial systems. The president (who leads the cabinet), members of the parliament, and city councillors are all elected by popular votes every 4 years (the speaker of the parliament is elected by the parliament members). All candidates should secure the Parliament's approval, which is the legislative body in Iran. Iran was the first country in the Middle East to have established parliamentary rule between 1905 and 1907.⁷

Within the past century, Iran has faced important political changes, all of which have influenced the socio-economic status of the nation and consequently affected the health of the population in different manners: the foundation of the first Parliament and establishment of a constitutional monarchy after the Constitutional Revolution during the Qajar Dynasty (1905–07), overthrowing of the Qajar Dynasty and establishment of the Pahlavi Dynasty by Reza Shah (1925), the Anglo-Soviet occupation of Iran and their abdication of Reza Shah in favour of his son Mohammad-Reza Shah (1941), nationalisation of the Anglo-Iranian Oil Company (1951) and the consequent British-American orchestrated coup d'état (1953), the Islamic Revolution and establishment of an Islamic Republic of Iran (1979), and the Iraq-Iran war (1980–88). Moreover, following the Islamic Revolution in 1979, the USA, EU, and the UN Security Council imposed several economic and political sanctions against the country and people. With the highest intensity action during 2010–13, the sanctions tempered Iran's access to global market, including the medications and medical equipment trade-off. However, several of these sanctions were lifted in 2016, following an agreement on the Joint Comprehensive Plan of Action (JCPOA, also known as Iran nuclear deal) between Iran and the five permanent members of the UN Security Council in addition to Germany, in which Iran accepted multiple limitations on

Key messages

- Iran is experiencing a transitional period; its population is ageing, risk factors contributing to diseases are changing, and infectious diseases and the burden they impose on the health-care system are being replaced by emerging non-communicable diseases, including cardiovascular diseases, malignancies, road injuries, and mental health disorders.
- The profile of risk factors predisposing Iranians to various diseases is changing with increasing trends of urbanisation, exacerbating air pollution in most Iranian megacities, and the increasing prevalence of substance abuse among the youth.
- The increasing burden of non-communicable diseases as well as ecological challenges, including air pollution and water crisis; the inefficient infrastructure of the Iranian health system, especially in preventive care; and weak intersectoral partnership to overcome these issues should be the priorities of any framework to address future health challenges in Iran.

its nuclear programme. Although the Iranian economic status was improving following JCPOA implementation, the USA withdrew from the agreement and started to reinstitute the sanctions in 2018.

In Iran, the public sector (ie, the government) dominates the economy and contributes to a major share of the GDP.⁸ The state is mainly responsible for nationwide provision of health care and social services, including retirement, redundancy, disability, accidents, and calamities.⁹ However, non-governmental organisations have an important role in the management of chronic hard-to-cure diseases, such as the Mahak Society, Charity Foundation for Special Diseases, and Gabric Diabetes Education Association), and none of the changes in dynasties and governments have affected its major role in health care and social security provision.⁴

Public free-of-charge schools are widespread across the country, with a remarkable (>95%) coverage in rural and urban areas for both boys and girls, at the primary school level;¹⁰ however, this coverage decreases at the secondary school level, particularly in rural areas. From 1955 to 2015, the literacy rates in women have risen from 10% to more than 84%, and in men from 30% to more than 91%. However, secondary school attendance was almost 75% in 2015, which illustrates a lag in education.⁶ The most prestigious universities of the country are publicly funded and provide tuition-free education to their pupils.¹¹ The number of university students has risen substantially over the past decade from around 310 000 in 1990 (230 000 men and 85 000 women) to around 4·07 million in 2016 (2·2 million men and 1·87 million women).¹²

In 2017 in Iran, the unemployment rate for men was 10·7% of the total labour force and for women was 20·4%. Moreover, the highest unemployment rate of the total

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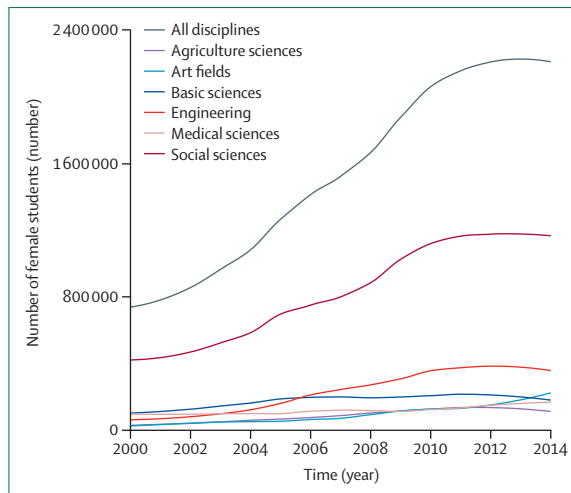


Figure 1: Tertiary education attainment rate in Iranian female university students

Data obtained and adapted from the online database of Statistical Center of Iran.

labour force was among people with advanced education (13·1% for men and 30·1% for women).¹³ This high unemployment rate among young people might be one of the main reasons making them susceptible to various risky and unhealthy behaviours, as well as outmigration of educated youth.

Iranian women had a substantial role in establishing parliamentary rule and their contributions in this rule, as well as several other sociopolitical, cultural, economic, and scientific achievements in the past few decades, which resulted in the ratification of women's rights (including suffrage) in 1962. Encouragement for women to pursue formal education has come from Islamic teachings as well as other broad social and cultural preferences on the obligation of seeking knowledge, in addition to educational opportunities. Figure 1 shows the rapid growth in tertiary education in women. Although women's education increased in the past decades, the labour force participation did not change considerably. Because of cultural and religious norms deem family formation and child rearing as important roles, women have faced social and cultural limitations in participating in the formal labour market. Therefore, the enormous increase in the educational status of the female population has not interpreted into similar gains in terms of economic productivity.

Development of health care and medicine in ancient Iran and the Middle Ages

Iran is one of the oldest civilisations in the world and its history of medicine and public health interventions date back to ancient times. Medical and health-care practices and rituals have been recorded in ancient Iranian texts, such as Avesta (the holy book of the Zoroastrian religion and an old Iranian encyclopaedia dating to the 5th century BCE).¹⁴ In Avesta, ancient Iranian physicians' classes and ranks have been described, and details of medical

practices and ethical considerations of the time have also been recorded. It has been documented in Avesta that Zoroaster, the prophet, asked Ahura Mazda (God) to show him a source of medication against different ailments, such as headache and "cold fever".¹⁴

In ancient Iran, medicine was practised through three different approaches of surgery, herbal medicine, and treatment with incantations. Moreover, strict warnings existed against contamination of rivers and small streams, and the air was to be kept purified by burning incense. Furthermore, the soil was to be kept free of putrefying matters, and fire (a symbol of purity of the Deity) was to be kept in eternal flames and free from any perceived contamination.¹⁵ These principles and rituals clearly show the importance of the concept of conserving the environment, hygiene, and related practices in ancient Iran. Moreover, as it can be deduced, medical education, public health, and the notion of preservation of the environment have always been inextricably interlinked with religion in Iran even before the Islamic era.

Additionally, several archaeological findings have provided solid evidence for ancient medical practices and procedures in Iran. For instance, body remains of a young girl who had undergone skull surgery for treatment of hydrocephalus about 4800 years ago in Shahr-i-Sokhta (Burned City) show the long history of surgical interventions in the country.¹⁶ Furthermore, different pieces of medical instruments, such as a bronze pipe and a forceps from 700–600 BCE unearthed in Lorestan Province, in west Iran, provide further evidence for traces of ancient medical practices in the country.¹⁶

The foundation of the Gundeshapur Academy and its affiliated hospital complex in the 3rd century CE, during the Sasanian dynasty, can be considered a milestone in the development of medical knowledge.¹⁷ Gundeshapur consisted of a university, a teaching hospital, and several affiliated libraries, and was destined to become a hub for medical education that attracted physicians and scientists from all around the world, including Rome, China, and India. During that period, many books and medical treatises were translated into Middle Persian in Pahlavi script from Indian and Greek languages, including works of Hippocrates and Galen, and, most notably, Kalilah wa Dimnah (also known as Panchatantra), an ancient Indian literary masterpiece.¹⁸ Kalilah wa Dimnah was perceived as important in teaching the principles of politics to young princes, and was securely guarded in the Indian treasury and was brought to Iran by Borzuya, a court physician.¹⁹ Gundeshapur and its legacy show the rich culture of sponsoring and promoting medicine in the 3rd century pre-Islamic Iran.

Following the Islamic conquest of Iran (mid-7th century CE), Gundeshapur gradually descended into oblivion. However, with the ascendance of the Abbasid caliphate in 750 CE, the Islamic world entered a so-called golden age of learning,²⁰ and the caliphate invited scientists to

move to the new capital of the Islamic empire, Baghdad. Many ancient Pahlavi texts (including Panchatantra) were translated into Arabic. During that period, scholars from Arab, Jewish, Syrian, Greek, and Iranian origins moved to the capital of the Caliphate and translated prominent works of their nations into Arabic.²¹ Within the first few hundred years, following the Islamic conquest of Iran and dismantling of the Persian empire, several local dynasties were formed in different parts of the Iranian plateau, which showed a great enthusiasm and ambition for inviting scientists, philosophers, and scholars to their courts. In those days, scientific interaction between scholars and scientists in courts of regional governments was at a climax and philosophers, theologians, and Sufis from across the country were intensely involved in debates, discussions, and scientific exchange on topics, such as medicine, science, theology, and mysticism. Many world-renowned Iranian physicians, such as Rhazes (865–925 CE), the author of *Al Hawi* or *Liber Continents*,³ Ali ibn al-'Abbas al-Majusi (930–94 CE) known in the west as Haly Abbas,²² and Avicenna (980–1037 CE), best known in Europe with his medical textbook, *Canon of Medicine* emerged during that era.²³

Rhazes was one of the few historical alchemists who followed a scientific approach in their careers. He classified matter into solids, liquids, and gases, and subdivided naturally occurring matter into animals, vegetables, and minerals.²⁴ He is widely recognised to have discovered alcohol as a substance and extracted sulphuric acid and ammonium chloride for the first time.^{2,24} Moreover, the first ever recorded animal experiments on mercurial intoxication is attributed to him, and there is solid evidence that Rhazes was the first physician to distinguish smallpox from measles through a detailed description of both diseases. In fact, Rhazes has written many monographs on different diseases with meticulous detail and his priceless collection of case reports have survived to this day.²⁵

