Iran in Transition

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Summary

Being the second-largest country in the Middle East, Iran has a long history of civilization during which it has witnessed the overthrowing and establishment of several dynasties and reorganization of health-related structures. It has witnessed 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, and epidemics of multiple communicable diseases and the shift toward 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; a country with a population exceeding 79 million, mainly inhabiting urban regions, and experiencing an increasing burden of non-communicable diseases, including cardiovascular diseases, hypertension, diabetes, malignancies, mental disorders, substance abuse, and road injuries.

Key messages

- Iran is experiencing a transitional period; its population is pacing toward aging, risk factors contributing to diseases are changing, and infectious diseases and the burden they impose on the healthcare 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 urbanization, 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 cares, and weak inter-sectoral partnership to overcome these issues should be the priorities of any framework addressing future health challenges in Iran.

Introduction

Iran is a Middle Eastern Country which has been governed as an Islamic Republic since 1979. However, based on archaeological findings, the history of civilization in the Iranian Plateau dates back to more than 5,000 years ago,[1] and the establishment of a sovereign state in Iran has a history of approximately 3,000 years. During this lengthy past, similar to many other ancient civilizations, many great scientists and physicians have emerged from Iran who played a great role in expanding medical knowledge, which was inextricably intertwined with mathematics, philosophy, and theology in the old ages. Some such physician-philosophers played 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 may be attributed to several factors, such as, the significance of learning and propagation of science in Iran, both before and after the Islamic conquest of the country in the 7th century A.D., and its geographical proximity to ancient Greece, India, China, and the cradle of the Islamic Empire, as well as being located on the Silk road, which grounded 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 paper, we will discuss the health system and the health status in Iran from ancient times and describe its challenges at the time. We will introduce world-renowned Iranian scientists, such as Avicenna and Rhazes, and highlight their prominent achievements and contributions to the global advancement of science and medicine, and review the socio-political events in Iran's history that have affected the healthcare system in the country.(Panel 1) Later, having provided a vivid picture of the political context of Iran in the past century, we will focus on the development of science, medicine, healthcare, and public health by introducing a solid background that provides

the opportunity to have an in-depth review of the current situation of the health system and its relevant components. The contemporary history is specifically marked with remarkable achievements in the control of major communicable diseases, the establishment of health institutes, establishment of a competent primary healthcare (PHC) system in rural areas, expansion of hospitals and secondary care centers, and development of health financing programs in Iran, along with impressive achievements in the improvement of health outcomes and addressing extensive nationwide inequity in healthcare provision, particularly in the rural areas. We further review emerging environmental challenges and their potential effects on the health status of Iran. Following these narrations, we will discuss major challenges related to epidemiological changes in our country; emergence of non-communicable diseases (NCDs) and the increasing burden of the mental health disorders.

Based on the image this paper provides from the current status of health in Iran, we further highlight the challenges and hurdles that our health system deals with, outline the actions and policies required to address these obstacles, and present a framework of activities to engage the community, health authorities, as well as other sectors to maintain the sustainable development in health.

Iran in brief

Iran is one of the ancient civilizations (historically known as Persia) that has had a relatively continuous existence as a sovereign state over the millennia. According to Herodotus, Deioces established the first Iranian government in Ecbatana (contemporary Hamadan and Biblical Acmeta) in the 7th century B.C. through forging unity among different local tribes.[4] The contemporary Iran has an area of 1,648,195 km^2 (636,372 sq. mi), occupying most of the Iranian Plateau in south west Asia, and has a population of about 79 million (based on the 2015 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 percentage increased from less than 30% to slightly more than 70% due to widespread rural to urban migration and the new classification of rural centers as towns. The capital, Tehran, now holds over 8 million people in the city and over 16 million in the wider metropolitan area, making it one of the world's largest megacities. Other major cities such as Mashhad, Karaj, and Isfahan have populations of over 2 million.

Iran is an ethnically diverse country, and is categorized as a higher-middle income country by the World Bank, with a Gross Domestic Product (GDP) exceeding $393.4 billion in 2015, and a GDP per capita of approximately $4,958.[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 Balouchi. Twelver Shia Islam is the official religion of Iran and over 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 categorized as part of the Middle East and is the third largest (after Saudi Arabia and Sudan) and the third most

populous (after Pakistan and Egypt) country in the region. The political system in Iran is constitutional Islamic republic and the Supreme Leader (elected by the Assembly of Experts) is the head of the state and supervises three separate arms of powers, namely, the Executive, Legislative, and the Judicial systems. The President (who leads the cabinet), Members of the Parliament, and City Councilors are all elected by popular votes every four 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. It should be noted that Iran is the first country in the Middle East to have established parliamentary rule between 1905 and 1907.[7]

Within the past century, Iran has witnessed important political changes; foundation of the first parliament and establishment of a constitutional monarchy after the Constitutional Revolution during the Qajar Dynasty (1905-1907), 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 favor of his son Mohammad-Reza Shah (1941), nationalization of the Anglo-Iranian Oil Company (1951) (Figure 1) 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 (1980-1988), all of which have influenced the socioeconomic status of the nation, and consequently, affected the health of the population in different manners. Moreover, following the Islamic Revolution in 1979, the United States, the European Union, and the United Nations Security Council imposed several economic and political sanctions against the country and people. With their highest intensity being in action between 2010-2013, the sanctions tempered Iran's access to global market, including the medications and medical equipment trade-off. However, several of these sanction was lifted in 2016, following Iran and P5+1 (the permanent members of

the United Nations Security Council in addition to Germany) agreement on the Joint Comprehensive Plan of Action (JCPOA, also known as Iran nuclear deal), in which Iran accepted multiple limitations on its nuclear program. Although the Iran economic status was improving following JCPOA implementation, the United States withdrew from the agreement and started to re-institute the sanctions in 2018.

In Iran, the public sector (the government) dominates the economy and contributes to a major share of the GDP.[8] The state is mainly responsible for nationwide provision of healthcare and social services, including retirement, redundancy, disability, accidents, and calamities[9] (although non-governmental organizations, (NGOs) play a significant role in the management of 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 healthcare and social security provision.[4]

Public free-of-charge schools are wide-spread all across the country, with a remarkable (over 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. Over the past decades (from 1955 to 2015), the literacy rates of females and males have risen from 10% and 30% to more than 84% and 91% percent, respectively. However, secondary school attendance was almost 75% in 2015, which illustrates a lag in education.[6] Moreover, the most prestigious universities of the country are publicly funded and provide tuition-free education to their pupils,[11] and the number of university students has risen dramatically over the past decade from 312,076 in 1990 (226,751 men and 85,325 women) to 4,073,827 in 2016 (2,202,231 men and 1,871,596 women).[12]

In the year 2011 in Iran, the unemployment rate for men was 10.9% and for and for women was 18.6% (as a percent of the total labor force). Moreover, the highest unemployment rate for youths was documented among university graduates including 29% for men and 48% for women.[13] The high percentage of unemployment among the youth might be one of the main reasons that have made them susceptible to various risky and unhealthy behaviors, as well as outmigration of educated youth.

Iranian women played a significant role in establishing parliamentary rule and their contributions in this rule, as well as several other socio-political, cultural, economic, and scientific achievements in the following years, resulted in the ratification of women's rights, including suffrage, later in 1962. Islamic teachings as well as other broad social and cultural preferences on the obligation of seeking knowledge, in addition to educational opportunities for females in Iran encouraged them to pursue formal education. Figure 2 demonstrates the rapid growth in tertiary education, with special focus on females. Although there was an increasing trend of education among women in the past decades, the labor force participation did not change considerably. Due to cultural and religious norms of family formation and child rearing as important roles, women have faced limitations in participating in the formal labor market. Therefore, the enormous rise in the educational status of the female population has not interpreted into comparable gains in terms of economic productivity.

Development of healthcare and medicine in ancient Iran and the middle ages

Iran is one of the oldest civilizations of the world and its history of medicine and public health interventions date back to ancient times. Medical and healthcare practices and rituals have been recorded in ancient Iranian texts, such as Avesta (the holy book of the Zoroastrian religion and an old Iranian encyclopedia dating to the 5th century B.C.).[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 practiced through three different approaches, including surgery, herbal medicine, and treatment with incantations. Moreover, there were strict warnings 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 demonstrate 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.

In addition to the aforementioned surviving texts, several archaeological findings have provided solid evidence for ancient medical practices and procedures in Iran. Body remains of a young girl who had undergone skull surgery for treatment of hydrocephalus about 4,800 years ago in 'Shahr-

i-Sokhta' (Burned City), for instance, demonstrate the long history of surgical interventions in the country (Figure 3).[16] Furthermore, different pieces of medical instruments, such as a bronze pipe and a forceps belonging to 700-600 B.C. 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 third century A.D. (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 (aka Panchatantra), an ancient Indian literary masterpiece.[18] The latter book was perceived important in teaching the principles of politics to young princes, Panchatantra, and was securely guarded in the Indian treasury and was brought to Iran by Borzuya, a court physician.[19] Gundeshapur and its legacy clearly demonstrate the rich culture of sponsoring and promoting medicine in the third-century pre-Islamic Iran.

Following the Islamic conquest of Iran (mid-7th century A.D.), Gundeshapur gradually descended into oblivion. However, with the ascendance of the Abbasid Caliphate in 750 A.D., the Islamic world entered a '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 all 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 A.D.), the author of 'Al Hawi' or 'Liber Continents',[3] Ali ibn al-'Abbas al-Majusi (930-994 A.D.) known in the west as Haly Abbas,[22] and Avicenna (980-1037 A.D.), 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 three different categories, namely solids, liquids and gases, and subdivided naturally occurring matter into animals, vegetables, and minerals.[24] He is widely recognized 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 experimentations 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 date.[25]

Avicenna's writings played 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

the West (Figure 4).[26] This book, which was authored based on 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, namely 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 the West). In the middle Ages, when Europeans came into contact with the Islamic civilization, 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 which continues to the 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 determinant of health in recent history

During the past two centuries, Iran has gone through many different socio-political events, which has affected the health status of the nation (Figure 5). At the start of the 19th century, Iran's population was around five million, which increased to about nine million by early 1900s, and the majority 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 peasants. During those years, similar to other countries in the region, life expectancy was low in Iran, child mortality was as high as 50 percent,[33] and the population suffered from repeated bouts of epidemics such as typhus, smallpox, cholera, measles, plague, tuberculosis, trachoma, and malaria.[34] Moreover, the underdeveloped transportation system and weak infrastructure made the whole region vulnerable to low domestic food production which intermittently occurred through loss of manpower due to war.[35] As a result, a number of severe famines struck the country in that period, notably the one in 1870-1871, which took the lives of an estimated 10% of the population[36], and another which broke out during World War I (1917-1919).[37] In fact, during that era, following the dismantling of the Ottoman empire in 1918-1923, the whole region which has always been vulnerable to droughts due to irregular precipitation, was sucked into 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 1848-1896 but the prime minister was assassinated in 1852).[38] He introduced several major reforms,

including license requirement for practicing 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 neighboring 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 of a region suffering 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 over 200,000, which increased to half a million by 1940. In those years, infectious diseases, such as malaria were rampant across the country, and women, in particular, suffered from ill health due to malnutrition, early marriage, and repeated pregnancies, which predisposed them to high maternal mortality and morbidity rates. Diarrhea was a major cause of infant mortality due to poor sanitation and lack of 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 that same year, through World War II, 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; 1 out of 3 children died before the age of five and life expectancy at birth was less than 50 years. Fertility rate was one of the highest in the world (Figure 6) and access to healthcare 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. Soon after that, in 1980, Iraqi military forces, under the command of Saddam Hussein, the President of Iraq at the time, invaded Iran and the eight-year Iran-Iraq (1980-1988) war broke out. During that period, the country suffered from lack of resources due to war, plummeting oil prices and economic sanctions.[43] Most importantly, this eight-year war imposed a great psychological burden on the young generation in Iran, which continues to be a health-issue up to date. With their highest intensity being between 2010 and 2013, during the three past decades, an unprecedented set of economic sanctions were imposed on the country which significantly constrained the availability of medicines and medical equipment in Iran.[44] Although, some of these sanctions were lifted following implementation of JCPOA in 2016, recent action of the Unlisted States to withdraw from the agreement and re-institute the sanctions, raises the concerns that the health system of the country will face shortage of medicines and medical equipment in near future.

Furthermore, during recent decades, the Iranian population has suffered from 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.[45]

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 (1950-1979). Although Iran's relatively high fertility rate plummeted from 6.5 births per woman to 1.72 due to a successful family planning campaign between 1985 and 2016, the population stood at 80 million in 2016 (Panel 10),[46] 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 holds over 16 million inhabitants and is followed by the major cities of Mashhad, Karaj and Isfahan, with populations of over 2 million each. The growth of the urban population has resulted in mismatches between the required and existing housing and physical infrastructure; this mismatch 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 one quarter of the average annual renewable water per capita globally (7,000m^3). With an average annual precipitation less than one third of the global average, over 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.[47] Iranians have established a thriving civilization 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.[48] 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.[49] They complimented the technical innovations with effective regulatory statures to meter and allocate water and resolve conflicts. Since 1960s, however, the traditional harvesting techniques lost their charm with the introduction of modern water supply techniques, including pumping technologies and deep wells, inter-basin transfers, and large dams.[48]

After the 1979 revolution, war and sanctions made food security a top priority for the country. However, this sector still suffers from (I) outdated farming practices, (II) low economic productivity (below 35% irrigation efficiency), (III) a mismatch between crop patterns and water availability, and (IV) aging population of farmers because of youngsters' incentives to migrate to cities. Iranian authorities prioritized building water storage and transfer structures, an unsustainable water withdrawal approach - which has led to drying lakes and rivers, groundwater decline[50] and lower quality drinking water.[51] Therefore, re-examining the current agricultural policies is a priority.