Avicenna's writings have had a prominent role in the development of medical knowledge in Europe and his book *Canon of Medicine* remained the main medical textbook until the 16th century in Europe (figure 2).²⁶ This book, which was authored on the basis of Hippocrates' and Galen's opinions, includes Avicenna's own astute observations, logical deductions, and criticisms of the conventional medical approach of the time,²⁷ and consisted of five volumes (ie, general principles of medical practice, simple drugs, local diseases, general diseases, and compound medicines).²⁸

Almost all of these scholars and physicians wrote their major works in the Arabic language, the lingua franca of science and philosophy during that period (similar to Latin in Europe). In the Middle Ages, when Europeans came into contact with the Islamic civilisation, they translated many of these works from Arabic into Latin, and consequently, the authors were erroneously believed to be Arabs, a mistake in written history that continues to the



Figure 2: Avicenna

With permission from Society for the Appreciation of Cultural Works and Dignitaries, Tehran, Iran.

present day.²⁹ Edward Browne, in his book *Arabian Medicine* writes that “when we speak of ‘Arabian Science’ or ‘Arabian Medicine’ we mean that body of scientific or medical doctrine... written in the Arabic language... which was for the most part produced by Persians, Syrians, Jews, and in lesser degrees by Greeks.”³⁰

Health status and major social determinants of health in recent history

During the past two centuries, Iran has gone through many different sociopolitical events, which has affected the health status of the nation (figure 3). At the start of the 19th century, Iran's population was about 5 million, which increased to about 9 million by early 1900s, and most of the population inhabited the rural areas.³¹ This period coincided with the reign of the Qajar Dynasty (1794–1925), during which, despite some efforts aimed at improving the health of the nation, the general health status of Iranians was in poor condition due to lack of public health measures, poor transportation infrastructure,³² and general malnutrition among agricultural labourers of low social status. During those years, similar to other countries in the region, life expectancy was low in Iran, child mortality was as high as 50%,³³ and the population had repeated bouts of epidemics such as typhus, smallpox, cholera, measles, plague, tuberculosis, trachoma, and malaria.³⁴ Moreover, the underdeveloped transportation

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Databases-Systems/Time-Series](https://www.amar.org.ir/english/Databases-Systems/Time-Series)

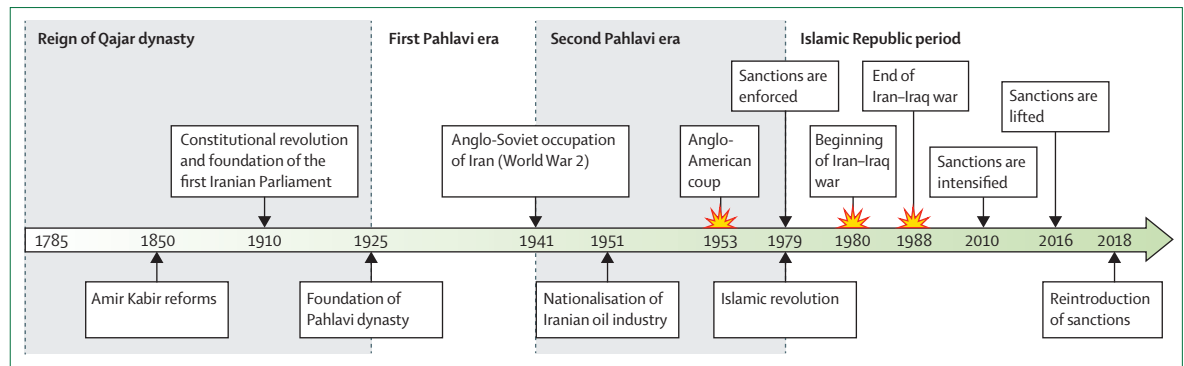


Figure 3: Timeline of major sociopolitical events in Iranian history from 1785 to 2018

system and weak infrastructure made the whole region susceptible to low domestic food production, which intermittently occurred through loss of manpower because of war.³⁵ As a result, a number of severe famines struck the country in that period, notably the one in 1870–71, which took the lives of an estimated 10% of the population,³⁶ and another that broke out during World War 1 (1917–19).³⁷ In fact, after the dismantling of the Ottoman empire in 1918–23, the whole region, which has always been susceptible to droughts because of irregular precipitation, was affected by the maelstrom of war and famine.

Among notable health-related initiatives launched in that period were those initiated by Amir Kabir, the first (and short-lived) Prime Minister of Naser al-Din Shah (the king himself reigned 1848–96 but the prime minister was assassinated in 1852).³⁸ He introduced several major reforms, including license requirement for practising physicians and dentists in 1851 (to become a law many years later in 1911),³³ founded Dar al-Fonun School (House of Techniques), and launched the smallpox inoculation campaign.³⁹ Moreover, the first three large state hospitals of Iran were founded in Tehran shortly after Amir Kabir's reforms. These reforms were initiated and implemented simultaneously with similar reforms elsewhere in the region (such as the Tanzimat reforms in the Ottoman Empire, the western neighbouring country and rival regional power of the time).⁴⁰ Similarly, in Arab countries and territories of the region, prevalent poverty and its health consequences in urban areas compelled local governments to intervene and adopt practical measures to prevent epidemics and promote public health through different sanitation and urban planning initiatives. However, despite providing some relief by controlling some infectious diseases, these interventions did not effectively ameliorate the pressing health needs in the region from different ailments, such as illiteracy, poor sanitation, and malnutrition.³⁹

In 1925, when the Pahlavi dynasty was founded (which coincides with the beginning of the reign of Mostafa Kemal, Ataturk, in Turkey), Tehran had a

population of more than 200 000 people, which increased to half a million by 1940. In the beginning of the Pahlavi dynasty, infectious diseases, such as malaria were rampant across the country, and women, in particular, had ill health because of malnutrition, early marriage, and repeated pregnancies, which predisposed them to high maternal mortality and morbidity. Diarrhoea was a major cause of infant mortality because of poor sanitation and inadequate safe drinking water.⁴¹ The Pahlavi dynasty coincided with several social, cultural, educational, and economic events, including the foundation of Tehran University and several other universities, the Iranian national radio station, the Iranian insurance company, and the launch of the trans-Iranian railway, in addition to the expansions of hospital care in the country. In 1941, the Ministry of Health was established on the foundations of the existing public health administration,⁴² and in that same year, through World War 2, the Allied Forces (Anglo-Soviet) occupied Iran, and drastic deterioration of different aspects of public health and a severe famine ensued. When the Allied Forces left Iran in 1946, the country was left with massive social, economic, and political problems; one in three children died before the age of 5 years and life expectancy at birth was less than 50 years.⁴³ The fertility rate was one of the highest in the world, and access to health care was limited to a few hospitals and clinics in the capital and a few other large cities, while close to three-quarters of the population lived in rural areas.

Widespread corruption in the government and the gap in rural and urban areas' amenities provoked overthrowing of the Pahlavi dynasty, referred to as the Islamic revolution of 1979. In 1980, Iraqi military forces, under the command of Saddam Hussein, the president of Iraq at the time, invaded Iran and the following 8-year Iran–Iraq war broke out. During that period, the country had a scarcity of health-care resources due to war, plummeting oil prices, and economic sanctions.⁴⁴ Most importantly, this 8-year war imposed a great psychological burden on the younger generation in Iran, which continues to be a health issue up to this day. The highest intensity of sanctions being between 2010 and 2013, during the past three decades

an unprecedented set of economic sanctions were imposed on the country, which substantially constrained the availability of medicines and medical equipment in Iran.⁴⁵ Although, some of these sanctions were lifted following implementation of JCPOA in 2016, recent action of the USA to withdraw from the agreement and reinstitute the sanctions raises the concerns that the health system of the country will face a shortage of medicines and medical equipment in the near future.

Furthermore, during recent decades, the Iranian population has had several large-scale natural disasters, including major earthquakes in Manjil and Rudbar (1990), Bam (2003), and Ezgeleh (2017), each claiming tens of thousands of lives.⁴⁶

Environmental and ecological changes and their effects on population health

Iran's population nearly tripled from 18 million to 38 million over the three decades preceding the revolution (1950–79). Although Iran's relatively high fertility rate plummeted from 6.5 births per woman to 1.72 because of a successful family planning campaign between 1985 and 2016, the population stood at 80 million in 2016 (figure 4),⁴⁷ the majority consisting of working age adults in urban areas. The proportion of the population living in urban areas increased from less than 30% in 1950 to more than 70% in 2010. The capital, the greater Tehran, now has more than 16 million inhabitants and is followed by the major cities of Mashhad, Karaj, and Isfahan, with populations of more than 2 million each. The growth of the urban population has resulted in mismatches between the required and existing housing and physical infrastructure; this disparity in provision of environmental, health, and social services has contributed to the emergence of slum and informal settlements in most Iranian cities.

Iran has less than a quarter of the average annual renewable water per capita globally (7000 m³). With an average annual precipitation of less than a third of the global average, more than 50% of the country is arid. The uneven spatial and temporal distribution of precipitation, as well as the irregularity of seasonal flows, make water resources management extremely challenging.⁴⁸ Iranians have established a thriving civilisation in the face of limited water resources by blending technical ingenuity with environmental stewardship. They pioneered one of the world's most sophisticated ancient water conveyance infrastructures and management systems to harvest and distribute water for millennia. The water infrastructure included canals and clay pipes, gravity dams, water mills, ice houses, residential and communal water storage tanks, and flood control structures.⁴⁹ Most remarkably, Iranians invented qanats, a mildly sloping underground aqueduct and a series of vertical access shafts to transport and withdraw groundwater from an upstream aquifer for downstream irrigation and domestic use.⁵⁰ They complimented the technical innovations with effective

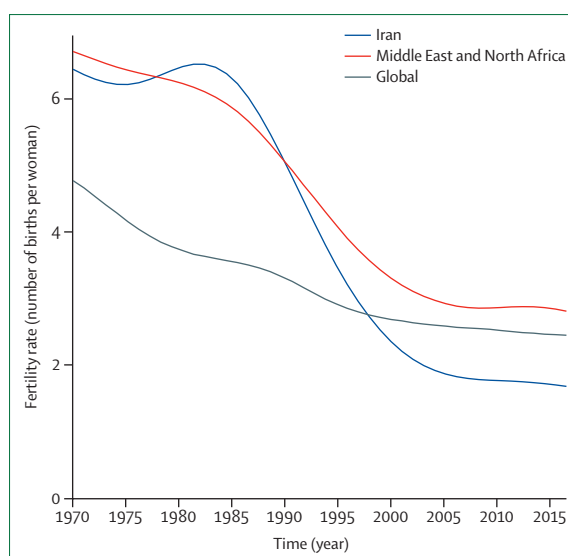


Figure 4: Total fertility rate in Iran, the Middle East and North Africa, and globally

Data obtained and adapted from the online database of the World Bank.