Around 92% of Iran's water supply is allocated to agriculture. Because of improper investments, the agricultural sector heavily relies on irrigation, despite a modest contribution to the country's GDP (~10%).[47] 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 considered to be clean and of good taste for drinking. Almost all the 70% of Iran's urban population have access to piped water. However, rural areas experience lower sanitation levels and increased risk of waterborne diseases due to an average 73% of piped water coverage. The industrial water consumption share is relatively small (2%) compared to developed countries. 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 (GNP) was derived from transportation or communication activities.[52] Transport facilities are mostly owned and managed by the government. In 2010, nearly one 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% and 13% of transportation and total energy consumption, respectively.[53] Contrary to a sustainable transportation perspective, the dominant mode of transport is passenger cars -consuming 95% of energy in this sector, while the rail system plays a minor role in freight and passenger transport.

Car ownership has increased from 70 in 2000 to 210 per 1,000 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.[53] However, the increase in the number of vehicles is the main cause of congestion and air pollution in major cities.

Traffic congestion as a result of rapid urbanization, poses major environmental, economic, and social problems. The 2015 Numbeo Traffic Index ranked Tehran as the seventh most congested city in the world.[54] Average travel-related costs have increased by 15% between 2004 and 2010 -a continuing trend due to the increase in the number of vehicles.[53] Consuming 3.6 billion liters of gasoline in 2010, Tehran's surface transportation alone has an astonishing high share of 15% of the national fuel consumption.[55]

In addition to income levels, regulations, vehicle fees, land-use patterns and the quality of public transport can constrain urban personal vehicle use.[56] Iran has a relatively cheap public transportation, with much lower than global rates, as low as $0.10/trip for the metro. Notably, similar to very few cities, Tehran has a congestion charging scheme with the potential to incentivize the use of alternative modes aimed at congestion/environmental mitigation.

As of 2010, private vehicle uses of 50% in Tehran and above 40% in other major cities [53] are comparable to high-income cities with strong public transport like London, but higher than many developing countries' cities.[54] 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/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.[57]

Development of formal structures for the health system in Iran

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 organizing 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 organizations changed and the 'Ministry of Health' was founded, separating medical affairs and public health issues from charity activities.[42] Subsequently, from 1941 to 1979, thirty 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, 5 presidents came to power (excluding the two first short-lived governments), each trying to improve different parts of the healthcare system in Iran (Table 1).

In 1975, the 'Ministry of Health and Welfare' was formed by merging two Ministries of Health and Social Welfare,[58] with the idea of implementing a more coordinated approach toward medical education and healthcare provision in the country.[59] 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 recognized as stand-alone universities under the supervision of this newly-formed ministry.[60] 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 all across the nation.[61] Since the establishment of this ministry, all decisions regarding healthcare 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 healthcare provision (which is considered as a unique structural reform in human health resource training) continues to this date. Although some experts believe that the establishment of Ministry of Health and Medical Education has resulted in increases in the number of graduates and improved the quality of their training,[58] 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.[62] 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 healthcare in Iran over these years dramatically.[63] 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 healthcare delivery into the universities has not been fully achieved.[64]

Development of medical knowledge and education in Iran

Although traditional medicine was taught in religious education centers (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 7). Prior to 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.[65] By 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 1,100 medical school graduates, many of whom continued their education abroad, and upon 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 Maddreseh-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.[66] Moreover, considering the tuition-free nature of the public medical education system, prosperous job prospects, and the traditional prestige which has always been heir to education in Iran, medicine has always been a popular choice for students from all strata of the Iranian society and admission to medical schools and residency programs 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.[67] 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,[68] and 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 healthcare 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.[69]

The Islamic Revolution in 1979 and Iraq's invasion of Iran in 1980 coincided with a severe shortage of healthcare professionals, which was further exacerbated by emigration of Iranian physicians to Western countries.[58] Though by 1980, 10 more medical schools had been established in the country, the significant expansion of medical education only occurred in 1985 following the establishment of the joint Ministry of Health and Medical Education.[70] This expansion has continued to the present day and peaked significantly during the last two decades with over 50 publicly-funded medical schools and numerous private ones in 2017.[71] Each year, more than 7,000 medical, pharmacy, and dental students are trained at medical universities all across the country. Furthermore, Iranian research practice has progressed in recent years, making Iran one of the leading countries in science production in the region (Panel 2).

Development of public health in Iran and infectious disease control strategies

Development of public health in Iran was mainly focused on infectious diseases control, and only recently have actions been directed towards addressing the increasing burden of NCDs (Figure 8). In the mid-nineteenth 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').[72] Later in 1942, the parliament approved the general and mandatory vaccination program as free of charge.[73] 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. Later, in 1961, the Razavi Leprosy Rehabilitation Center was formed in Khorasan Province.[74, 75]

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. Later, 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.[76] In 1923, immunization against communicable diseases was still limited to smallpox, while 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 (more than 90% coverage) were only attained in the mid-80s, when the Iranian PHC network was established. In the first decade of the 20th century, free anti-diphtheria vaccines were provided by the Pasteur Institute of Paris.[77] Funding was provided for the production of smallpox vaccine and the anti-diphtheria serum. After World War II, 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,[72] simultaneously with India and approximately 25 years after its eradication in north America, Europe, and Oceania.[78] 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.[79] Considering the lack 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, which was ultimately eradicated in the mid-70s.[80]

Prior to the commencement of the malaria-prevention program, 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.[81] At this stage, in 1952, the government's response was to design and implement several national eradication programs for

malaria control,[82] and in this year, the Institute of Malariology and Parasitology was founded at the University of Tehran. Conducting research on different aspects of malaria and provision of training to the public health personnel were the main activities of this institute.[82] The first Malaria Eradication Program was initiated during this decade and managed to reduce malaria transmission in the northern parts of the country by the early 1980s, though the disease remained endemic in the southern provinces. In 1980, a new Malaria Control Program was designed and implemented which is still in progress. Analysis of data indicates that the incidence of malaria has declined substantially from 271 in 1966 to 2 cases per 100,000 in 2013. The decline in disease incidence was interrupted during the 1980s due to the Iran-Iraq war, but strengthening the controlling programs 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.

The Pasteur Institute of Iran also played a major role in tuberculosis management by producing the Bacillus Calmette-Guérin (BCG) vaccines.[83] The efforts of the Pasteur Institute came into effect with the launch of the National Tuberculosis Surveillance program; one of the main activities of the PHC network including treatment protocols that adopted the Directly Observed Treatment Short-Course (DOTS) strategy.[84] Improved socioeconomic conditions, better detection, and treatment of cases have reduced the incidence 10-fold 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 and 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, declined dramatically due to health promotion and safe water supply.[85]

Efforts to prevent polio in Iran preceded the announcement of the global goal of eradicating the disease. Routine immunization has been mandatory since 1984. and since 2002, routine administration of oral vaccine has reached and maintained full coverage.[86] In 1977, there were 231 confirmed cases, whereas, despite numerous cases reported in Pakistan, there has been no reports of new cases in Iran since 2001. From then on, a national surveillance system for acute flaccid paralysis has been established and supplementary immunization campaigns are conducted for children in the southeastern part of the country that borders Pakistan.[87]

As a result of these interventions and socioeconomic development of the country, most major diseases caused by poverty and poor sanitation in the 50s started to diminish across the country. The disease pattern shifted from a dominance of infectious diseases in the 1950s-1970s to the present status of overwhelming prevalence of NCDs. Moreover, in recent years several successful public health programs were launched, including the national thalassemia prevention program (Panel 3), iodine deficiency control (Panel 4), organ transplantation policies (Panel 5), and advances in the pharmaceutical industry (Panel 6), and the establishment of the National Iranian Blood Transfusion Organization.[88]

Development of the primary healthcare network in Iran

During the past century, Iran has attained remarkable achievements in addressing nationwide inequity and the provision of primary health services to its rural areas. As discussed, remote and rural areas have always suffered from a severe shortage of health professionals and their reluctance to work in regional areas. In 1950, the Regional Director of the World Health Organization's Eastern Mediterranean Regional Office estimated that in Iran, there was only 1 physician per 60,000 of the population,[89]. In fact, 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 healthcare provision was the training of junior health professionals called 'Behdar' in 1940 in Iran.[90] They were trained for four years at a graduate level (instead of seven years required for physicians), and were licensed to practice in rural areas.[69] This program achieved little success, and 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 two years in rural and remote areas, an initiative known at the time as 'Sepah Behdasht' (Health Corps).[91] 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.[69] 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.[91]

In 1970, analysis of the outcomes demonstrated that despite all efforts to persuade doctors to work in disadvantaged areas, the doctor to patient ratios ranged from 1 per 200 to 1 per 100,000 population depending on the region (average 1 per 3,750).[69] Such disappointing results clearly demonstrated the overwhelming need for development of a national network of trained and supervised community-based health-workers for provision of PHC services in rural areas.[92] Consequently, a few pilot networks of rural health-workers were formed in 1972 in four provinces of Iran.[93] By the late 70s, although some encouraging achievements in terms of improvement of health outcomes were reported in some catchment areas,[94] lack of a 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 program and managed to secure funding for establishment of a nationwide PHC network.[93]

In this program, 'Health Houses' were established in rural areas all 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 program 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 two years by Behvarz Training Centers 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 (DOTS for tuberculosis, diabetes, and hypertension), screening (malaria, diabetes, and hypertension), family health - including child and

maternal care, reproductive health, vaccinations, and mental health services.[95] Moreover, Behvarzes are provided with well-defined protocols, enabling them to prescribe 46 medicines, mostly antibiotics, vitamins, contraceptives, and oral rehydration solutions (ORS) available in the health houses without the need for physician prescriptions.[96] A Behvarz works in a health house to provide services to 1,000 - 1,500 of the rural population,[97] and is responsible for referring patients of her or his catchment areas, if need be, to the Rural Health Center where a family physician provides services.[96] With changes and improvement of the PHC network over time, several other members joined the PHC team, including midwives, experts on disease control, environmental health, and family health. These members work in rural health centers to manage and supervise three to five health houses and visit all referred patients from the catchment areas. The launching of this program was associated with substantial achievements in a short period of time, and from 1984 onwards, maternal and child health have significantly improved, the rates of mortality for both children and adults have significantly decreased, and the gap in health-service provision (both coverage and health indicators) in urban and rural areas of the country have markedly narrowed.[98]

Even though the PHC program 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 PHC system in the rural areas only partially addresses the healthcare needs of a minority of the population, missing inhabitants of urban settings. In a similar effort in urban areas, PHC facilities (health posts) provide primary health services (including maternal and child care, family planning, school healthcare, 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 PHC network has come short of addressing these newly-emerging issues (Panel 7 and 8). The challenge following referrals outside the PHC system remains unresolved. The referral system works perfectly in the PHC system and between the Behvarz and the family physician, but fails when a family physician refers a patient to a tertiary healthcare facility. Fragmentation of the administration of services and categorizing it into PHC, 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.[99] Moreover, in light of the widespread urbanization, the aging population, and increase in the prevalence of NCDs, this network is faced with the contemporary challenges that NCDs are posing on the nation.

Improving access to secondary and hospital care in Iran

Hospitals have a long history in Iran, where medical services of the time were offered to patients requiring hospitalization.[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 played a prominent role in the propagation of Western knowledge of medicine across Iran, especially in major cities.[100] However, in the early years, expansion of hospital beds was sluggish and hospitals were seldom built in small towns.[101] 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. In 1942, three additional major hospitals were established, and in 1950 the number of public hospital beds reached approximately 700 in Tehran (in large teaching hospitals), and about 2,000 in the rest of the country (distributed among 80 small hospitals).[81] The 'Pahlavi hospital' referred to as the '1000-bed hospital' (a name which seems to represent the number of intended beds), and currently known as the 'Imam Khomeini Hospital Complex' was officially founded in 1946 and is currently 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.[69] Apart from the limited number of beds in major teaching hospitals, all services were provided free of charge. By the early 70s 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 have vastly expanded

in Iran after 1990, covering a wide range of health services. Based on recent statistics, inpatient services are provided by more than 920 hospitals,[102] 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 1,000 among the Iranian population.[103] 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.[103] Although some hospital regionalization plans have been implemented, the unequal distribution of hospital beds in remote and regional areas still remains a problem. There is evidence indicating that hospital bed density in different provinces have varied in the past decade.[103] Moreover, bed occupation rate and average length of stay have had increasing and decreasing trends, respectively, during the past 20 years in Iran.[104] Comparable geographical variations in these two metrics among different provinces have been reported too.[105]

There is a huge gap in quality of care in hospitals both in public and private sectors, which has led to poor outcomes of healthcare delivery. The cancer survival rate in Iran is lower than European and several Asian countries [106] and mortality rates in intensive care units (ICU) are approximately twice as high as in the US.[107] The poor outcomes of healthcare 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 high-income countries.[108] The other contributor to poor outcomes of healthcare is the induced demand. There are evidences showing that 47% of patients with low back pain who were referred to imaging centers had no magnetic resonance imaging (MRI) indications,[109] 37% of cases referred for computed tomography (CT) scan due to mild head trauma didn't have the required indications,[110] and 27%

of angiographies in a teaching hospital didn't meet the necessary indications for undergoing angiography.[111]

In outpatient services, currently more than 80% of services in urban areas are provided by the private sector.[59] Patients, both insured and uninsured, can choose their healthcare providers and also, they can directly visit public or private practitioners, specialists, or sub-specialists.[112] The aforementioned healthcare system in rural and urban areas differentiates healthcare utilization among urban and rural populations; among rural populations more services are delivered by the general practitioner and PHC, whereas among the urban population, specialist and sub-specialist service utilization are more common.[113] Based on literature, the family physician program has reduced the number of visits to pharmacies in rural areas,[114] while the mean level of medicine consumption among the Iranian population is higher than other middle-income countries.[115]

Similar to hospital care delivery in Iran, outpatient services have some inadequacies in their delivery. For instance, in 2011, 20% of women and 28% of men with diabetes remained undiagnosed, and 40% and 49% of diagnosed diabetic women and men 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 <10% of the diagnosed cases were appropriately controlled. The higher chance of diagnosis for diabetes compared with hypertension may be due to better and earlier integration of diabetes diagnosis protocols into the community healthcare workers' (Behvarzes) training program which occurred during 1996-2002.[116]