For the online database of the World Bank see <https://data.worldbank.org/indicator/>

regulatory statutes to meter and allocate water and resolve conflicts. Since the 1960s, however, the traditional harvesting techniques lost their appeal with the introduction of modern water supply techniques, including pumping technologies and deep wells, inter-basin transfers, and large dams.⁴⁹

After the 1979 revolution, war and sanctions made food security a top priority for the country. However, this sector is still limited by outdated farming practices, low economic productivity (<35% irrigation efficiency), a mismatch between crop patterns and water availability, and an ageing population of farmers because of youngsters' incentives to migrate to cities. Iranian authorities prioritised building water storage and transfer structures, an unsustainable water withdrawal approach that has led to drying lakes and rivers, groundwater decline,⁵¹ and a decrease in the quality of drinking water.⁵² Therefore, re-examining the present agricultural policies is a priority.

Around 92% of Iran's water supply is allocated to agriculture.⁴⁸ Because of improper investments, the agricultural sector heavily relies on irrigation, despite a modest contribution to the country's GDP (about 10%).⁴⁸ In contrast to an inefficient agricultural sector, Iran has a relatively strong domestic water treatment sector, which benefits from the application of standards. The water delivered through distribution networks is clean and of good taste for drinking. Of the 70% of Iran's urban population, almost all have access to piped water.⁴⁸ However, rural areas have lower sanitation levels and increased risk of waterborne diseases due to an average 75% of piped water coverage.⁴⁹ The industrial water consumption share is relatively small (2%) compared with developed countries.⁴⁸ Industries can purchase water for agriculture or use desalinated water when the

corresponding costs are not prohibitive. Environmental and water pollution are challenging problems caused by industries in peripheral urban areas. Without major policy reforms, Iran continues to face increasing challenges in the water and agricultural sectors.

Transportation plays important economic, environmental, and social equity roles; in 2012, 8% of Iran's gross national product was derived from transportation or communication activities.⁵³ Transport facilities are mostly owned and managed by the Government. In 2010, nearly a quarter of Iran's energy was consumed by the transportation sector from burning gasoline and diesel. However, natural gas has become a major fuel, accounting for 50% of transportation and 13% of total energy consumption.⁵⁴ Contrary to a sustainable transportation perspective, the dominant mode of transport is passenger cars, consuming 95% of energy in this sector, whereas the rail system has a minor role in freight and passenger transport.

Car ownership has increased from 70 per 1000 people in 2000 to 210 in 2013, resulting in 16 million private and public vehicles on the road.⁶ This increasing demand for passenger vehicles followed by income growth has led to halving of the average fleet age over the same period.⁵⁴ However, the increase in the number of vehicles is the main cause of congestion and air pollution in major cities.

Traffic congestion because of rapid urbanisation, poses major environmental, economic, and social problems. The 2018 Numbeo Traffic Index ranked Tehran as the ninth most congested city in the world.⁵⁵ Average travel-related costs have increased by 15% between 2004 and 2010, a continuing trend due to the increase in the number of vehicles.⁵⁴ Consuming 3·6 billion L of gasoline in 2010, Tehran's surface transportation alone has an astonishing high share of 15% of the national fuel consumption.⁵⁶

In addition to income levels, regulations, vehicle fees, land-use patterns, and the quality of public transport can constrain urban personal vehicle use.⁵⁷ Iran has a relatively cheap public transportation, with much lower than global prices, as low as \$0·10 per trip for the metro. Notably, like very few cities, Tehran has a congestion charging scheme with the potential to incentivise the use of alternative modes aimed at congestion and environmental mitigation.

As of 2010, private vehicle uses of 50% in Tehran and more than 40% in other major cities⁵⁴ are similar to high-income cities with strong public transportation such as London, but higher than many developing countries' cities.⁵⁵ Despite the relatively high use of private cars and low rate of cycling (with a share of nearly 0% in Tehran and 8% in Isfahan), the use of the metro has escalated from 5% to 9% between 2004 and 2010.

The low fuel price poses as a historical obstacle for public transportation development and usage in Iran. Although the radical subsidy reform has increased prices, a sudden shift towards public transportation is difficult

for people and the government. This is in line with the small price elasticity of fuel consumption in Iran.⁵⁸

Development of formal structures for the health system

Back in 1881, the first official health institution in Iran, called the Sanitary Council, or Majles-e Hefz al-Sehheh (the Council for Preservation of Health) was founded with the goal of systematically organising and directing efforts toward improving the public health status and combating fatal disease epidemics.³³ The Sanitary Council operated under the auspices of the Ministry of Interior until 1920, when the Ministry of Health and Charity Affairs was officially launched and the responsibilities of the council were transferred to this ministry. The Public Health Administration in the Ministry of Health and Charity Affairs was then established and assigned to manage the public health and medical affairs of the country. In 1941, once again, the structure of these organisations changed and the Ministry of Health was founded, separating medical affairs and public health issues from charity activities.⁴² Subsequently, from 1941 to 1979, 30 individuals were appointed as Ministers of Health, most of whom had a background of attending French universities during their education. After the Islamic Revolution back in 1979, five presidents came to power (excluding the two first short-lived governments), each trying to improve different parts of the health-care system in Iran (appendix).

In 1975, the Ministry of Health and Welfare was formed by merging two Ministries of Health and Social Welfare,⁵⁹ with the idea of implementing a more coordinated approach toward medical education and health-care provision in the country.⁶⁰ By 1986, when the responsibility of training health personnel was taken over by the Ministry of Health, the Ministry of Health and Medical Education was formed, and medical schools, which were previously supervised by the Ministry of Higher Education, were now recognised as stand-alone universities under the supervision of this newly formed ministry.⁶¹ Although strongly disputed by the Minister of Higher Education at the time, two main justifications were given for this integration: improving the quality of health personnel training (including a more community focused approach) and promoting self-sufficiency in the country by expanding the supervisory capacity of the medical schools across the nation.⁶² Since the establishment of this ministry, all decisions regarding health-care strategic planning and resource allocation (according to parliamentary legislations) are made at a national scale by the Ministry of Health and Medical Education, and the ministry is considered as the ultimate authority to oversee, license, and regulate the activities of both public and private health providers in the country.

The debate on the benefits and perils of integration of medical education with health-care provision, which is considered as a unique structural reform in human

See Online for appendix

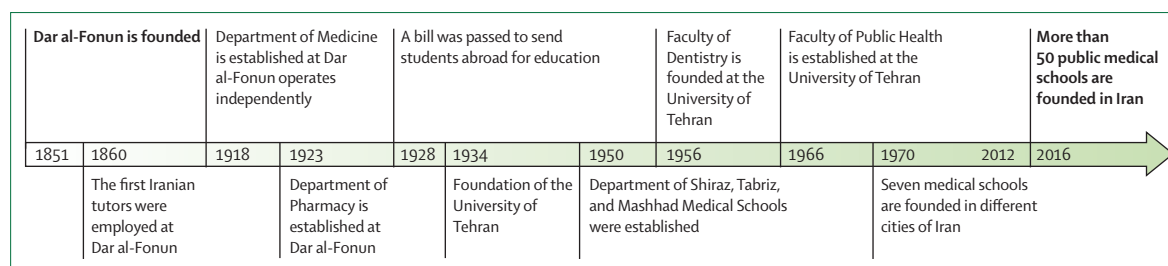


Figure 5: Timeline of major events in medical education in Iran from 1851 to 2016

health resource training, continues to this day. Although some experts believe that the establishment of the Ministry of Health and Medical Education has resulted in increases in the number of graduates and improved the quality of their training,⁵⁹ many argue that medical universities have been diverted from their main roles in research and education without being granted enough authority to deal with health issues in their catchment areas.⁶³ The number of students admitted to medical, nursing, and public health schools has increased from almost 66 000 in 1988 to 256 000 in 2017, which has improved access to health care in Iran over these years substantially.⁶⁴ Nevertheless, the linkage between health professionals' curricula and community needs, which was one of the key elements in the minds of the initiators of integrating health-care delivery into the universities, has not been fully achieved.⁶⁵

Development of medical knowledge and education

Although traditional medicine was taught in religious education centres (Howza) for centuries, the Dar al-Fonun School (House of Techniques), established in 1851, was the first modern higher educational institute that had a medical department in Iran (figure 5). Before the establishment of Dar al-Fonun, traditional physicians were the sole medical practitioners in Iran and there were no approved rules and regulations for medical practice in the country.⁶⁶ Before 1860, when Iranians joined the teaching ranks of the medical department, all lecturers at Dar al-Fonun were Europeans (mostly from Austria), who had been invited to the country in the early years of its establishment. In half a century, the school had already trained approximately 1100 medical school graduates, many of whom continued their education abroad, and on return, occupied senior positions in the health and medical education system. In 1918, the Dar al-Fonun's Department of Medicine became independent, and, as a result, the first Madsresh-ye Tebb (medical school) was formed in Tehran. Later, in 1934, this newly founded medical school laid the foundations of the medical faculty of the University of Tehran. It is noteworthy that female students entered the medical school for the first time in the early decades of the 20th century.⁶⁷ Moreover, considering tuition is free for the public medical education system, prosperous

job prospects, and the traditional prestige that has always been heir to education in Iran, medicine has always been a popular choice for students from all strata of the Iranian society. As such, admission to medical schools and residency programmes in Iran have been highly competitive.