Mental disorders and developments in mental healthcare

Before the 1940s, mental health services were characterized 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.[117] 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 PHC 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 (1980-1988). Studies showed a high prevalence of mental disorders and a low capacity to respond, especially in rural areas. In 1986, the first 'National Program on Mental Health' was developed in Iran. The objectives of the program were, to make essential mental healthcare services available to the public, with a special emphasis on the underprivileged, deprived, and at risk populations. In line with its objectives and strategies, and following the motto of 'mental health for all Iranians by the year 2000', the PHC system was adopted as the primary delivery platform for this program.[118] Behvarzes, who were at the frontline 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 them according to the instructions. Fifteen years later, in 2005, 86% of rural health centers were providing mental health services.[119] Although the expansion and implementation of the program 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 a rise in mental health awareness.[120]

However, with continuous industrialization and urbanization, mental health professionals were increasingly concerned about the inadequacy of the mental health program.[121] Most importantly, the PHC system was not established in the urban areas that are home to a large migrant population with diverse psycho-social needs. Therefore, new mental health responses were developed during the past decade. These responses included, school mental health (e.g. 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 hospitals have shifted toward short in-patient care in psychiatric wards of general hospitals, and day care and home care for those with severe mental illnesses. At the time being, these interventions are at different levels of development, coverage, and quality.

Despite all these developments, still one-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.[122] The mental health literacy is still low and the services are inadequate. Insurance systems do not cover most non-pharmacologic services to those with mental disorders. There is a need to increase mental health awareness and access to care, 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 PHC 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-skills 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 suicide ideation and nonfatal suicide are more common in women.[123] The IranMHS in 2011 showed that 7.7% and 1.8% of women aged 15 to 64 had suicidal thoughts and attempts in the prior year, respectively, which was 1.6 and 2.0 times more prevalent than in men. Suicide attempt is much more common in girls (15-19 years) and the rate decreases with an increase in age.[124] Although studies conducted 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.[123] Self-inflicted burn is a public health problem in some parts of Iran, specifically in West and North regions. The annual incidence rate of self-inflicted burn is reported between 2 and 27 per 100,000 populations in different areas, and the mortality rates were higher than 50% in all reports.[125] Those who survive tend to have extensive physical and psychological sequels. Young women account for more than 80% of self-inflicted burns in Iran. Majority of them are in the age range of 20 to 35, with low educational and socio-economic 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.[125]

Youth risks and behavior

Iran's population is mostly consisted of young people. So, the health status of this particular group can highly affect the health of the entire population both in the present and in the future. Additionally, society has experienced rapid social shifts (mostly due to the rapid pace of tertiary education, the increasing roles of females in communities, globalization and the expansion of information, technology, and urbanization) which has made remarkable changes in the lives of the youth living in Iran. This is why these youths' health risks and behaviors needs more specific attention.

In the past four decades, the Iranian society has experienced the world highest and fastest fertility decline. At the late 1940s, the population growth shifted in Iran from the high mortality, high fertility pattern to the high fertility and relatively low mortality, i.e. fitting the classic demographic transition. In 1966, the first Iranian family planning program was launched to encourage families to reduce the number of their children; "fewer children, a better life". After the Islamic revolution in 1979, the family planning program was replaced by pronatalist policy, which emphasized on early marriage with the large number of children.[126] 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 antinatalist 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 level of decline in the total fertility rate became a new and serious challenge that encouraged Iranian politicians to support the pronatalist policy.[127]

In Iran, religious, traditional and cultural educations do not approve non-marital sex (pre/extra marital sex); however, as discussed earlier, Iran, similar to many developing countries, has gone

through social changes that have led to more permissive attitudes towards cross-gender friendship among youths. In the past two decades, concerns have been raised about the possibility of an increase in pre-marital sexual practices among youths; while consistent condom use is uncommon.[128] Although the prevalence of non-marital sex in Iranian youths still 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 marginalized 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 around 100,000 people lived with HIV (PLHIV) in 2014,[129] which around 10% of them contracted HIV in recent year.[130] Sadly, this trend continues, and it is estimated that without a comprehensive controlling program, its burden might upsurge around four times in following years.[131] Although it seems that still unsafe injection is the main route of new infections, with 45.5% of new cases among intravenous drug users (IDUs), and 12.2% among their sexual partners,[132] sexual transmissions particularly among women, has been more prominent in recent years. Although from the beginning of HIV epidemic, around 10% of detected positives were women, in new detected cases in 2015, it increased to 29%.[133]

The results of latest bio-behavioral studies in Iran showed that around 4.5% of female sex-workers (FSWs),[134] they did use condom in only half of their sexual contacts, and around 20% had the history of drug injection.[135] In addition, there are strong links between FSWs and people who

inject drugs (PWIDs); drug use is relatively common among their clients and their permanent sexual partners, also more than 30 % of FSWs are drug user as well. Because of these factors, FSWs are categorized as a core group for HIV transmission in Iran.[136] Although commercial sex work is illegal in Iran, in recent years, FSWs may receive special services such as counseling, voluntary HIV test, STI care and treatment, and condom free of charge in different types of facilities such as drop-in centers (DICs), shelters and harm reduction centers. Around 350 centers are managed by different governmental organizations (medical schools and public health sectors, welfare organization), and NGOs mainly in big cities. However, because of stigma and inaccessibility everywhere in the country, a considerable part of FSWs do not use these services.[137]

In Islam, it is forbidden to drink alcohol; therefore, limited studies have been conducted on alcohol use in Iran and the findings of some of them have not been published. Nevertheless, the 2011 national IranMHS survey, reported that in the prior year 6.3% (11% of males and 1.6% of females) of participants had used alcohol and 2.4% (4.4% of males and 0.4 percent of females) of participants had a history of binge drinking (i.e. at least five standard drinks in a row).[124] One percent of the population met the criteria for diagnosis of alcohol use disorders (1.8% of men and 0.1% of women).[124] Studies in groups of youth have revealed that both indicators are higher in the young male and female population and alcohol use has been much more prevalent than other illicit substances in youth and young adults.[138] However, the extent of alcohol use and its associated harms are much lower than western countries. After recognition of alcohol-related problems, the first national program to control alcohol use and its problems was designed by the Iran's MoHME and the Interior ministry.[139]

Development of health financing and risk protection in Iran

The social health insurance program in Iran began in 1974, with the main objective of providing health insurance coverage to the whole nation. However, the early years of the program was marred with the lack of proper planning and fiscal viability, a problem that has continued to this date.[140] Many years later, in 1995, efforts to provide universal health insurance were revived through the passing of a new legislation. However, the program 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.[141]

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%.[142] However, out-of-pocket expenditure for health services reached its highest value in the last decade in 2010 (59%), albeit showing a decreasing trend afterward and reached to 40% in 2016.[143] 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. While the health budget has increased 7.5 times from 2002 to 2012, the total health expenditure during the same period has showed increments of 9-fold. In this period, there was a 12% growth of public health insurance resources, while the population covered by public insurance increased by 25%.[144] 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 healthcare costs.[145] Until 2014, no special action was taken to reduce out-of-pocket payments; however, that year the Health Transformation Plan -aiming at Universal Health

Coverage- was implemented, details of which are presented in (Panel 9). 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 PHC 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.[144]

According to the Health Services Utilization (HSU) survey conducted in 2015, 97% of the population was covered by basic insurance,[146] while it was 83.5% in the household survey conducted in 2010,[147] indicating a significant improvement resulting from the Health Transformation Plan (Panel 9). 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 healthcare expenditure is spent via hospitals, outpatient service providers, as well as pharmacies and other retailers of medical products (according to the NHA report of 2009). It is also reported that about 52% costs of services provided by hospitals are paid by households, while the contribution of three main public health insurance organizations was estimated to be 21%.[148] However, there is evidence that after implementing the Health Transformation Plan in 2014, the percentage of costs covered by households for services provided by hospitals of Ministry of Health and Medical Education dropped to less than 10%.[142]

Public hospitals mostly include hospitals managed by Ministry of Health and Medical Education (both teaching and nonteaching), 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 organizations, including the 'Iran Health Organization' and the 'Social Security Organization' (after the Health Transformation Plan, Ministry of Health and

Medical Education pays 15%, while the remaining 10% is paid by the public). In Social Security Organization hospitals, the organization pays 90% of all inpatient services' expenses for insured individuals. Private hospitals have their own tariffs, which are dramatically higher than tariffs for public hospitals, albeit both private and public tariffs are tariffs approved by the Supreme Insurance Council. Those who are insured by complementary insurance plans (provided by private insurance organizations) benefit from private inpatient services (all services that are included in the basic package), since they are obliged to pay 10% to 20% of expenses and the rest are paid by the private insurance organizations.[149]

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 PHC, 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 in Iran

The population size in Iran has experienced a nearly 4-fold increase over the past 60 years, while it has paced toward an older age structure and experienced decreases in the annual population growth by half during this period (Figure 9). The transitional trends of the socio-demographic measures over these years in Iran, in addition to several economic and scientific achievements, have resulted in improvements in health indices (Table 2).

Like most other developing countries in the twentieth century, communicable diseases were the major causes of death and disability in Iran at that time. For instance, tuberculosis, pneumonia, malaria and diarrhea were the main causes of death in Tehran. Malaria, intestinal worms, diarrhea, typhoid, anthrax, and whooping cough were prevalent in rural areas, where almost three quarters of the Iranian population lived at the time.[150] 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 programs helped reduce the burden of infectious diseases in the next few decades,[75] and grounded the shift toward NCDs in the country. NCDs 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 youth (Panel 12). Moreover, ischemic 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 compared to high-income countries.[151] Mental and behavioral disorders are the second group of diseases causing the highest disability-adjusted life years (DALYs) rates and the first group of diseases causing years of life with disability (YLDs) in Iran.[152] Furthermore, Illicit drug abuse imposes a large burden

among the youth and opium use is still the most prevalent drug use disorder among adults (Panel 13).[153] Different types of malignancies are also on this list, causing 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. The profile of prevalent malignancies in Iran differ from other nations, probably due to different lifestyles and exposure to associated factors.[154] 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 esophageal cancer, which was among the highest in the 1970s, declined by almost 50%, perhaps as a result of improvements in socioeconomic conditions, smoking and opium use frequency, and increase in intake of fruits and vegetables.[155]

The modifiable risk factors for all groups of NCDs are mostly dyslipidemia, high blood pressure, tobacco smoking, as well as overweightness and obesity, and their drivers are, poor diet and physical inactivity.[156] Serum total cholesterol has remained fairly stable in the past 3 decades at about 5.0 mmol/L,[157] and systolic blood pressure has declined by 3 mmHg in women and 5 mmHg in men.[158] Data from the last round of the National NCD Survey conducted in 2011 shows that 20% of men and women are hypertensive. During the last four decades, the prevalence of adult obesity has increased from 13% to 30% in women and from 4% to 17% in men,[159] and this may be a major driver of the doubling of diabetes prevalence since 1980 from around 5% to 10%.[160] The substantial increase in the prevalence of overweightness and obesity and its high prevalence (15%) among adolescents [161] may soon lead to larger increases in diabetes and dyslipidemia and a reversal in the declining trends of blood pressure.[162] Results of a cohort study in Tehran indicated a high incidence of pre-diabetes and pre-hypertension among its population,

which may lead to subsequent increases in the incidence of diabetes and hypertension in the next decade.[163, 164] The prevalence of tobacco smoking, which is much more common among men than in women, has slightly declined in the past decade, possibly due to the enactment of smoking ban laws and introduction of taxes.[165] Nevertheless, the prevalence of smoking remains relatively high among men, at 24% (as opposed to 2% in women).[165] The other uses of tobacco, including hookah, is a concern among adolescents, youth and women. Another specific risk factor of major impact in urban areas is the urban air pollution. For instance, in Tehran, the concentration of particulate matter pollutants is deemed unhealthy during 100 to 200 days a year.

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 cancer, ischemic heart disease, stroke, rheumatic heart disease and injuries, which declined substantially between 2000 and 2015.

Call to action

Iran is a country with a history of more than 3,000 years of civilization. During this long history, many great scientists have emerged in the country with invaluable contributions to the advancement of science and medicine. The great number of scientists, physicians, and scholars of Iranian origin throughout history and their contributions to science and medicine can be attributed to the huge emphasis Iranians have always placed on learning and acquisition of knowledge. Since the establishment of the Iranian constitution in 1910, provision of PHC 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 significant achievements in terms of provision of health services with particular success in controlling infectious diseases and decreasing child and adult mortality.[166] 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 with the sanctions ultimately lifted in 2016 (even though the US' sanctions came back in 2018). Although great advancements have been achieved in Iran in different fields of healthcare provision during the past 30 years, significant challenges still remain to be addressed. NCDs remain rampant in Iran (similar to many countries in the region) and their prevalence is predicted to dramatically increase due to the aging population, urbanization, and sedentary lifestyle. In this regard, a national

collaborative initiative has been recently launched under the auspices of the Ministry of Health and Medical Education, involving several ministries as well as the parliament to combat NCDs from different social, health, and cultural fronts. This initiative will distribute the responsibility of confronting NCDs among different sectors of the government. Accordingly, with the main objective of confronting risk factors as well as exposures of NCDs and their health consequences, the government has rectified the 'National Action Plan to Prevent and Control NCDs', which includes several national programs and reforms for implementation across the country.[167] Some of these are, introducing tax on cigarette and other tobacco products, as well as calorie-dense food and sugar-sweetened beverages, adopting measures to promote physical activity amongst the population, fortification of processed food with fiber, and change in regulations of food industries to reduce free fatty acid, sugar, and salt in processed foods.

In this paper, we discussed how the PHC 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 exploited to combat NCDs which are the new threat confronting the nation.[116] Iran's PHC 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 NCDs. Moreover, implementation of the family physician program 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 harmonized and synergic manner in order to utilize human resources and funding more efficiently. Financial risk protection measures remain a growing health system concern, due to highly prevalent NCDs, population

aging, 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 healthcare 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. As we discussed in this paper, quality of care, medical errors, and induced demand are weaknesses of healthcare provision in Iran's health system, which need urgent responses to enable the health system to combat NCDs effectively. Using quality indicators, installing a health information system to report medical errors and patient experiences in receiving healthcare (e.g. 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 healthcare quality.