In 1928, a special act was passed by the Parliament to send 100 students abroad annually for higher education, and approximately 7% of the national budget was allocated to this task. Consequently, from 1928 to 1935, 640 students, including 125 medical students were sent abroad (mainly to France) for higher education. Most of these students returned home after completing their training and some graduates later joined the Medical School at the University of Tehran. This resulted in a substantial increase in the number of trained physicians in the country in different specialties.⁶⁸ During the next two to three decades, independent faculties were established in Tehran University: Nursing and Midwifery in 1916, Pharmacy in 1956, Dentistry in 1956, and Public Health in 1966.⁴² Establishment of these faculties were followed by the foundation of medical schools in other major cities: Tabriz (1947), Mashhad (1949), Isfahan (1950), Shiraz (1952), Ahwaz (1956), and National (1960) medical schools.⁶⁹ By 1970, seven medical, three dentistry, and three pharmacy schools had been established in Iran. However, such developments were not sufficient to meet the dire needs of the country in terms of provision of health-care professionals, especially considering the fact that most health career promotions usually resulted in migration of the professionals to the large cities and limitation of their services to such areas.⁷⁰

The Islamic revolution in 1979 and Iraq's invasion of Iran in 1980 coincided with a severe shortage of health-care professionals, which was further exacerbated by emigration of Iranian physicians to western countries.⁵⁹ Although by 1980, ten more medical schools had been established in the country, the substantial expansion of medical education only occurred in 1985 following the establishment of the joint Ministry of Health and Medical Education.⁷¹ This expansion has continued to the present day and peaked substantially during the past two decades with more than 50 publicly funded medical schools and numerous private ones in 2017.⁷² Each year, more than 7000 medical, pharmacy, and dental students are trained at medical universities all across the country.

National smallpox vaccination campaign		Pasteur institute of Iran is founded		A leprosarium is established in Tabriz		Parliament approves a free vaccination programme		National malaria eradication programme is launched		A leprosy rehabilitation centre is founded in Khorasan		Smallpox is officially eradicated in Iran	
1850	1910	1921	1926	1933	1934	1939	1942	1947	1950	1952	1961	1965	1978
	A vaccination bill is passed by the parliament		Vaccination department of the Pasteur Institute of Iran is formed		Institute of Malariology is founded at the Pasteur Institute of Iran		A tuberculosis sanitarium is founded in Tehran		A plague research centre is formed by the Pasteur Institute of Iran		Institute of parasitology and Malariology is founded at University of Tehran		National Institute of Public Health is established

Figure 6: Timeline of major events in Iran to address public health challenges and infectious diseases from 1850 to 1978

Furthermore, Iranian research practice has progressed in recent years, making Iran one of the leading countries in science production in the region.

Development of public health and infectious disease control strategies

Development of public health in Iran has previously mainly focused on controlling infectious diseases (figure 6), and only recently have actions been directed towards addressing the increasing burden of non-communicable diseases. In the mid-19th century, Amir Kabir launched the first national initiative to address a serious public health concern of the time and to control infectious diseases through implementation of a national smallpox vaccination campaign, which was made into a law by the parliament in 1910 as the Act of Health Protection and Smallpox Vaccination.⁷³ Later in 1942, the parliament approved the general and mandatory vaccination programme as free of charge.⁷⁴ Moreover, several public institutions were founded to control hard-to-treat infectious diseases of the time from the early 1900s onwards. In 1933, a leprosarium was established near Tabriz (in north west of Iran), and the first tuberculosis sanatorium (known as Shahabad tuberculosis sanatorium) was founded in Tehran in 1939. In 1961, the Razavi Leprosy Rehabilitation Center was formed in Khorasan province.^{75,76}

Establishment of the Pasteur Institute and the Institute of Public Health Research can be considered as major breakthroughs in the control of infectious diseases and as game changers in improving public health in Iran. The Pasteur Institute of Iran was inaugurated in 1921 in Tehran with scientific support from France and the Pasteur Institute of Paris, following an official request by the Iranian Government. In 1926, the institute was further expanded through the establishment of a vaccination department, foundation of a zoonotic diseases' prevention unit, and establishment of several diagnostic medical laboratories with the main focus of research on different endemic diseases in Iran.⁷⁷ In 1923, immunisation against communicable diseases was still limited to smallpox, whereas diphtheria was a deadly prevalent disease, particularly in children. In fact, although vaccination mandates have steadily expanded ever since, prominent achievements in national vaccination coverage (>90% coverage) were only attained in

the mid-1980s, when the Iranian primary health-care network was established. In the first decade of the 20th century, free anti-diphtheria vaccines were provided by the Pasteur Institute of Paris.⁷⁸ Funding was provided to produce smallpox vaccine and the anti-diphtheria serum. After World War 2, the domestic production of smallpox vaccines increased to 50 million doses per year. As a result of these efforts, in November, 1978, Iran officially reported the eradication of smallpox in the country,⁷³ simultaneously with India and approximately 25 years after its eradication in north America, Europe, and Oceania.⁷⁹ In 1965, the Pasteur Institute of Iran was upgraded to the Institute of Public Health Research with a wider mandate of both research and primary health-service provision.⁸⁰ Considering the absence of any effective primary care system in the country, widespread posts of this institute were formed all across Iran which became actively involved in the provision of nationwide pictures of the burden of diseases, such as malaria, trachoma, schistosomiasis (which were very effectively controlled), and Guinea-worm disease, which was ultimately eradicated in the mid-1970s.⁸¹

Before the commencement of the malaria prevention programme, the disease was prevalent in Iran for centuries. At that time, about 60% of the population lived in malaria endemic areas, and an estimated 4–5 million of them were afflicted by the disease each year. In 1934, the Malaria Unit of the Pasteur Institute expanded malaria studies in northern Iran and patients were treated with quinine free of charge.³⁴ However, malaria still remained a major health concern in Iran and affected at least half a million people in the early 1950s.⁸² In 1952, the Government's response was to design and implement several national eradication programmes for malaria control,⁸³ and the Institute of Malariology and Parasitology was founded at the University of Tehran. Research on different aspects of malaria and provision of training to the public health personnel were the main activities of this institute.⁸³ The first malaria eradication programme was initiated during that decade and managed to reduce malaria transmission in the northern parts of the country by the early 1980s; although the disease remained endemic in the southern provinces. In 1980, a new malaria control programme was designed and implemented, which is still in progress. Data indicate that the incidence of malaria has declined substantially from

271 in 1966 to two cases per 100 000 in 2013.⁸⁴ The decline in disease incidence was interrupted during the 1980s because of the Iran–Iraq war, but strengthening the controlling programmes after the war resulted in further reductions in malaria incidence and the country is now in the pre-elimination phase. About a third to half of the new malaria cases in more recent years have been diagnosed among immigrants.⁴⁵

The Pasteur Institute of Iran also played a major role in tuberculosis management by producing the BCG vaccines.⁸⁵ The efforts of the Pasteur Institute came into effect with the launch of the National Tuberculosis Surveillance programme; one of the main activities of the primary health-care network, including treatment protocols that adopted the Directly Observed Treatment Short-Course strategy.⁸⁶ Improved socioeconomic conditions, better detection, and treatment of cases have reduced the incidence ten times in the past 50 years.

In addition to the active role of the Pasteur Institute in controlling infectious diseases, several other diseases were controlled with improvements in sociodemographic and economic conditions in Iran. Cholera and typhoid fever, for instance, were controlled by improving access to safe drinking water and sanitation in recent decades. The incidence of cholera has shown a substantial decline during the past 50 years. Now, the disease is under control and a sensitive surveillance system is in effect, except for periodic epidemics every 5–6 years as a result of consumption of infected vegetables grown using waste water or imported cholera cases from Afghanistan and Pakistan. Typhoid fever, which was one of the leading drivers of mortality and morbidity in the past, reduced substantially because of health promotion and safe water supply.⁸⁷

Efforts to prevent polio in Iran preceded the announcement of the global goal of eradicating the disease. Routine immunisation has been mandatory since 1984; and since 2002, routine administration of oral vaccine has reached and maintained full coverage.⁸⁸ In 1977, there were 231 confirmed cases, whereas, despite numerous cases reported in Pakistan, no new cases have been reported in Iran since 2001. From then on, a national surveillance system for acute flaccid paralysis has been established and supplementary immunisation campaigns are done for children in the south-eastern part of the country that borders Pakistan.⁸⁹

As a result of these interventions and socioeconomic development of the country, most major diseases caused by poverty and poor sanitation in the 1950s started to diminish across the country. The disease pattern shifted from a dominance of infectious diseases in the 1950–70s, to the present status of overwhelming prevalence of non-communicable diseases. Moreover, in recent years, several successful public health programmes were launched, including the national thalassaemia prevention programme, iodine deficiency control, organ transplantation policies, advances in the pharmaceutical industry and the

establishment of the National Iranian Blood Transfusion Organization.⁹⁰

Development of the primary health-care network

During the past century, Iran has attained remarkable achievements in addressing nationwide inequity and the provision of primary health services to its rural areas. Remote and rural areas have always had a severe shortage of health professionals because of their reluctance to work in these areas. In 1950, the Regional Director of the WHO's Eastern Mediterranean Regional Office estimated that in Iran, there was only one physician per 60 000 of the population.⁹¹ This shortage of health professionals and health service provision was most dire in the rural and remote regions of the country.