In terms of medical education and research (if the sanctions remained lifted), Iran has detailed plans in place to design and carry out national and international collaborative research projects to improve the quality of education, minimize redundancy, and promote the quality of research carried out 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 NCDs is possible if we 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 NCDs.[168] Furthermore, air pollution originating from fossil fuel or dust storms have tremendous direct effects on chronic obstructive

pulmonary disease (COPD), cardiovascular diseases, cancer, and vitamin D deficiency.[169, 170] A syndetic approach must be adopted, which includes, inter-sectoral collaborations involving communities, improving awareness among individuals, and enhancing healthcare provision on early detection and effective treatment.

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1 Tables

2 Table 1: Health Reforms after Islamic Revolution in Iran

Name of President &Terms in the Office	Government	Political Party	Main characteristics of the government	Four Years National Development Plan (FYNDP)	Main health policies	Major health reforms
Ali Khamenei (1981-1989): 3rd President, President was ceremonial, while Prime Minister (PM) was chief of the cabinet with executive role	Third & Fourth governments after Islamic revolution of 1979 (The 1st government was transitional, had no president, and stayed in the office only few months, the 2nd was impeached shortly and the 3rd was only few months in the office. Hence, no major reform took place until 3rd president.	Islamic Republican Party (Conservative)	- This government was in power during the 8 years forced war with Iraq; -The economy was inevitably government- driven, with emphasis on social justice, economic and political independency; -Explicit measures against privatization and removing subsides	None	-Preventive policies and focus on primary healthcare (PHC) [coverage of basic health services and universal access nationwide]; -Comprehensive nutrition policy; --Initial steps towards Health Promotion and eradication of some infectious diseases; -Increasing public funds and citizens' contribution to medical insurance	-Establishment of PHC network (1983) - Establishment of Ministry of Health & Medical Education (MOHME) in 1986: Establishment of the MOHME (1986) -Transforming Ministry of health services and medical education towards formation of the Universities of Medical Sciences and Health Services (UMSHSs) (1986).
Akbar Hashemi - Rafsanjani (1989-1997): 4th President, The constitution was revised: PM removed and President became executive	Fifth & Sixth governments	Combatant Clergy Association (Conservative)	-War over; -Economic reconstruction; --expanding international relations	1st FYNDP (1989-95) 2nd FYNDP (1995-2000)	- Extensive expansion of PHC, particularly in rural areas; - Improving main health indicators, i.e. reducing maternal and child mortality; - National plan to enhance universal	-High Council for Cultural Reform adopted the Act of Establishment of boards of trustees for medical universities (1988); -Establishment of boards of trustees for universities and

					access to family planning initiatives and declining fertility rate; - Expansion of public health insurance	higher education institutes legalized by an Act adopted by High Council of Cultural Reform (1988). - Establishment of the medical Services insurance organization (MSIO) (1994); -Establishment of the Supreme Council of Health Insurance (1995); - Informal implementation of hospital autonomy Act (1995).
Mohammad Khatami (1997-2005): 5th president	Seventh & Eight governments	Association of Combatant Clerics (Reformist)	Political and cultural development, i.e. enhancement of citizens' rights	3th FYNDP (2000-2005)	- Enhancing health promotion & prevention policies for communicable and non-communicable disease (NCDs); - Structural reforms, i.e. Private-Public Partnership (PPP) to build hospitals and health centres; - Fee for services (FFS) payment to service providers; -Fostering multisectoral policy making for health;	-Enactment of Comprehensive Organizational Structure of the Social Security System (COSSS) (2004). -Implementation of operational budgeting in hospitals (2004); - liberalization of public university owned hospitals, (granting autonomy to 18 hospitals); - Establishment of Ministry of Welfare

					-Levelling healthcare services and determining medical tariffs based on cost; - Introduction to Health Technology Assessment (HTA).	and Social Security (MWSS) (2004); -Establishment of Supreme Council for Health and Food Security (SCHFS) (2004); -Delegation of private sector's tariffs to Iranian Medical Association (2004); -Universal implementation of Family physician and rural health insurance program (2005).
Mahmoud Ahmadinejad (2005-2013): 6th President	Ninth & Tenth governments	Alliance of Promoters of Iran (Fundamentalist)	Emphasis on spirituality, social justice, and Islamic State; special attention to the poor and equity-driven economy	4th FYNDP (2005-2010) 5th FYNDP (2010-2015)	-Continuous promotion of health indicators (air, food security, environment, etc.,); - Free treatment for traffic-injured; - Establishment of targeted subsidies towards real tariffs for essential goods; -Expansion of family physician and referral system.	-Establishment of Food and Drug Organization (FDO) under MOHME; -Establishment of Ministry of Cooperatives, Labour and Social Welfare (MCLSW), formerly MWSS; -Social Security Organization (SSO) moves under MCLSW (2011); - Expansion of family physician program to cities (two pilot provinces since 2011); -Determination of medical tariffs by

						High Council of Health Insurance (2012).
Hassan Rouhani (2013-present): Incumbent 7th President	Eleventh &, Twelfth governments	Moderation and Development Party (Moderate)	-Attention to economic development; -Improving international relations; -Improving citizens' rigth and social policies.	5th FYNDP (2010-2015) 6th FYNDP (2016-Present)	-Moving towards universal health coverage (UHC); -Prioritizing NCDs; - Reforming medical education; -Expansion of health facilities for deprived and marginalized areas; -Health diplomacy; -Social participation for health; -Universal electronic health record system.	-Health Transformation Plan (2014); - National Action Plan for Prevention and Control of NCDs (2015); - Establishment of Social Deputy with MOHME (2016); - Establishment of National Health Assembly (NHA) of Iran; - Extensive expansion of PHC and hospital capacity; -Revising medical tariffs and payment to providers, leading to more than two folds increase in total health expenditure.