One of the first and short-lived systematic attempts to address the widespread inequity in health-care provision was the training of junior health professionals called *Behdar* in 1940 in Iran.⁹² They were trained for 4 years at a graduate level (instead of 7 years required for physicians), and were licensed to practise in rural areas.⁷⁰ This programme achieved little success, and was halted completely in 1952 mainly because most *Behdars* chose to continue their training as physicians and left rural areas for larger cities. In 1964, a bill was approved by the parliament requiring all male medical graduates to serve 2 years in rural and remote areas, an initiative known at the time as *Sepah Behdasht* (Health Corps).⁹³ A year later, female graduates were also expected to join this service. As a result, approximately 450 health posts were established around the country with the main objective of providing basic health services to the rural population.⁷⁰ Although the design and implementation of these measures before the Islamic Revolution provided some relief in terms of provision of health services in rural areas, in the long-term, they did not prove to be as effective as envisaged.⁹³

In 1970, analysis of the outcomes showed that despite all efforts to persuade doctors to work in disadvantaged areas, the doctor-to-patient ratios ranged from one per 200 to one per 100 000 depending on the region (ie, average one per 3750).⁷⁰ Such disappointing results clearly showed the overwhelming need for development of a national network of trained and supervised community-based health workers for provision of primary health-care services in rural areas.⁹⁴ Consequently, a few pilot networks of rural health workers were formed in 1972 in four provinces of Iran.⁹⁵ By the late 1970s, although some encouraging achievements in terms of improvement of health outcomes were reported in some catchment areas,⁹⁶ no nationwide systematic approach resulted in only minor achievements on a national scale.

After the Islamic revolution in 1979, with a few years of delay, the country entered a new era in addressing inequity and provision of primary health services in rural areas. Benefiting from the experiences of the pilot projects undertaken before the revolution, the Ministry of Health

and Medical Education devised a national programme and managed to secure funding for establishment of a nationwide primary health-care network.⁹⁵

In this programme, so-called health houses were established in rural areas across the country and were staffed with community health workers (known as Behvarzes in Iran) trained as the first point of contact for health service delivery in these regions. This programme continues to date, and Behvarzes are selected from the inhabitants of the village she or he is supposed to provide services to. They are trained for 2 years by Behvarz training centres in universities of medical sciences and are able to provide a range of individual and population level health services. These services mainly include environmental health, school health, disease control (eg, directly observed treatment short-course for tuberculosis, diabetes, and hypertension), screening (eg, malaria, diabetes, and hypertension), and family health, including child and maternal care, reproductive health, vaccinations, and mental health services.⁹⁷ Moreover, Behvarzes are provided with well-defined protocols, enabling them to prescribe 46 medicines, mostly antibiotics, vitamins, contraceptives, and oral rehydration solutions available in the health houses without the need for physician prescriptions.⁹⁸ A Behvarz works in a health house to provide services to 1000–1500 people in the rural population,⁹⁹ and is responsible for referring patients of her or his catchment areas, if need be, to the rural health centre where a family physician provides services.⁹⁸ With changes and improvement of the primary health-care network over time, several other members joined the primary health-care team, including midwives, experts on disease control, environmental health, and family health. These members work in rural health centres to manage and supervise three to five health houses and visit all referred patients from the catchment areas.

The launching of this programme was associated with substantial achievements in a short period of time, and from 1984 onwards, maternal and child health have substantially improved, mortality for both children and adults have substantially decreased, and the gap in health service provision (both coverage and health indicators) in urban and rural areas of the country have markedly narrowed.¹⁰⁰

Although the primary health-care programme is considered a successful health reform in rural settings, the proportion of the rural population has reduced to 30% during recent decades. Thus, a well-functioning primary health-care system in the rural areas only partially addresses the health-care needs of a minority of the population and misses inhabitants of urban settings. In a similar effort in urban areas, primary health-care facilities (health posts) provide primary health services (eg, maternal and child care, family planning, school health care, and vaccinations); however, their service coverage among the population of their catchment areas is relatively low. Moreover, with the increasing population of refugees and

slum inhabitants, the primary health-care network has come short of addressing these newly emerging issues. The challenge following referrals outside the primary health-care system remains unresolved. The referral system works perfectly in the primary health-care system and between the Behvarz and the family physician but fails when a family physician refers a patient to a tertiary health-care facility. Fragmentation of the administration of services and categorising it into primary health care, outpatient curative services, and inpatient curative services have resulted in the failure of all efforts to provide an integrated and comprehensive system of health services.¹⁰¹ Moreover, as a result of widespread urbanisation, the ageing population, and increase in the prevalence of non-communicable diseases, this network is faced with the contemporary challenges that non-communicable diseases are posing on the nation.

Improving access to secondary and hospital care

Hospitals have a long history in Iran.²¹ However, the history of modern hospital care dates back to the time of the Qajar dynasty (1785–1925), when Qajar kings frequently travelled to Europe and adopted similar measures in Iran. During this period, hospitals also had a prominent role in the propagation of western knowledge of medicine across Iran, especially in major cities.¹⁰² However, expansion of hospital beds was sluggish and hospitals were seldom built in small towns.¹⁰³ Up to 1916, three main state hospitals were founded in Tehran, Marizkhaneh-ye Dowlati, which was later called Sina Hospital (1873); Vaziri Hospital (1900); and the Women's Hospital (1916), which was later renamed as Amir A'lam.³⁹ The Sina and Amir A'lam Hospitals are still functioning as major teaching hospitals in Tehran.

In 1922, publicly funded hospitals increased to eight in number.³⁹ In 1942, three additional major hospitals were established, and in 1950 the number of public hospital beds was about 700 in Tehran (in large teaching hospitals), and about 2000 in the rest of the country (distributed among 80 small hospitals).⁸² The Pahlavi hospital commonly referred to as the 1000-bed hospital (a name which seems to represent the number of intended beds), and now known as the Imam Khomeini Hospital Complex, was officially founded in 1946 and is one of the biggest hospitals in Iran. In the 1960s, the government provided low return health loans for those who were willing to build small private hospitals in regional areas.⁷⁰ Apart from the small number of beds in major teaching hospitals, all services were provided free of charge. By the early 1970s and the expansion of private hospital beds and physician offices, the limited budget and financial constraints became a major concern for policy makers. However, hospitals vastly expanded in Iran after 1990, covering a wide range of health services. On the basis of recent statistics, inpatient services are provided by more than 920 hospitals,¹⁰⁴ almost 84% of which are public, and the rest belong to the private sector. This number

approximately equals 117 000 hospital beds, which provides a density of 1.62 beds per 1000 among the Iranian population.¹⁰⁵ Hospital bed density has increased by 69% from 2001 to 2011, while the overall population has increased by 11% over the same period in Iran.¹⁰⁵ Although some hospital regionalisation plans have been implemented, the unequal distribution of hospital beds in remote and regional areas still remains a problem. Evidence indicates that hospital bed density in different provinces have varied in the past decade.¹⁰⁵ Moreover, during the past 20 years in Iran, bed occupation rate has had an increasing trend whereas average length of stay has had a decreasing trend.¹⁰⁶ Similar geographical variations in these two metrics among different provinces have been reported too.¹⁰⁷

There is a huge gap in quality of care in hospitals both in public and private sectors, which has led to poor outcomes of health-care delivery. The cancer survival rate in Iran is lower than European countries and several Asian countries,¹⁰⁸ and mortality in intensive care units is approximately twice as high as that in the USA.¹⁰⁹ The poor outcomes of health-care delivery are partly due to medical errors. Although there is no system to collect data regarding medical errors systematically, there is evidence for medical errors in Iran being more frequent than in high-income countries.¹¹⁰ The other contributor to poor outcomes of health care is the induced demand. Evidence shows that 47% of patients with low back pain who were referred to imaging centres had no MRI indications,¹¹¹ 37% of cases referred for CT scan because of mild head trauma did not have the required indications,¹¹² and 27% of angiographies in a teaching hospital did not meet the necessary indications for undergoing angiography.¹¹³

In outpatient services, more than 80% of services in urban areas are provided by the private sector.⁶⁰ Patients, both insured and uninsured, can choose their health-care providers and they can directly visit public or private practitioners, specialists, or subspecialists.¹¹⁴ The aforementioned health-care system in rural and urban areas differentiates health-care use among urban and rural populations; among rural populations more services are delivered by the general practitioner and primary health care, whereas among the urban population, specialist and subspecialist service utilisation are more common.¹¹⁵ The family physician programme has reduced the number of visits to pharmacies in rural areas,¹¹⁶ whereas the mean level of medicine consumption among the Iranian population is higher than other middle-income countries.¹¹⁷

Outpatient services also have some inadequacies in their delivery. For instance, in 2011, 20% of women and 28% of men with diabetes remained undiagnosed, and 40% of women and 49% of men diagnosed with diabetes did not receive appropriate treatment. The gap in diagnosis and treatment is even worse for hypertension; in 2011, roughly 70% of cases in women and 80% in men remained undiagnosed and less than 10% of the diagnosed

cases were appropriately controlled. The higher chance of diagnosis for diabetes compared with hypertension might be because of better and earlier integration of diabetes diagnosis protocols into the community health-care workers' (Behvarzes) training programme, which occurred during 1996–2002.¹¹⁸

Mental disorders and developments in mental health care

Before the 1940s, mental health services were characterised by large mentally ill shelters with poor conditions. The establishment of new psychiatric hospitals and departments in the 1950s and psychiatric training since the 1960s resulted in improvement of services to psychiatric patients.¹¹⁹ The Rouzbeh mental hospital followed by the Tehran Psychiatric Institute were pioneers of delivering modern psychiatric services and training in the country.

While the establishment of the primary health-care system in 1983 resulted in a continuous improvement in many aspects of public health, concerns about mental health problems emerged only after the end of the Iraq–Iran war (1980–88). Studies showed a high prevalence of mental disorders and a low capacity to respond, especially in rural areas. In 1986, the first National Programme on Mental Health was developed in Iran. The objectives of the programme were to make essential mental health-care services available to the public, with a special emphasis on the underprivileged, deprived, and at-risk populations. Following the motto of “mental health for all Iranians by the year 2000”, the primary health-care system was adopted as the primary delivery platform for this programme.¹²⁰ Behvarzes, who were at the front line of health delivery, were trained to find cases of four categories of mental disorders, to refer them to general physicians at the second level, and to follow up patients according to the instructions. 15 years later, in 2005, 86% of rural health centres were providing mental health services.¹²¹ Although the expansion and implementation of the programme has been facing some obstacles, overall results have showed moderately positive results in terms of case identification, treatment skills of general physicians, access to essential psychiatric medications, and an increase in mental health awareness.¹²²

However, with continuous industrialisation and urbanisation, mental health professionals were increasingly concerned about the inadequacy of the mental health programme.¹²³ Most importantly, the primary health-care system was not established in the urban areas that are home to a large migrant population with diverse psychosocial needs. Therefore, new mental health responses were developed during the past decade. These responses included, school mental health (eg, teaching life-skills and parenting skills at schools), psychosocial interventions for survivors of natural disasters, suicide prevention, prevention of domestic violence, and providing various drug abuse treatments and harm reduction interventions. In addition, long-term admissions in large mental health

hospitals have shifted toward short inpatient care in psychiatric wards of general hospitals, and day care and home care for those with severe mental illnesses. At present, these interventions are at different levels of development, coverage, and quality.

Despite all these developments, still a third of those with a diagnosis of a mental disorder do not feel any need to receive services and two-thirds do not receive any health services for their mental problems.¹²⁴ Mental health literacy and mental health services are inadequate. Insurance systems do not cover most non-pharmacological services for those with mental disorders. Mental health awareness and access to care need to be increased, especially in urban areas and to the most disadvantaged people. A comprehensive plan of evidence-based interventions for primary and secondary prevention has been included in the package of the new primary health-care system in urban areas and might be an appropriate response to the high prevalence of diverse mental health problems. Examples of these interventions are teaching self-care, life and parenting skills, and the management of various common mood, anxiety, psychotic, and substance use disorders.

Worldwide, fatal suicide is more prevalent in men than in women, but suicidal ideation and non-fatal suicide are more common in women.¹²⁵ The Iran mental health survey in 2011 showed that 7.7% of women aged 15–64 years had suicidal thoughts, which was 1.6 times more prevalent than in men, and 1.8% attempted suicide in the previous year, which was 2.0 times more prevalent than in men.¹²⁶ Suicide attempt is much more common in girls (15–19 years) and the rate decreases with an increase in age.¹²⁶ Although studies done worldwide show that men use more lethal methods, self-inflicted burn (one of the harshest and torturous methods of suicide) is an exception to the rule and women choose it more frequently.¹²⁵ Young women account for more than 80% of self-inflicted burns in Iran. Most of them are aged 20–35 years, with low educational and socioeconomic level and live in suburban or rural areas. Most are married housewives and in the first years of their marriage. Marital and family conflicts were the most frequently reported reason for attempting suicide.¹²⁷ Self-inflicted burn is a public health problem in some parts of Iran, specifically in the west and north regions. The annual incidence of self-inflicted burn is reported between two and 27 per 100 000 people in different areas, and mortality was higher than 50% in all reports.¹²⁷ Those who survive tend to have extensive physical and psychological sequels.

Youth risks and behaviour

Iran's population is mostly consisted of young people, so the health status of this group can affect the health of the entire population both now and in the future. Additionally, society has had social shifts (mostly due to the rapid uptake of tertiary education, the increasing roles of women in communities, globalisation, and the

expansion of information, technology, and urbanisation), which has made remarkable changes in the lives of the young people living in Iran. This social shift is why these young peoples' health risks and behaviours need more specific attention.

In the past four decades, the Iranian society has had the world's largest and fastest fertility decline. During the late 1940s, the population growth shifted in Iran from the high mortality and high fertility pattern to the high fertility and relatively low mortality (ie, fitting the classic demographic transition). In 1966, the first Iranian family planning programme was launched to encourage families to reduce the number of their children with the slogan, fewer children, a better life. After the Islamic Revolution in 1979, the family planning programme was replaced by pronatalist policy, which encouraged early marriage with many children.¹²⁸ This new population policy, along with the context of the Iran–Iraq war, rapidly raised the annual population growth rate from 2.7% in 1976 to 3.2% in 1988. After initiating the anti-natalist policy in 1988, the fertility rate rapidly declined to 1.8 births in 2011, which was lower than the birth replacement level. The speed and amount of decline in total fertility rate became a new and serious challenge that encouraged Iranian politicians to support the pronatalist policy.¹²⁹

In Iran, religious, traditional, and cultural educations do not approve non-marital sex (pre-marital or extra-marital sex); however, as discussed earlier, Iran, like many developing countries, has gone through social changes that have led to more permissive attitudes towards cross-gender friendship among young people. In the past two decades, concerns have been raised about the possibility of an increase in pre-marital sexual practices among young people; while consistent condom use is uncommon.¹³⁰ Although the prevalence of non-marital sex in Iranian young people is much lower than many other countries, the nationwide public messages encourage either abstinence or early marriage. There is a possibility of legal temporary marriage approved by religion as well. However, it is a substantial taboo to talk about the necessity of using protective measures in high-risk sex. In addition, sex work has always been an underground illegal job after the Islamic revelation in 1979 and female sex workers have mainly been a small marginalised group. In this social context, it has been difficult to provide sexual health care and contraception facilities.

HIV has had a sharp increasing trend in Iran. It is estimated that about 100 000 people lived with HIV in 2014,¹³¹ with around 10% of them contracting HIV in the past decade.¹³² Sadly this trend continues, and without a comprehensive controlling programme, the burden is estimated to increase to about four times in the next decade.¹³³ Although unsafe injections are still the main route of new infections, with 45.5% of new cases among intravenous drug users and 12.2% among their sexual partners,¹³⁴ sexual transmissions (particularly among women) has been more prominent in recent years.

However, from the beginning of the Iranian HIV epidemic, about 11% of detected positive cases were women, whereas in new detected cases in 2013, this proportion has increased to 29%.¹³⁴

The results of the latest biobehavioural studies in Iran showed prevalence of HIV in about 4·5% of female sex workers,¹³⁵ they used a condom in only half of their sexual contacts, and about 20% had a history of drug injection.¹³⁶ In addition, there are strong links between female sex workers and people who inject drugs; drug use is relatively common among their clients and their permanent sexual partners, also more than 30% of female sex workers are drug users as well. Because of these factors, they are categorised as a core group for HIV transmission in Iran.¹³⁷ Although commercial sex work is illegal in Iran, in recent years, female sex workers might receive special services such as counselling, voluntary HIV tests, care and treatment for sexually transmitted infections, and condoms free of charge in different types of facilities such as drop-in centres, shelters, and harm reduction centres. About 350 centres are managed by different governmental organisations (eg, medical schools, public health sectors, and welfare organisation), and non-governmental organisations mainly in big cities. However, because of stigma and inaccessibility across the country, a substantial amount of female sex workers do not use these services.¹³⁸

In Islam, it is forbidden to drink alcohol; therefore, few studies have been done on alcohol use in Iran and the findings of some of them have not been published. Nevertheless, the 2011 national Iran mental health survey reported that in the previous year 6·3% (11% of men and 1·6% of women) of participants had used alcohol and 2·4% (4·4% of men and 0·4% of women) had a history of binge drinking (at least five drinks in a row).¹²⁶ 1% of the population met the criteria for diagnosis of alcohol use disorders (1·8% of men and 0·1% of women).¹²⁶ Studies in groups of young people have shown that both indicators are higher in men and women (15–64 years), and alcohol use has been much more prevalent than other illicit substances in young people.^{126,139} However, the extent of alcohol use and its associated harms are much lower than in western countries. After recognition of alcohol-related problems, the first national programme to control alcohol use and its problems was designed by the Iran's Ministry of Health and Medical Education and the Interior Ministry.¹⁴⁰

Development of health financing and risk protection

The social health insurance programme in Iran began in 1974, with the main objective of providing health insurance coverage to the whole nation. However, the early years of the programme was marred by inadequate planning and fiscal viability, a problem that has continued to this date.¹⁴¹ Many years later, in 1995, efforts to provide universal health insurance were revived through the passing of a

new legislation. However, the programme had little success in improving access to hospital care through further expansion of insurance. The establishment of a government-funded premium-free rural health insurance was one of the remarkable achievements in expanding access to hospital care for the unemployed.¹⁴²

The Iranian fifth 5-year development plan set multiple targets and goals that were to be achieved by 2015, wherein Iran aimed for a reduction in the share of out-of-pocket payment to 30%.¹⁴³ However, out-of-pocket expenditure for health services reached its highest value in the past decade in 2010 (59%), albeit showing a decreasing trend afterwards and reached to 40% in 2016.¹⁴⁴ A considerable part of the problem of the high proportion of out-of-pocket payment lies in the inadequate increase of governmental health budget in the past decades. Although the health budget has increased 7·5 times from 2002 to 2012, the total health expenditure during the same period has showed increments of nine-times. In this period, there was a 12% growth of public health insurance resources, while the population covered by public insurance increased by 25%.¹⁴⁵ As a result, governmental and public health insurance resources have decreased and there have been no additional resources to control the share of out-of-pocket payment for financing health-care costs.¹⁴⁶ Until 2014, no special action was taken to reduce out-of-pocket payments; however, in that year the Health Transformation Plan (aiming at universal health coverage) was implemented. Besides the insufficient increases in the health budget, the distribution of resources allocated to various sectors of health is also a matter of debate. The share of primary health care is an issue; since the beginning of the 2010s, it was only 12·7% of the health sector's public budget, which was equal to 3% of the total health resources.¹⁴⁵

According to the Health Services Utilisation survey done in 2015, 97% of the population was covered by basic insurance,¹⁴⁷ whereas the household survey done in 2010 was only 83·15%,¹⁴⁸ indicating a substantial improvement resulting from the Health Transformation Plan. However, the narrow spectrum of the diversity of services covered by insurance schemes remains a continuing problem that undermines the population's health.