1

1 Table 2: Status of Selected Health Measures in Iran between 1990 and 2016, and propagation to 2030

Measure	Year		
	1990	2016	2030
Death rate due to exposure to forces of nature (per 100,000 population)	13.41 (3.2 - 23.54)	0.08 (0.04 - 0.13)	1.91 (0.56 - 3.18)
Prevalence of stunting in children under 5 (%)	26.09 (21.72 - 30.26)	7.86 (5.8 - 10.36)	4.28 (2.93 - 6.48)
Prevalence of wasting in children under 5 (%)	10.57 (8.9 - 12.41)	4.83 (3.63 - 6.42)	4.63 (2.55 - 7.88)
Prevalence of overweight in children aged 2-4 (%)	6.52 (2.94 - 12.28)	19.52 (10.48 - 31.92)	24.66 (7.62 - 48.33)
Maternal mortality ratio (maternal deaths per 100,000 livebirths) in women aged 10-54 years	39.86 (26.51 - 58.35)	13.79 (9.61 - 18.91)	7.73 (2.81 - 17.16)
Proportion of births attended by skilled health personnel (%)	88.83 (81.83 - 93.48)	98.2 (97.03 - 99.02)	99.09 (97.5 - 99.83)
Under-5 mortality rate (probability of dying before the age of 5 per 1,000 livebirths)	67.38 (57.66 - 78.97)	17.8 (12.59 - 24.53)	9.32 (3.44 - 19.93)
Neonatal mortality rate (probability of dying during the first 28 days of life per 1,000 livebirths)	30.97 (26.39 - 36.2)	10.89 (7.71 - 14.98)	6.3 (2.34 - 13.53)
Age-standardized rate of new HIV infections (per 1,000 population)	0 (0 - 0.01)	0.02 (0.01 - 0.03)	0.02 (0.01 - 0.03)
Age-standardized rate of tuberculosis cases (per 100,000 population)	24.96 (22.45 - 27.71)	19.96 (18.02 - 22.24)	14.3 (12.57 - 16.12)
Age-standardized rate of malaria cases (per 1,000 population)	13.08 (0 - 101.99)	0.01 (0.01 - 0.01)	0 (0 - 0)
Age-standardized rate of hepatitis B incidence (per 100,000 population)	2000.9 (1589.8 - 2483.86)	737.04 (577.49 - 907.89)	428.65 (327.74 - 540.92)
Age-standardized prevalence of the sum of 15 neglected tropical diseases (NTDs) (%)	2.98 (2.71 - 3.29)	2.78 (2.38 - 3.25)	2.75 (2.34 - 3.24)
Age-standardized death rate due to cardiovascular disease, cancer, diabetes, and chronic respiratory disease in populations aged 30-70 (per 100,000 population)	436.17 (367.1 - 514.83)	346.12 (285.81 - 410.68)	265.29 (157.37 - 428.22)

Age-standardized death rate due to self-harm (per 100,000 population)	6.49 (5.07 - 8.11)	5.94 (4.83 - 7.39)	5.58 (3.11 - 9.25)
Risk-weighted prevalence of alcohol consumption, as measured by the summary exposure value (SEV) for alcohol use (%)	0 (0 - 0.01)	0 (0 - 0.02)	0 (0 - 0.02)
Age-standardized death rate due to road injuries (per 100,000 population)	59.87 (50.33 - 71.35)	34.82 (28.97 - 42.3)	17.95 (9.98 - 30.82)
Proportion of women of reproductive age (15-49 years) who have their need for family planning satisfied with modern methods (%)	55.04 (47.07 - 62.44)	80.07 (74.36 - 84.95)	86.27 (76.91 - 92.59)
Number of livebirths per 1,000 women aged 10-14 years and women aged 15-19 years	44.06 (37.39 - 51.16)	14.37 (6.17 - 28.83)	7.69 (1.17 - 25.41)
Coverage of essential health services, as defined by the UHC index comprised of the coverage of 9 tracer interventions and risk-standardized death rates from 32 causes amenable to personal healthcare (scale of 0 to 100)	55.01 (51.89 - 57.86)	67.5 (64.02 - 70.74)	72.8 (69.09 - 76.2)
Age-standardized death rate attributable to household air pollution and ambient air pollution (per 100,000 population)	88.78 (76.74 - 102.96)	62.58 (51.23 - 73.82)	48.85 (39.89 - 58.45)
Age-standardized death rate attributable to unsafe water, sanitation, and hygiene (WaSH) (per 100,000 population)	16.97 (9.83 - 25.72)	1.83 (1.01 - 3.03)	0.88 (0.4 - 1.63)
Age-standardized death rate due to unintentional poisonings (per 100,000 population)	6.18 (3.59 - 9.93)	1.54 (1.18 - 2.41)	0.65 (0.31 - 1.54)
Age-standardized prevalence of daily smoking in populations aged 10 and older (%)	12.08 (10.61 - 13.96)	10.96 (9.85 - 12.25)	10.74 (8.32 - 13.56)
Geometric mean of the coverage of eight vaccines, conditional on inclusion in national vaccine schedules, in target populations (%)	90.09 (87.64 - 92.03)	99.87 (99.8 - 99.91)	99.97 (99.94 - 99.99)
Age-standardized prevalence of women aged 15 years and older who experienced physical or sexual violence by an intimate partner in the last 12 months (%)	44.8 (39.87 - 49.74)	36.9 (32.72 - 41.21)	33.96 (29.52 - 38.81)
Risk-weighted prevalence of populations using unsafe or unimproved water sources, as measured by the summary exposure value (SEV) for unsafe water (%)	22.51 (17.4 - 26.06)	9.25 (6.76 - 11.87)	7.68 (5.6 - 10.26)
Risk-weighted prevalence of populations using unsafe or unimproved sanitation, as measured by the summary exposure value (SEV) for unsafe sanitation (%)	40.84 (31.93 - 49.87)	8.08 (4.02 - 15.94)	5.09 (2.12 - 11.23)
Risk-weighted prevalence of populations without access to a handwashing facility, as measured by the summary exposure value (SEV) for unsafe hygiene (%)	15.63 (14.72 - 16.51)	13.07 (12.37 - 13.88)	12.23 (11.61 - 13.01)

Risk-weighted prevalence of household air pollution, as measured by the summary exposure value (SEV) for household air pollution (%)	3.12 (1.63 - 5.4)	0.22 (0.12 - 0.39)	0.07 (0.04 - 0.14)
Age-standardized all-cause disability-adjusted life year (DALY) rates attributable to occupational risks (per 100,000 population)	900.85 (746.81 - 1064.4)	692.69 (588.56 - 802.61)	597.65 (500.8 - 702.52)
Population-weighted mean levels of fine particulate matter smaller than 2.5 microns in diameter (PM2.5)	49.41 (48.89 - 49.97)	48.96 (48.47 - 49.42)	43.15 (41.58 - 46.31)
Age-standardized death rate due to interpersonal violence (per 100,000 population)	2.57 (1.61 - 3.49)	2.01 (1.35 - 2.61)	1.19 (0.58 - 2.13)
Death rate due to conflict and terrorism (per 100,000 population)	0 (0 - 0)	0.14 (0.03 - 0.24)	0.14 (0.01 - 1.07)
Age-standardized prevalence of physical or sexual violence experienced by populations in the last 12 months (%)	12.68 (11.18 - 14.35)	8.86 (7.77 - 10.04)	8.12 (7.14 - 9.21)
Age-standardized prevalence of women and men aged 18-29 years who experienced sexual violence by age 18 (%)	7.22 (5.52 - 9.23)	7.29 (5.51 - 9.38)	7.36 (5.49 - 9.57)
Percentage of well-certified deaths by a vital registration (VR) system among a country's total population (%)	15.78 (7.1 - 28.98)	64.216 (51.375 - 76.261)	76.37 (50 - 91.8)

1 Extracted from Measuring progress and projecting attainment on the basis of past trends of the health-related Sustainable Development Goals in 188 countries:
2 an analysis from the Global Burden of Disease Study 2016. Fullman, Nancy et al. The Lancet , Volume 390 , Issue 10100 , 1423 - 1459

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