In Iran, most of the health-care expenditure is spent via hospitals, outpatient service providers, as well as pharmacies and other retailers of medical products (according to the National Health Accounts report of 2009). It is also reported that about 52% costs of services provided by hospitals are paid by households, whereas the contribution of three main public health insurance organisations was estimated to be 21%.¹⁴⁹ However, there is evidence that after implementing the Health Transformation Plan in 2014, the proportion of costs covered by households for services provided by hospitals of Ministry of Health and Medical Education dropped to less than 10%.¹⁴³

Public hospitals mostly include hospitals managed by the Ministry of Health and Medical Education (both

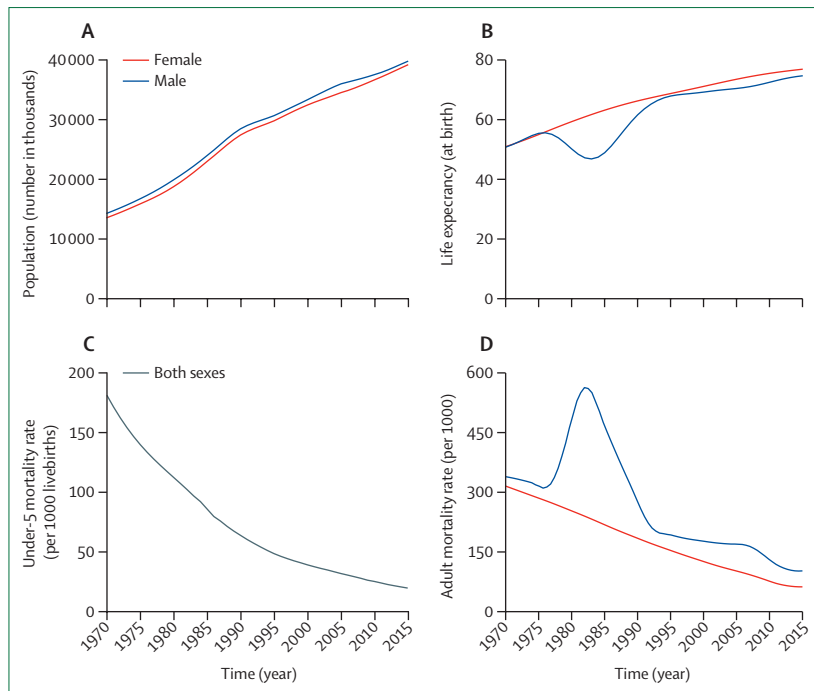


Figure 7: Trends in population size (A), life-expectancy at birth (B), under-5 years' mortality (C), and adult mortality (D) in Iran from 1970 to 2015
Data obtained and adapted from the Global Burden of Disease 2015 Study,¹⁵¹ Mohammadi et al,¹⁵² and the online database of the World Bank.

teaching and non-teaching), Social Security Organization hospitals, and military hospitals. These hospitals are obliged to respect the tariffs for public inpatient services, while 75% of all expenses are paid by public insurance organisations, including the Iran Health Organization and the Social Security Organization (after the Health Transformation Plan, the Ministry of Health and Medical Education pays 15%, while the remaining 10% is paid by the public). In Social Security Organization hospitals, the organisation pays 90% of all inpatient services' expenses for insured individuals. Private hospitals have their own tariffs, which are substantially higher than tariffs for public hospitals, albeit both private and public tariffs are approved by the Supreme Insurance Council. Those who are insured by complementary insurance plans (provided by private insurance organisations) benefit from private inpatient services (all services that are included in the basic package), because they are obliged to pay 10–20% of expenses and the rest are paid by the private insurance organisations.¹⁵⁰

Overall, there are ongoing challenges within Iran's health financing system, including the inadequate share of the public sector in total health expenditures, the low share of primary health care, catastrophic costs, increased treatment costs, the existence of several insurance funds and heterogeneous policies in this regard, as well as differences between tariffs of public and private services.

Health transition during the past century

The population size in Iran has increased by nearly four times over the past 60 years, with an older-age structure and has had decreases in the annual population growth by half during this period (figure 7).^{151,152} The transitional trends of the sociodemographic measures over these years in Iran, in addition to several economic and scientific achievements, have resulted in improvements in health indices (table).^{153,154}

Similar to most other developing countries in the 20th century, communicable diseases were the major causes of death and disability in Iran at that time. For instance, tuberculosis, pneumonia, malaria, and diarrhoea were the main causes of death in Tehran. Malaria, intestinal worms, diarrhoea, typhoid, anthrax, and whooping cough were prevalent in rural areas, where almost three-quarters of the Iranian population lived at the time.¹⁵⁵ However, improvements in socioeconomic conditions, such as better child nutrition, better access to clean water and sanitation, improved heating systems, availability of oral rehydration solutions, and national vaccination programmes helped to reduce the burden of infectious diseases in the next few decades,⁷⁶ and grounded the shift toward non-communicable diseases in the country. Non-communicable diseases are estimated to be the underlying cause of death of more than three-quarters of registered mortalities in 2012, with road traffic injuries leading the list of mortality causes among adolescents and young people. Moreover, ischaemic heart disease and stroke are the primary causes of death among middle-aged and older adults, and studies show that cardiovascular diseases occur at a relatively lower age in Iran than in high-income countries.¹⁵⁶ Mental and behavioural disorders are the second group of diseases causing the highest disability-adjusted life-years and the first group of diseases causing years of life with disability in Iran.¹⁵⁷ Furthermore, illicit drug abuse imposes a large burden among the youth, and opium use is still the most prevalent drug use disorder in adults.¹⁵⁸ Other types of malignancies also cause 12% of all deaths in the country. Breast cancer in women and prostate cancer in men are the two most prevalent types among non-skin cancer sites recorded.¹⁵⁹ Moreover, in response to variations in risk factors over the years, the incidence, prevalence, and mortality of each cancer has been subject to further changes. For example, the mortality of oesophageal cancer, which was among the highest in the 1970s, declined by almost 50%, perhaps as a result of improvements in socioeconomic conditions, reduction in smoking and opium use, and increase in intake of fruits and vegetables.¹⁶⁰

The modifiable risk factors for all groups of non-communicable diseases are mostly dyslipidaemia, high blood pressure, tobacco smoking, as well as being overweight and obesity and their drivers, such as poor diet and physical inactivity.¹⁶¹ Serum total cholesterol has remained fairly stable in the past three decades at

	1990 (95% UIs)	2016 (95% UIs)	2030 (95% UIs)
Death rate due to exposure to forces of nature (per 100 000 population)	13.4 (3.2–23.5)	0.1 (0.0–0.1)	1.9 (0.6–3.2)
Prevalence of stunting in children younger than 5 years (%)	26.1 (21.7–30.3)	7.9 (5.8–10.4)	4.3 (2.9–6.5)
Prevalence of wasting in children younger than 5 years (%)	10.6 (8.9–12.4)	4.8 (3.6–6.4)	4.6 (2.6–7.9)
Prevalence of overweight in children aged 2–4 years (%)	6.5 (2.9–12.3)	19.5 (10.5–32.0)	24.7 (7.6–48.3)
Maternal mortality ratio (maternal deaths per 100 000 livebirths) in women aged 10–54 years	39.9 (26.5–58.4)	13.8 (9.6–19.0)	7.7 (2.8–17.2)
Proportion of births attended by skilled health personnel (%)	88.8 (81.8–93.5)	98.2 (97.0–99.0)	99.1 (97.5–99.8)
Under-5-years' mortality rate (probability of dying before the age of 5 years per 1000 livebirths)	67.4 (57.7–79.0)	17.8 (12.6–24.5)	9.3 (3.4–19.9)
Neonatal mortality rate (probability of dying during the first 28 days of life per 1000 livebirths)	31.0 (26.4–36.1)	10.9 (7.7–15.0)	6.3 (2.3–13.5)
Age-standardised rate of new HIV infections (per 1000 population)	0 (0–0)	0 (0–0)	0 (0–0)
Age-standardised rate of tuberculosis cases (per 100 000 population)	25.0 (22.5–27.7)	20.0 (18.0–22.2)	14.3 (12.6–16.1)
Age-standardised rate of malaria cases (per 1000 population)	13.1 (0–102.0)	0 (0–0)	0 (0–0)
Age-standardised rate of hepatitis B virus infection incidence (per 100 000 population)	2000.9 (1589.8–2483.9)	737.0 (577.5–907.9)	428.7 (327.7–540.9)
Age-standardised prevalence of the sum of 15 neglected tropical diseases (%)	3.0 (2.7–3.3)	2.8 (2.4–3.3)	2.8 (2.3–3.2)
Age-standardised death rate due to cardiovascular disease, cancer, diabetes, and chronic respiratory disease in populations aged 30–70 years (per 100 000 population)	436.2 (367.1–514.8)	346.1 (285.8–410.7)	265.3 (157.4–428.2)
Age-standardised death rate due to self-harm (per 100 000 population)	6.5 (5.1–8.1)	6.0 (4.8–7.4)	5.6 (3.1–9.3)
Risk-weighted prevalence of alcohol consumption, as measured by the summary exposure value for alcohol use (%)	0 (0–0)	0 (0–0)	0 (0–0)
Age-standardised death rate due to road injuries (per 100 000 population)	59.9 (50.3–71.4)	34.8 (29.0–42.3)	18.0 (10.0–30.8)
Proportion of women of reproductive age (15–49 years) who have their need for family planning satisfied with modern methods (%)	55.0 (47.1–62.4)	80.1 (74.4–85.0)	86.3 (76.9–92.6)
Number of livebirths per 1000 women aged 10–14 years and women aged 15–19 years	44.1 (37.4–51.2)	14.4 (6.2–28.8)	7.7 (1.2–25.4)
Coverage of essential health services, as defined by the UHC index consisting of the coverage of nine tracer interventions and risk-standardised death rates from 32 causes amenable to personal health care (scale of 0–100)	55.0 (51.9–57.9)	67.5 (64.0–70.7)	72.8 (69.1–76.2)
Age-standardised death rate attributable to household air pollution and ambient air pollution (per 100 000 population)	88.8 (76.7–103.0)	62.6 (51.2–73.8)	48.9 (39.9–58.5)
Age-standardised death rate attributable to unsafe water, sanitation, and hygiene (WaSH); per 100 000 population	17.0 (9.8–25.7)	1.8 (1.0–3.0)	0.9 (0.4–1.6)
Age-standardised death rate due to unintentional poisonings (per 100 000 population)	6.2 (3.6–9.9)	1.5 (1.2–2.4)	0.7 (0.3–1.5)
Age-standardised prevalence of daily smoking in populations aged 10 years or more (%)	12.1 (10.6–14.0)	11.00 (10.0–12.3)	10.7 (8.3–13.6)
Geometric mean of the coverage of eight vaccines, conditional on inclusion in national vaccine schedules, in target populations (%)	90.1 (87.6–92.0)	99.9 (99.8–99.9)	100.0 (99.9–100.0)
Age-standardised prevalence of women aged 15 years or more who experienced physical or sexual violence by an intimate partner in the past 12 months (%)	44.8 (39.9–49.7)	36.9 (32.7–41.2)	34.0 (29.5–38.8)
Risk-weighted prevalence of populations using unsafe or unimproved water sources, as measured by the summary exposure value for unsafe water (%)	22.5 (17.4–26.1)	9.3 (6.8–11.9)	7.7 (5.6–10.3)
Risk-weighted prevalence of populations using unsafe or unimproved sanitation, as measured by the summary exposure value for unsafe sanitation (%)	40.8 (31.9–49.9)	8.1 (4.0–16.0)	5.1 (2.1–11.2)
Risk-weighted prevalence of populations without access to a handwashing facility, as measured by the summary exposure value for unsafe hygiene (%)	15.6 (14.7–16.5)	13.1 (12.4–13.9)	12.2 (11.6–13.0)
Risk-weighted prevalence of household air pollution, as measured by the summary exposure value for household air pollution (%)	3.1 (1.6–5.4)	0.2 (0.1–0.4)	0.1 (0.0–0.1)
Age-standardised all-cause disability-adjusted life-year rates attributable to occupational risks (per 100 000 population)	900.9 (746.8–1064.4)	692.7 (588.6–802.6)	597.7 (500.8–702.5)
Population-weighted mean levels of fine particulate matter with a diameter of less than 2.5 µm	49.4 (48.9–50.0)	49.0 (48.5–49.4)	43.2 (41.6–46.3)
Age-standardised death rate due to interpersonal violence (per 100 000 population)	2.6 (1.6–3.5)	2.0 (1.4–2.6)	1.2 (0.6–2.1)
Death rate due to conflict and terrorism (per 100 000 population)	0 (0–0)	0.1 (0.0–0.2)	0.1 (0.1–1)
Age-standardised prevalence of physical or sexual violence experienced by populations in the past 12 months (%)	12.7 (11.2–14.4)	8.9 (7.8–10.0)	8.1 (7.1–9.2)
Age-standardised prevalence of women and men aged 18–29 years who experienced sexual violence by age 18 years (%)	7.2 (5.5–9.2)	7.3 (5.5–9.4)	7.4 (5.5–9.6)
Well certified deaths by a vital registration system among a country's total population (%)	15.8 (7.1–29.0)	64.2 (51.4–76.3)	76.4 (50.0–91.8)

Data extracted and adapted from Fullman et al.¹⁵⁴ UHC=universal health coverage. UIs=uncertainty intervals.

Table: Status of selected health measures in Iran between 1990 and 2016, and propagation to 2030¹⁵³

about 5·0 mmol/L,¹⁶² and systolic blood pressure has declined by 3 mm Hg in women and 5 mm Hg in men.¹⁶³ Data from the last round of the National Non-Communicable Disease Survey done in 2011 shows that 20% of men and women are hypertensive. During the past four decades, the prevalence of adult obesity has increased from 13% to 30% in women and from 4% to 17% in men,¹⁶⁴ and this increase might be a major driver of the doubling of diabetes prevalence since 1980 from around 5% to 10%.¹⁶⁵ The substantial increase in the prevalence of overweightness and obesity and its high prevalence (15%) among adolescents¹⁶⁶ might soon lead to larger increases in diabetes and dyslipidaemia and a reversal in the declining trends of blood pressure.¹⁶⁷ Results of a cohort study in Tehran indicated a high incidence of prediabetes and prehypertension among its population, which might lead to subsequent increases in the incidence of diabetes and hypertension in the next decade.^{168,169} The prevalence of tobacco smoking, which is much more common in men than in women, has slightly declined in the past decade, possibly due to the enactment of smoking ban laws and introduction of taxes.¹⁷⁰ Nevertheless, the prevalence of smoking remains relatively high among men, at 24% compared with 2% in women.¹⁷⁰ The other uses of tobacco, including hookah, is a concern among adolescents, young people, and women. Another specific risk factor of major impact in urban areas is urban air pollution. For instance, in Tehran, the concentration of particulate matter pollutants is deemed unhealthy during 100–200 days a year.¹⁷¹

More recent statistics indicate that between 2000 and 2015, the top ten leading causes of death remained fairly stable among all age groups in men and women, with a few exceptions. However, this stagnant ranking masks impressive reductions in mortality from avoidable causes of death, such as breast and stomach cancers, ischaemic heart disease, stroke, rheumatic heart disease, and injuries, which declined substantially between 2000 and 2015.

Call to action

Since the establishment of the Iranian constitution in 1910, provision of primary health-care services has always been an obligation of the state and all citizens have been entitled to benefit from free-of-charge primary health services.³⁹ During the past century, the Iranian health system has earned important achievements in terms of provision of health services with particular success in controlling infectious diseases and decreasing child and adult mortality.¹⁷² Given the political instability, war, sanctions, and natural disasters affecting the country during this period, the contemporary achievements of the health system can be considered monumental. It is important to note, however, that these great achievements have been obtained through scattered and ad-hoc efforts of different governments and policy makers during the

past decades, which have culminated and resulted in this impressive success.

Considering the invaluable wealth of experience, great advancements can be anticipated henceforth in the health sector and research industry (even though the USA sanctions came back in 2018). Although great advancements have been achieved in Iran in different fields of health-care provision during the past 30 years, substantial challenges still remain to be addressed. Non-communicable diseases remain rampant in Iran (similar to many countries in the region) and their prevalence is predicted to substantially increase because of the ageing population, urbanisation, and sedentary lifestyle. In this regard, a national collaborative initiative has been launched under the auspices of the Ministry of Health and Medical Education, involving several ministries as well as the parliament to combat non-communicable diseases from different social, health, and cultural fronts. This initiative will distribute the responsibility of confronting non-communicable diseases among different sectors of the government. Accordingly, with the main objective of confronting risk factors as well as exposures of non-communicable diseases and their health consequences, the Government has rectified the National Action Plan to Prevent and Control Non-communicable Diseases, which includes several national programmes and reforms for implementation across the country.¹⁷³ Some of these programmes and reforms are introducing tax on cigarette and other tobacco products as well as on calorie-dense food and sugar-sweetened beverages, adopting measures to promote physical activity among the population, fortification of processed food with fibre, and change in regulations of food industries to reduce free fatty acid, sugar, and salt in processed foods.

In this Review, we discussed how the primary health-care system of Iran succeeded to control infectious diseases through the extensive primary care network and health houses across the country. This robust infrastructure is now to be strengthened and used to combat non-communicable diseases, which are the new threat confronting the nation.¹¹⁸ Iran's primary health-care network has great potentials to reach a substantial proportion of the Iranian population, and thereby to provide good coverage in terms of delivering a wide range of community-based interventions for the prevention, screening, and treatment of non-communicable diseases. Moreover, implementation of the family physician programme in both urban and rural areas is expected to be a giant leap towards the provision of universal health coverage for the nation. Moreover, this system can focus all government investments in a harmonised and synergistic manner to use human resources and funding more efficiently. Financial risk protection measures remain a growing health system concern, because of highly prevalent non-communicable diseases, population ageing, induced demand, and poor quality of care, and

need to be addressed urgently considering Iran's fragile health insurance system and extremely constrained health finance. However, changes in health-care provision, including the family physician (as a gatekeeper) and home care, improving quality of care, and enforcing national guidelines are major foci of interventions for improving financial risk protection measures. Quality of care, medical errors, and induced demand are weaknesses of health-care provision in Iran's health system, which need urgent responses to enable the health system to combat non-communicable diseases effectively. Use of quality indicators, installing a health information system to report medical errors and patient experiences in receiving health care (eg, the Customer Assessment of Healthcare Provider Surveillance in the health system), and setting effective rules and regulations to enforce national guidelines are effective interventions that can improve health-care quality.

In terms of medical education and research if the sanctions remained lifted, Iran has detailed plans in place to design and implement national and international collaborative research projects to improve the quality of education, minimise redundancy, and promote the quality of research done in the country. The Iranian medical research budget, provided by the government sector and distributed by Ministry of Health and Medical Education, which has recently increased considerably, can be boosted and more efficiently distributed through well designed collaborative networks and projects.

Finally, the effective tackling of non-communicable diseases is possible if Iran would be able to manage a sustainable environment. Energy and greenhouse gases are affecting climate change measures and could lead to devastating outcomes on the control and prevention of non-communicable diseases.¹⁷⁴ Furthermore, air pollution originating from fossil fuel or dust storms have tremendous direct effects on chronic obstructive pulmonary disease, cardiovascular diseases, cancer, and vitamin D deficiency.^{175,176} A syndetic approach must be adopted, which includes, intersectoral collaborations involving communities, improving awareness among individuals, and enhancing health-care provision on early detection and effective treatment.

Contributors

GD, FF, RK, AR, OMR, ME, HRJ, BL, RMaj, and RMal were involved with the study conception and design. FF, RH, and FP were responsible for coordinating comments and feedback from all coauthors during the drafting of the manuscript. All authors reviewed and approved the final manuscript.

Declaration of interests

AAH reports that he has a managerial position at the Iranian Ministry of Health, as the Deputy Minister for Planning and Coordination. KM, outside this work, served as a Deputy Vice President of Iran in his position as the Deputy Head of Iran's Department of Environment from 2017 to 2018. His role was irrelevant to this research—ie, contribution to this paper was before taking the governmental appointment and he was not involved in the research while serving on the Government. KR received grants from the National Institute for Health Research Oxford Biomedical Research Centre, grants from Oxford Martin School,

University of Oxford, and grants from the Economic and Social Research Council (grant number: ES/P011055/1), during the conduct of the study. ME received grants from AstraZeneca Young Health Programme and personal fees from SCOR, Third Bridge, and Prudential, outside the submitted work. BL, outside this work, serves as the Vice Minister of Medical Education in the Iranian Ministry of Health in addition to Director-General and Chief Scientific Officer at the Endocrinology and Metabolism Research Institute. BL is also president and a stakeholder of a private clinic; and has served as the former head of Tehran University of Medical Sciences. RMal served as Vice Minister of Research in the Iranian Ministry of Health for 8 years and previously served as Minister of Health for 3 years. He is also a stakeholder of a private hospital and a clinic. All other authors declare no competing interests.

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